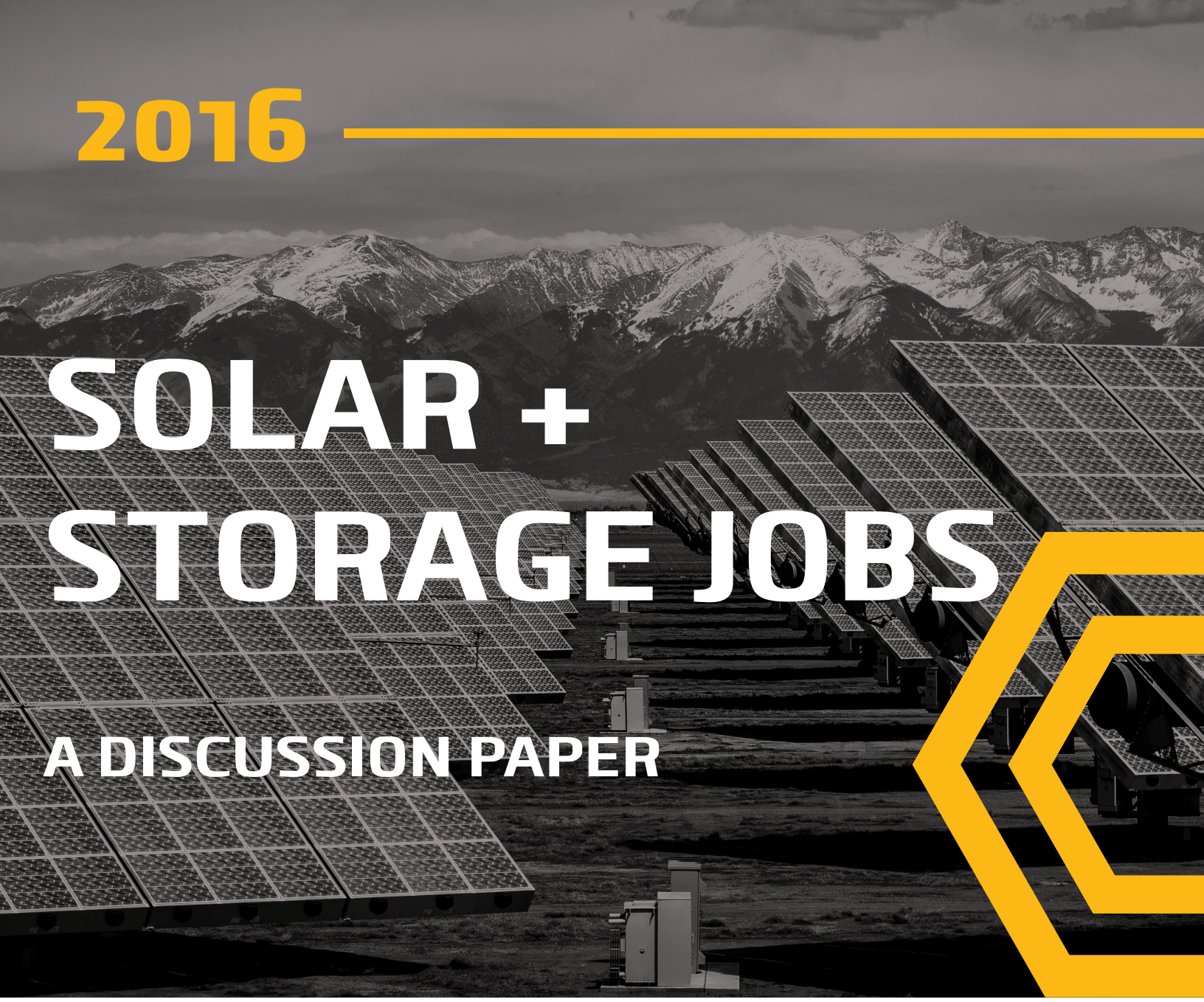
2016

SOLAR + STORAGE JOBS

A DISCUSSION PAPER



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ABOUT THE SOLAR FOUNDATION®

The Solar Foundation® is an independent 501(c)(3) nonprofit organization whose mission is to increase understanding of solar energy through strategic research and education that transforms markets. It has set itself apart as the premier research organization on the solar workforce, employment trends, and the economic impacts of the solar industry. The common thread throughout The Solar Foundation's work is a deep interest in increasing access to solar for everyone and the bedrock of that work is its *National Solar Jobs Census*, which has proven time and again that demand-side solar policies are working - the solar industry is creating good paying jobs faster than other sectors of the economy.

