IEA INTERNATIONAL ENERGY AGENCY

SunShot
U.S. Department of Energy

National Survey Report of PV Power Applications in the United States 2015

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

PVPS

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries

The IEA Photovoltaic Power Systems Technology Collaboration Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The participating countries and organisations can be found on the www.iea-pvps.org website.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "*Trends in photovoltaic applications*" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2015. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 INSTALLATION DATA

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, **PV installations are included in the 2015 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2015, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

Growth in the United States' (U.S.) PV market has been propelled by grid-connected PV installations, with approximately 7 260 MW_{DC} of new grid-connected PV capacity added in 2015, bringing its cumulative total to approximately 25 599 MW_{DC}.[1] Because a reliable data source for off-grid systems is not available, new data presented here is for grid-connected systems only.

Grid-Connected PV: For the purposes of this report, distributed grid-connected PV systems are defined as residential and commercial applications, while centralized grid-connected PV systems are defined as utility applications. Distributed PV systems can be mounted on the ground near the facility, on the building roof, or integrated into the building roof, walls, or windows. Distributed generation is connected to the grid on the consumer side of the meter, usually at a facility or building that uses electricity and owns or leases the PV generation. By the end of 2015, there were nearly 958 643 distributed PV systems interconnected across the United States.[2]

Centralized PV systems (utility applications) generate electricity that is fed directly to the grid, without serving an on-site load. This sector expanded from 3 934 MW_{DC} installed in 2014 to 4 150 MW_{DC} installed in 2015.[3]

Community or shared solar projects, a process in which groups of individuals either jointly own, or jointly purchase electricity from large centralized PV arrays are also growing rapidly in parts the U.S. As the end of 2015, 20 states have either implemented or are in the process of implementing legislation enabling community solar business models. The ownership structures of community solar projects can vary widely, and have been implemented by utilities, developers, and other organizations.

Off-Grid PV: Off-grid systems have storage (traditionally deep-cycle, lead-acid batteries, though lithium batteries are becoming more commonplace) and charge controllers that extend battery life and prevent the load from exceeding the battery discharge levels. Some off-grid systems are hybrids, with diesel or gasoline generators. Off-grid PV installations serve both the domestic and non-domestic market. Off-grid domestic PV systems are often used where utility-generated power is unavailable, or the customer requires back-up power and a second utility service is too costly. Applications also occur when the price of extending power lines costs more than a PV system. Off-grid domestic systems are ideal when only small amounts of power are needed, such as in residential applications in rural areas, boats, motor homes, travel trailers, vacation cottages, and farms. Most systems are rated at less than 1 kW, have several days of battery storage, and usually serve direct current (DC) loads. Some larger systems use stand-alone inverters to power alternating current (AC) loads and may include a diesel generator as backup.

[1] "U.S. Solar Market Insight Report: Q4 2015." GTM Research/SEIA. March 2016.

[2] Ibid.

[3] Ibid.

Off-grid non-domestic PV systems are used in commercial, industrial, agricultural, and government activities. These include large PV and diesel hybrid power stations where grid connections are impractical. Telecommunications are often powered by PV for telephone, television, and secure communications, including remote repeaters and amplifiers for fibre optics. Additionally, off-grid PV systems supply power for data communication for weather and storm warnings and security phones on highways. In the United States, PV-powered lighting and signals are numerous along highways and in cities; they are used at bus stops, shelters, and traffic signals. Off-grid non-domestic PV is also used for pumping water into stock ponds and for irrigation control. The Energy Information Agency estimates that as much as 274 megawatts of remote electricity generation with PV applications (i.e., off-grid power systems) were in service in 2013, plus an additional 573 megawatts in communications, transportation, and assorted other non-grid-connected, specialized applications.[4]

1.2 Total photovoltaic power installed

Table 1: PV power installed during calendar year 2015

AC			**MW installed in 2015**	**MW installed in 2015**	**AC or DC**
Grid-connected	BAPV	Residential	7 260	2 099	DC
		Commercial		1 011	DC
		Industrial		4 150	DC
	BIPV (if a specific legislation exists)	Residential	N/A		DC
		Commercial			DC
		Industrial			DC
	Ground-mounted	cSi and TF	4 150		DC
		CPV			
Off-grid		Residential	Not avalable		
		Other			
		Hybrid systems			
		Total	7 260		DC

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	N/A
Is the collection process done by an official body or a private company/Association?	Collaboration between official body (DOE and NREL) and Association (SEIA)
Link to official statistics (if this exists)	http://www.seia.org/research-resources/us-solar-market-insight; http://www.eia.gov/electricity/

[4] Energy Information Administration. Annual Energy Outlook. September 2015. Washington, DC. U.S. Department of Energy.