In addition to its highly acclaimed *Solar Jobs Census* work, The Solar Foundation is the prime awardee on four, multiyear U.S. Department of Energy grants – totaling $15 million. Through this work, The Solar Foundation:

- Leads a team of experts via SolSmart to build capacity among cities nationwide in order to make solar more accessible and affordable for all Americans;
- Leads a team of experts via CivicPACE to provide PACE financing for nonprofits and other tax-exempt entities including homeless shelters and multifamily affordable housing;
- Serves as the National Administrator for the Solar Ready Vets program – which trains transitioning military personnel for solar careers, and;
- Serves as the National Administrator for the Solar Training Network – which connects solar trainers, employers and jobseekers in order to better meet growing workforce demands.

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Introduction

As energy storage systems are added to the electricity grid at an accelerating pace, it is imperative that decision makers have a general understanding of the economic impacts. To this end, The Solar Foundation (TSF) produced this discussion paper on the current labor efficiencies experienced by the U.S. solar industry and how such measures may provide insight about solar related employment in the energy storage industry. While we consider the storage results to be preliminary, this discussion paper was developed using data collected through The Solar Foundation's *National Solar Jobs Census 2015*, as well as information collected through interviews of solar and energy storage experts from across the country.

Solar Installation Productivity

According to the *National Solar Jobs Census 2015*, there were nearly 209,000 people employed in the U.S. solar industry in 2015, representing the third consecutive year of roughly 20% job growth. This growth mirrored that of installed solar capacity; 7,451 MWs were installed in 2015, a 19% increase over that estimated for 2014.[1] The installation sector employs 119,931 people, or about 57% of the total solar workforce. As counted in *Census 2015*, this figure primarily consists of residential and non-residential installers and installation support staff.

Labor efficiency in the solar industry, as measured by the number of jobs/MW installed has increased over the past five years, with the number of jobs needed per MW installed dropping rapidly from 75 in 2010, to 46 in 2011, and declining unevenly to 37 in 2015. This decline is expected to continue as improvements in equipment, technology, and experience among installers lead to more streamlined installation techniques. Nonetheless, the rate of this decline is decreasing as many of the simplest to achieve efficiencies, such as integrated racking systems, have already been realized.

Table 1: Installation Sector (Residental & Non-Residential) Jobs/MW Calculation

Year	Jobs*	MW Installed**	Jobs/MW
2010	43,934	585	75.10
2011	52,503	1,140	46.06
2012	57,177	1,569	36.44
2013	69,658	1,906	36.55
2014	97,031	2,325	41.73
2015	119,931	3,228	37.15
2016 (projected)	139,813	4,044	34.57

*The Census survey defines solar employees as any worker who spends at least 50% of their time on solar-related work. For the installation sector it would not only include installation work crews but supporting staff such as those needed to obtain permits, order parts, and manage human resources.
**SEIA/GTM Solar Market Insight Report Series, 2010 – Q1 2016

Most of the *Census 2015* utility-scale installation jobs were counted in the project development sector. In 2015, this sector consisted of 22,452 jobs, growing nearly 50% since 2014. Project development firms hired about 50 employees per firm in 2015, more than eight times the rate of such hiring in 2014. Utility-scale capacity deployment experienced improved efficiency until 2015, with the number of jobs/MW declining from 4.43 in 2012 to 3.85 in 2014, before rising again to 5.32 in 2015. This increase is attributable to the buildup in employment given that 2016 was presumed to be the final year of the 30% federal investment tax credit.[2] Utility-scale projects require more lead time to develop and complete than residential rooftop. Thus, the ramp up in employment to support projects that would come online in 2016 likely began in 2015 and was factored into *Census 2015* employer responses.

Table 2: Project Development Sector (Utility-Scale) Jobs/MW Calculation

Year	Jobs	MW Installed*	Jobs/MW
2012	7,988	1,803	4.43
2013	12,169	2,855	4.26
2014	15,112	3,922	3.85
2015	22,452	4,223	5.32
2016 (projected)	26,074	10,498	2.48

*SEIA/GTM Solar Market Insight report series, 2010 – Q1 2016

Given the subjectivity of the above analysis, The Solar Foundation also examined the jobs/MW question from a slightly different perspective. The breakdowns above assume that firms that self-identified as installation firms only install for residential and non-residential projects and that those that identified as project developer firms only worked on utility-scale projects. As part of *Census 2015*, firms in the two sectors collectively reported the following breakdown of their workforces by project sector:

Table 3: Revised Jobs/MW Calculation

	Percent of Jobs	Jobs	MWs Installed	Jobs/MW
Residential	63.3%	90,128	2,159	41.75
Non-Residential	15.2%	21,642	1,069	20.25
Utility-Scale	21.5%	30,612	4,223	7.25
Total	100.0%	142,382	7,451	

This breakdown provides a cleaner approach to matching jobs to MWs by market segment, but this data is only available for 2015. Based on these figures, the average jobs/MW for each market segment in 2015 were 41.75 for residential, 20.25 for non-residential, and 7.25 for utility-scale. If we assume that the utility-scale projects hired in anticipation of the coming year's projected capacity additions, then average labor efficiency is best calculated using 2015 jobs and projected 2016 installed capacity. With such an adjustment, there were 2.92 utility-scale jobs/MW.

Utility-scale work is more labor efficient because these projects benefit from economies of scale. While the permitting and approval process is longer than for a residential project, it is relatively short given the project size or on a time per MW basis. The utility-scale workforce is also more specialized, and since the arrays are typically ground mounted, in one location, and fairly uniform, the installation process itself is generally easier than a portfolio of residential rooftop projects of comparable capacity. While not as efficient, rooftop residential projects create significantly more jobs (but lower paying ones), and thus, from a tax-base and purchasing power standpoint, can provide a stronger stimulus to the local economy.

The dichotomy between utility-scale, commercial and residential MW labor productivity has numerous economic and policy implications. While job creation is desired, it is also desirable for firms to develop efficiently at the lowest cost. And while utility-scale solar development is more efficient than residential rooftop solar, there are merits for distributive generation as well. Such issues take on added complexity when storage is considered.

The previous discussion on solar productivity forms the basis for a comparison with energy storage productivity and subsequently, solar + storage jobs. In the next section we introduce the solar + storage market followed by an analysis of solar + storage jobs.

Photo courtesy of Solar City

Solar + Storage Benefits

While energy storage is experiencing significant growth, most of it has not been in support of solar installation. Storage growth is needed to meet demand for everything from mobile devices to electric vehicles to the electricity market. In the electricity market, storage is primarily used by utilities and independent system operators (ISOs) to improve the speed and accuracy of the wholesale market. As such, storage serves to improve grid efficiency for all energy sources, whether renewables or fossil fuels.[3]

As it relates to solar power, storage benefits vary depending on markets and policies. Solar supported by storage can help the grid and wholesale markets as noted above. Specifically, storage can help regulate changes in grid frequency and voltage caused by load variation. Similarly, storage can support the grid through black start capability, providing a quick injection of energy in case of system failure, such as that caused by inclement weather. In contrast, many large fossil fuel plants are unable to start quickly after a system-wide shut down. Storage can also support utilities and ISOs in transmission congestion relief. Finally, storage can provide peak load power that can help to defer capital investment for increased generation, transmission, or distribution capacity.

To provide some or all of the energy services above, the storage owner contracts with a utility, ISO, or third party, providing them access to the owner's storage system. Front of the meter, utility-scale storage has typically deployed solar to meet the above needs.

Storage has other benefits, some of which specifically apply to solar. Storage can smooth the impact of cloud caused variation in solar irradiation, allowing a solar farm to provide a greater, more consistent supply of energy. Storage batteries can also be charged by solar energy during the daytime for use at night. Similarly, storage systems can store solar or grid-provided energy when electricity rates are low and use it or sell it back to the grid when rates are high.

Photo courtesy of NREL

Solar + Storage Residential/ Non-Residential Benefits

While utility-scale storage has been the largest electricity-related market, there is growing interest in deploying storage to support behind the meter renewables such as solar. Like utility-scale, behind the meter residential and non-residential storage can provide backup power and a source of evening power. Notably, the latter benefit materializes where net metering is unavailable or uneconomical, or when demand charges or time-of-use rates encourage energy price arbitrage. Therefore, non-residential customers are finding greater use for storage than residential customers, as they are more frequently subjected to these variable rate structures. Residential demand for storage will grow as customers encounter more of these variable rates. Thus, the benefits of storage are highly contingent on policies and regulations.