Table 3: PV power and the broader national energy market.

MW-GW for capacities and GWh-TWh for energy	2015 numbers	2014 numbers
Total power generation capacities (all technologies)	1 078 GW_{AC}	1 070 GW_{AC}
Total power generation capacities (renewables including hydropower)	191,3 GW_{AC}	177,5 GW_{AC}
Total electricity demand (= consumption)[5]	4 087 381 GWh	4 093 606 GWh
New power generation capacities installed during the year (all technologies)	21,1 GW_{AC}[6]	20, 96 GW_{AC}[7]
New power generation capacities installed during the year (renewables including hydropower)	15,12 GW_{AC} [8]	11,2 GW_{AC}[9]
Total PV electricity production in GWh-TWh	38 614 GWh	27 227 GWh
Total PV electricity production as a % of total electricity consumption	0,9%	0,7%

Source: data in this table are from the United States Energy Information Administration (EIA)[10] unless cited otherwise.

Table 4: Other informations

	2015 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	Residential: 904 194 Non-residential: 54 449 Utility: 1 476
Capacity of decommissioned PV systems during the year in MW	Not available
Total capacity connected to the low voltage distribution grid in MW	11 718 (includes all distributed PV)

[5] Refers to net generation, not consumption

[6] Includes PV capacity as reported by the Solar Electric Power Association report, "Utility Solar Market Snapshot: Sustained Growth in 2015." Data for utility-scale generation capacity from the United States Federal Energy Regulatory Commission report, "Office of Energy Projects Energy Infrastructure Update for December 2015." https://www.ferc.gov/legal/staff-reports/2015/decinfrastructure.pdf.

[7] Ibid.

[8] Ibid.

[9] Ibid.

[10] http://www.eia.gov/electricity/data/browser/

Total capacity connected to the medium voltage distribution grid in MW	5374 (includes all utility scale PV below 20 MW_{AC})[11]
Total capacity connected to the high voltage transmission grid in MW	8508 (includes all utility scale PV above 20 MW_{AC})[12]

Table 5: The cumulative installed PV power in 4 sub-markets.

Sub-market	Stand-alone domestic	Stand-alone non-domestic	Grid-connected distributed	Grid-connected centralized	Total (MW)
2004	NA	NA	94	17	111
2005	NA	NA	172	18	190
2006	NA	NA	277	18	295
2007	NA	NA	428	27	455
2008	NA	NA	710	43	735
2009	NA	NA	1 087	101	1 188
2010	NA	NA	1 672	368	2 040
2011	NA	NA	2 807	1 152	3 959
2012	NA	NA	4 373	2 955	7 328
2013	NA	NA	6 277	5 802	12 079
2014	NA	NA	8 932	9 744	18 305
2015	NA	NA	11 718	13 882	25 599

[11] Data represents GTM/SEIA of utility PV projects, excluding all projects above 20 MWAC which are tracked by an internal NREL utility-scale database.

[12] Data represents GTM/SEIA of utility PV projects, including only those projects above 20 MWAC which are tracked by an internal NREL utility-scale database.

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

The global-weighted average PV module price increased 9 % from 2012 to 2013; however is still 75 % below what it was 5 years ago, in 2008. In 2015 there was a wide variety in reported module price, with average Chinese module prices reported between 0,58 USD/Wp and 0,67 USD/Wp for portions of the year, as noted below.[13]

Table 6: Typical module prices for a number of years

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Standard module crystalline silicon price(s): Typical[14]	3,50	3,25	2,18	1,48	1,37	0,75	0,81	0,71	0,72
Lowest prices (Chinese modules)	NA	NA	NA	NA	0,89	0,64	0,65	0,58	0,58
Highest prices	NA	NA	NA	NA	NA	NA	NA	NA	NA