Behind the meter storage can also support the grid. There is rapidly growing interest in aggregating smaller commercial and residential customers to provide energy services to the wholesale market. Firms can aggregate multiple solar + storage systems through software to provide energy services to the wholesale market in similar fashion to that of ISOs and utilities.

For example, New York's Consolidated Edison (Con Edison) is starting a pilot project to aggregate 300 solar-plus-storage customers to serve the wholesale market in return for lower electric bills. To set up this "Virtual Power Plant," Con Edison has contracted with SunPower (panels) and Sunverge (batteries) to install the systems. The customers will lease the systems, but Con Edison will maintain operation of the systems to support the grid by providing over 1.8 MWs of storage capacity.[4] The customers, in turn, will also benefit by having a source of backup electricity if the power goes out.

Storage systems need not be limited to providing just one of the above benefits; they can serve multiple uses at different times, increasing return on investment. For example, a solar + storage system can reduce demand charges and shift billing to lower time-of-use rates for the customer. When storage is not supporting these customer needs, it can, in conjunction with other customer storage units, provide frequency regulation and ancillary services to the grid. The further down the electric grid supply chain, the more valuable these services can be.[5] So behind the meter residential and commercial customers have the greatest opportunity to capture and monetize this multitude of uses.

Photo courtesy of NREL

Solar + Storage Market Opportunity

In 2015, the energy storage market deployed 221 MWs of storage, 243% more than the 65 MWs deployed in 2014. Of the 221 MWs, 187 MWs were estimated to be in front of the meter (utility-scale), with the remaining 35 MWs behind the meter.[6] The U.S. market is expected to deploy 2,081 MWs by 2021, nine times larger than the 2015 market. The greatest growth is expected to occur in the behind the meter (residential & non-residential) segment, growing from 15% to 49% of deployed MWs in 2021 with residential demand experiencing the fastest growth.[7]

Table 4: Storage Deployment Trends 2015 - 2021 (MWs)*

	2015	2021
Front of the Meter	187	1,061
Behind the Meter	35	1,020
Total	221	2,081

*GTM Research/ESA, U.S. Energy Storage Monitor, Q2 Review

Key drivers of market growth include many of the same factors that have driven PV growth: declining costs, comparably high electricity rates, policies, and incentives. Battery prices have declined 80% over the last six years[8] and total costs are projected to decline more than 40% over the next five years.[9] As storage costs decline, the value of the solar + storage package increases. The package cost is higher than just solar but of greater value – so storage will likely increase PV installation and related employment. Furthermore, storage makes larger systems more economical. Many residential customers installed smaller, 2-3 KW systems so as to not exceed the total annual load for their net metering credit. With storage, it becomes economical to enlarge their system, which, at scale, would result in more jobs.

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The fastest growing storage market segment – residential – will likely be driven by solar deployment if states restrict net metering, increase residential time-of-use rates (or demand charges), or encourage virtual power plants as is being done in New York. While net metering is being challenged in many states, the proposed legislation is not passing in most instances.[10] Conversely, it is likely that more states will be subject to time-of-use rates; California has already enacted them for residential customers. The virtual power plants have both policy and economic appeal and, thus, will likely experience significant growth. Distributed generation can be aggregated to optimize both customer and utility needs, providing a return on investment for all parties. With solar coupled with storage, utilities are starting to view distributed generation (DG) as a business opportunity.

Solar + Storage Jobs Analysis Overview

What will all of this mean for solar + storage jobs? The Solar Foundation looked at two major sources of jobs: 1) storage deployment or installation jobs and 2) storage induced PV installation jobs. The latter would result from the additional solar to be installed because of the added value of storage. In both cases, the jobs include associated installation support jobs, but exclude related manufacturing, sales, and distribution jobs.

Assuming expected strong growth in time-of-use rates and virtual power plants, solar + storage might represent nearly 40% of energy storage MWs deployed in 2021. And like solar PV, employment will be more efficient for utility-scale developers than for smaller residential ones, resulting in a much greater amount of residential employment. As such, the scenario below might follow for 2021:

Table 5: Solar + Storage Related Deployment Jobs, 2021 (projected)

Sector	Storage Installation Jobs	Storage Induced PV Jobs	Total Jobs
Utility-Scale	122	245	367
Non-Residential	600	1,200	1,800
Residential	8,305	16,609	24,914
Total	9,027	18,054	27,081

Photo courtesy of Sun Tech CA.

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Analysis, Assumptions & Methodology

About a third, or 9,000, of the projected 27,000 jobs are from storage installation/deployment. The calculation of storage jobs assumes that just under 40% of projected installed storage MWs are tied to solar with utility-scale representing the fewest (10%) and residential the most (90%) as shown in Table 6.

The projected storage jobs/MW are based on The Solar Foundation's solar jobs/MW calculation as shown in Table 7. We assumed that storage deployment can be completed on average in 25% of the time that it takes to install solar given the same size work crew. Since labor efficiency will vary greatly based on many factors, the 25% figure is a composite figure. For example, storage labor is more efficient if the system is deployed when the solar panels are originally installed.[11]

We used a factor to convert solar jobs/MW into storage jobs/MW as shown in Table 8. The needed storage capacity in MWs does not necessarily match the capacity of the associated PV system or systems. Therefore, storage MWs must be converted into solar MWs to get a comparable ratio of jobs/MW. Storage jobs are primarily based on the number of customers rather than MWs. So while 1 MW of PV might equate to 167 installations at an average of 6 kW per installation, a MW of storage might equate to over 300 installations averaging 3.3 kW per customer. For residential storage, we assumed such a scenario: that smaller sized kilowatt storage units are paired with larger sized kilowatt PV systems. This adjustment results in a greater number of jobs/MW for storage as shown in Table 8. However, these calculations are very subjective requiring further research. Dozens of factors, including the selected set of benefits discussed previously, help to determine the optimum size storage system. Several examples, used in our calculations for the three solar sectors, are shown in the Table 8.

Photo courtesy of O2 EMC

Table 6: Storage Installation Jobs, 2021 (projected)					
Sector	Storage MWs Deployed*	Solar + Storage Deployed**		Storage Jobs/ MW	Storage Jobs
		Percent	MWs		
Utility-Scale	1,061	10%	106	1.15	122
Non-Residential	440	40%	176	3.41	600
Residential	580	90%	522	15.91	8,305
Total	2,081	39%	804		9,027

*Total and utility-scale projections: U.S. Energy Storage Monitor: Q2 Review, GTM Research/ESA
**The percent and MWs of total deployed storage that is collocated with and tied to a solar array.

Table 7: Storage Installation Jobs/MW, 2021 (projected)					
Sector	Solar Jobs/ MW	Additional Labor to Install Storage		Factor to Convert Storage Jobs/MW	Storage Jobs/ MW*
		Percent	Jobs/MW		
Utility-Scale	2.5	25%	0.63	1.85	1.15
Non-Residential	15	25%	3.75	0.91	3.41
Residential	35	25%	8.75	1.82	15.91

*Per MW of storage. Additional solar jobs/MW times conversion factor

Table 8: Factor to Convert Solar Jobs/MW to Storage Jobs/MW			
Sector	Typical or Sample Solar Installation	Typical or Sample Storage Installation	Factor to Convert Storage to Jobs/MW
Utility-Scale*	24 MW	13 MW	1.85
Non-Residential**	50 MW	55 MW	0.91
Residential***	6 MW	3.3 MW	1.82

* Kaua'i, Hawaii 24 MW solar farm being supported by a 13 MW (52 MWH) storage system.
**Hypothetical 27,625 sq. ft. Los Angeles store, *Economic Analysis Case Studies of Battery Energy Storage with SAM, NREL*, Nov., 2015
***Based on a 3.3 KW Tesla Powerwall matched with an average 6 KW rooftop solar installation

The storage employment includes installation and associated support jobs. Storage deployment typically includes a battery, inverter, software controls, wiring, and onsite programming. Skills and wages for storage deployment are expected to mirror the median wage for PV installation ($21 per hour in 2015). Efficiency could improve quickly as firms gain practice with modular, plug-and-play equipment. Nonetheless, with the growing complexity of storage uses, demand for higher skilled programming work will likely increase. Non-residential and utility-scale storage deployment skills, like those for PV installation, will be greater and more specialized than residential. Onsite programming could be considerable, driving up required skills and wages.