2.2 System prices

Installed system prices continue to fall in the United States, driven by three primary factors: 1) falling non-module hardware prices 2) the shift toward larger systems and 3) improved installation practices. While average system prices are still higher than those seen in Germany, the trend is clearly downward in all sectors and utility scale prices are beginning to drop below 1,50 USD/Wp. This downward trend is somewhat masked by the popularity of third-party ownership of PV systems in the U.S. systems deployed under these lease or power purchase agreement structures tend to have higher installed prices that reflect higher financing transaction costs, as well as more substantial performance requirements. In total, the capacity-weighted average installed price fell from 2,64 USD/Wp in 2014 to 2,12 USD/Wp in 2015, driven by both declining costs and an increasing share of utility scale projects.[15]

Table 7: **Turnkey Prices of Typical Applications – local currency**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW	N/A	
OFF-GRID >1 kW	N/A	
Grid-connected Rooftop up to 10 kW (residential)	Turnkey pricing for installers with more than 1 MW (150 systems) of quarterly installations.	3,10 USD
Grid-connected Rooftop from 10 to 250 kW (commercial)		N/A

[13] Bloomberg New Energy Finance. Solar Spot Price Index. Assessed May 25, 2016.

[14] Mints, Paula. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2015/2016." SPV Market Research. April 2016.

[15] "U.S. Solar Market Insight Report: Q4 2015." GTM Research/SEIA. March 2016.

Grid-connected Rooftop above 250kW (industrial)	Turnkey pricing for a 300 kw flat roof system with standard modules, ballasted mounting, and string inverters	2,20 USD
Grid-connected Ground-mounted above 1 MW	Turnkey prices for 10 MW system in CA with standard modules, minimal grading, and 1,3 DC-to-AC ratio	1-axis tracking: 1,90 USD Fixed tilt: 1.75 USD
Other category (hybrid diesel-PV, hybrid with battery…)	N/A	N/A

Source: Price data developed using bottom up cost model developed by the National Renewable Energy Laboratory.[16]

Table 8: National trends in system prices (current) for different applications – local currency

Price/Wp	2006	2007	2008	2009	2010	2011	2012	2013	2014	H1 2015
Residential PV systems < 10 KW	9,07	9,20	8,83	8,43	7.14	6,31	5,39	4,69	4,27	4,24
Non-Residential ≤500 kW	8,81	8,91	8,69	8,56	6,90	5,83	5,02	4,32	3,90	3,85
Non-Residential >500 kW	7,81	7,51	7,43	7,56	5,75	4,72	4,34	3,50	2,76	2,74
Ground-mounted					3,74	3,53	2,95	2,76	2,94	

Source: data from The Lawrence Berkeley National Laboratory.[17] Pricing for "residential" and "non-residential" represent the median reported price for behind-the-meter systems for their given size and market segments. Pricing for "ground-mounted" represents the median price of systems 5 MW or greater. 2015 prices only include a subset of systems installed in the first half of 2015.

2.3 Cost breakdown of PV installations

2.3.1 Residential PV System < 10 kW

Table 9: Cost breakdown for a residential PV system – local currency

Cost category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	0,70 USD		
Inverter	0,30 USD		

[16] Woodhouse, Michael, Rebecca Jones-Albertus, David Feldman, Ran Fu, Kelsey Horowitz, Donald Chung, Dirk Jordan, and Sarah Kurtz. 2016. On the Path to SunShot: The Role of Advancements in Solar Photovoltaic Efficiency, Reliability, and Costs. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy16osti/65872.pdf.

[17] Barbose, G.; Darghouth, N.; Weaver, S.; Wiser, R. "Tracking the Sun VIII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2015." Berkeley, CA: Lawrence Berkeley National Laboratory.

Other (racking, wiring…)	0,50 USD[18]		
Soft costs			
Installation Labour	0,35 USD[19]		
Customer Acquisition	0,35 USD[20]		
Profit	0,70 USD[21]		
Other (permitting, contracting, financing…)	0,20 USD		
Subtotal Hardware	1,50 USD		
Subtotal Soft costs	1,60 USD		
Total	3,10 USD		

2.3.2 Utility-scale PV systems > 1 MW

Table 10: Cost breakdown for a utility-scale PV system – local currency

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	0,65 USD		
Inverter	0,15 USD		
Other (racking, wiring, etc.)	0,50 USD[22]		
Soft cost			
Installation Labour	0,20 USD		
Customer acquisition	0,04 USD[23]		
Profit	0,20 USD[24]		

[18] Balance of system equipment

[19] Includes direct labor only

[20] Includes customer acquisition and system design

[21] Includes profit and installer overhead

[22] Includes 1-axis tracker

[23] Includes system design

[24] Includes overhead

Other (contracting, permitting, financing etc.)	0,16 USD[25]		
Subtotal Hardware	1,30 USD		
Subtotal - Soft cost	0,60 USD		
Total Installed Cost	1,90 USD		

2.4 Financial Parameters and specific financing programs

Table 11: PV financing scheme

Average rate of loans – residential and commercial rooftop installations	Tax-equity investor for a portfolio of rooftop installations: 9%[26]
Average cost of capital – industrial and ground-mounted installations	Tax-equity investor for utility-scale project: 7-8%[27]

2.5 Specific investments programs

Third Party Ownership (no investment)	The up-front capital requirements of PV installations often deter PV adoption. As a result, innovative third-party financing schemes that address high up front capital requirements, such as solar leases and power purchase agreements (PPA), have become popular. In 2015, Third party owned systems accounted for 47-90% of quarterly residential installations in the top 7 solar states. However, TPO is declining in many markets due to a combination of declining system costs, and new loan products entering the market.
Renting	N/A
Leasing	Leasing remains a popular model for procuring solar energy, especially in states that do not allow residential PPAs. Many solar installers that provide PPA products also have solar lease products.

[25] Includes logistics, overhead, margin, design, engineering, permitting and miscellaneous costs.

[26] Martin, K. (2016). "Cost of Capital: 2016 Outlook." *Chadbourne & Parke Project Finance News: January 2016*.

[27] Ibid.

Financing through utilities	On Bill Financing, a process by energy efficiency upgrades are financed through utility bills, is being explored by some utilities. 12 states currently have enabling legislation for On Bill Financing, and at least one state (New York) has a state-wide on bill financing program for solar.[28]
Investment in PV plants against free electricity	
Crowdfunding (investment in PV plants)	A number of platforms exist to facilitate the crowdfunding of solar projects. More generally, the Securities and Exchange Commission provides general guidance and annual limits for crowdfunded investments.[29]

2.6 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range)	Average: 0,13 USD. Range 0,09 USD (Washington) – 0,30 USD (Hawaii) / KWh[30]
Retail Electricity Prices for a commercial company (range)	Average: 0,11 USD. Range 0,08 USD (Oklahoma) –0,27 USD (Hawaii) / KWh[31]
Retail Electricity Prices for an industrial company (range)	Average: 0,07 USD. Range 0,04 USD (Washington) – 0,23 USD (Hawaii) / KWh[32]
Population at the end of 2014 (or latest known)	322,755,353[33]
Country size (km^2)	9 833 517[34]
Average PV yield (according to the current PV development in the country) in kWh/kWp	Typical solar radiation in the United States ranges from 3 kWh/m^2/day to 7 kWh/m^2/day[35]

[28] National Conference of State Legislatures. "On-Bill Financing: Cost-Free Energy Efficiency Improvements." April 7, 2015. http://www.ncsl.org/research/energy/on-bill-financing-cost-free-energy-efficiency-improvements.aspx, accessed May 20, 2016.

[29] Securities and Exchange Commission "Investor Bulletin: Crowdfunding for Investors." February 16, 2016. https://www.sec.gov/oiea/investor-alerts-bulletins/ib_crowdfunding-.html, accessed May 23, 2016.

[30] Data, as of 2015, from EIA, forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U. http://www.eia.gov/electricity/data/browser, accessed May 20, 2016.

[31] Ibid.

[32] Ibid.

[33] Annual Estimates of the Resident Population for the United States, States, Counties, and Puerto Rico Commonwealth and Municipals: as of December 31, 2014. Source: U.S. Census Bureau, Population Division. Release Date: May 2016. Census.gov, accessed May 20, 2016.

[34] Data from the CIA World Factbook, as of May 24, 2016. https://www.cia.gov/library/publications/the-world-factbook/geos/us.html, accessed May 24, 2016.

[35] Data from the National Renewable Energy Laboratory, PVWatts – version 1. http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/, accessed July 10, 2014.