For the second projection, we assumed that 50% of the storage installations will stimulate solar installation that, if not for the availability of storage, wouldn't occur. Given the natural fit between solar and storage, we consider 50% a conservative estimate, as shown in Table 9. This estimate generates another 18,000 jobs for a total of 27,000 jobs after adding in the 9,000 storage jobs.

Table 9: Storage Induced PV Jobs, 2021 (projected)

Sector	Storage MWs Deployed*	Equivalent Amount of Solar Installation		Storage Induced PV		Solar Jobs/MW	Additional Solar Jobs
		Factor	MWs	Market Share	MWs		
Utility-Scale	106	1.85	196	50%	98	2.5	245
Non-Residential	176	0.91	160	50%	80	15	1,200
Residential	522	1.82	949	50%	475	35	16,609
Total	804						18,054

*Storage that is collocated with and tied to a solar array.

Conclusion

Like the experience of solar PV, storage deployment labor efficiency has been improving, helping to drive down costs and stimulate demand for the technology. Fortunately, it is expected that storage will continue to experience greater declines in both soft and hard costs. Yet solar + storage, from a business model and policy perspective, is where solar PV was approximately ten years ago. There are a number of ways for storage to add value, yet business practices and policies are not well enough established to capitalize on these opportunities. However, as the practices and policies improve, storage and related jobs are anticipated to experience significant growth.

While this discussion paper attempts to project labor market impacts and efficiencies of storage with PV systems, many assumptions were necessary. Thus, additional research focused on the following questions will be required in order for any future analysis to be more rigorous.

1. What is the labor required to install storage? What size crew is needed to install storage for what length of time under various scenarios? How is this changing?

2. What is the likely solar + storage share of the overall electric grid storage market and how will it change? How will it vary for the utility-scale, non-residential, and residential segments?

3. What is the right mix of storage and solar capacity? How does it vary for the three sectors under various scenarios?

4. How can we make the solar + storage market more attractive? What policies and business practices need to change to grow this promising market?

5. Similarly, what proportion of solar + storage customers install solar because of the benefits of storage? That is, they would not install solar if not for the chance to acquire the entire solar + storage package and related benefits.

6. What can the U.S. learn from other countries?

Photo courtesy of Direct Energy Solar

Endnotes

[1]SEIA/GTM Solar Market Insight Report, 2015

[2]The investment tax credit was extended in December 2015 at the full 30% through 2019, declining to 26% in 2020 and 22% in 2021, and for commercial, 10% thereafter.

[3]An October 2015 report, *The Economics of Battery Energy Storage*, by the Rocky Mountain Institute identified 13 uses for storage for the electric grid for three stakeholder groups: ISOs & regional transmission organizations (RTOs), utilities, and customers.

[4]Con Edison virtual power plant shows how New York's REV is reforming utility practices, Utility Dive, June 21, 2016, http://www.utilitydive.com/news/coned-virtual-power-plant-shows-how-new-yorks-rev-is-reforming-utility-pra/421053/

[5]*The Economics of Battery Storage*, Rocky Mountain Institute, October, 2015

[6]U.S. Energy Storage Monitor: 2015 Year in Review, GTM Research/ESA U.S. Energy Storage Monitor

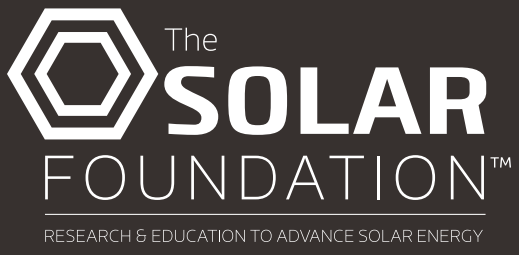
[7]U.S. Energy Storage Monitor: Q2 Review, GTM Research/ESA U.S. Energy Storage Monitor

[8]*Evaluating Behind-the-Meter Energy Storage Systems with NREL's System Advisor Model*, NREL, Jan., 2016, http://www.nrel.gov/docs/gen/fy16/65729.pdf

[9]*Grid-Scale Energy Storage Balance of Systems 2015-2020: Architectures, Costs and Players*, Jan. 2016, GTM Research, figure is for utility-scale storage systems.

[10]GTM Solar Summit, Future of Solar, solar is winning 95% of net metering battles.

[11]Similar to the way that the *National Solar Jobs Census* counts solar workers, for storage installation we not only include installation work crews but supporting staff such as those needed to obtain permits, order parts, and manage human resources.



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