Name and market share of major electric utilities.	Exelon Corp. (5,7%), Duke Energy Corp. (4,9%), FirstEnergy Corp. (4%), PG&E Corp. (3,5%), American Electric Power (3,5%)[36]

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies for PV installations

3.1.1 New, existing or phased out measures in 2015

3.1.1.1 Description of support measures excluding BIPV, and rural electrification

Most PV in the US is tied to the grid. The process for valuing solar energy sold to the grid is regulated by state and local governments. Net metering is the most popular process for selling distributed solar energy to the grid and 41 states plus the District of Columbia and Puerto Rico have net metering policies.[37] Recently some jurisdictions have seen disputes between utilities and solar advocates over net metering, and several jurisdictions have approached, or are approaching the maximum capacity allowed for their net metering programs. Some states have successfully gotten these caps raised; however, others have modified their net metering policies, decreasing the value of energy put onto the grid by PV systems, or moving to alternative rate structures such as time of use. Areas without net metering may employ different practices to value solar energy while some do not compensate for gird pared solar.

3.1.1.2 BIPV development measures

The voluntary Leadership for Energy and Environmental Design (LEED) certification program produces criteria and guidelines for incorporating energy efficient practices and renewable energy systems into buildings. To date over 44,000 buildings have been LEED certified in the US. 11 States and numerous local governments provide incentives for builders that achieve LEED status.[38]

[36] 2014 data from EIA, forms EIA-861- schedules 4A & 4D and EIA-861S, released February, 2016. http://www.eia.gov/electricity/data.cfm#sales, accessed May 20, 2017. Percentages based on total U.S. customers served. Exelon Corp.'s customers updated to include Pepco Holdings acquisition.

[37] Two other states have no state-wide mandatory rules, but some utilities allow net metering. Four other states offer distributed generation compensation rules other than net metering.

[38] LEED http://www.usgbc.org/Docs/Archive/General/Docs2021.pdf

3.1.1.3 Rural electrification measures

Nearly 99 % of Americans have access to electricity.[39] The Rural Utility Service (RUS) offers loans and loan guarantees to finance energy efficiency and renewable distributed energy improvements to Americans without access to electricity.

3.1.1.4 Support for electricity storage and demand response measures

California has led efforts for energy storage deployment, as it is the nation's leading market for distributed PV deployment. Its current Self-Generation Incentive Program offers rebates for "advanced energy storage" at 1,31 USD/Wp. To-date it has funded approximately 27 MW of storage, however in 2016 over 117 MW of storage reserved rebates.[40] Additionally, Hawaii Electric Company installed 1 MW of distributed storage in September of 2014 as a pilot project to test the feasibility of using energy storage to respond to demand spikes.[41] The current Hawaiian self-consumption program also provides a self-supply option, where PV owners can gain preferential permitting treatment by consuming all PV onsite (no value is given to exported generation). Though still a relatively recent development, an increasing number of PV systems in Hawaii are being coupled with smart water heaters, battery storage systems, and other load controls.

[39] Data from the World Bank. http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS, accessed June 19, 2015.

[40] Data from the Center for Sustainable Energy California. "Quarterly Statewide Report." May 13, 2016. https://energycenter.org/self-generation-incentive-program/program-statistics, accessed May 23, 2016.

[41] HECO. Stem Strengthens Grid Response for Hawaiian Electric Company. September 11, 2014. http://www.hawaiianelectric.com/heco/_hidden_Hidden/CorpComm/Stem-Strengthens-GridResponse-for-Hawaiian-Electric-Company?cpsextcurrchannel=1, accessed June 19, 2015.

Table 13: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2015 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2015 – ground mounted
Feed-in tariffs	3 states currently have FiTs that are accepting new applicants. Some utilities offer feed in tariffs.	N/A	3 states currently have FiTs that are accepting new applicants. Some utilities offer feed in tariffs.	N/A	N/A	N/A
Feed-in premium (above market price)	The state of Washington's FiT is above retail electricity rates	N/A	The state of Washington's FiT is above retail electricity rates	N/A	N/A	N/A
Capital subsidies	Federal: 30 % Investment Tax Credit, State: At least 15 states offer capital subsidies.	The Federal ITC was extended in 2015; rebates through the California Solar Initiative expired in 2015	Federal: 30 % Investment Tax Credit, State: At least 15 states offer capital subsidies.	The Federal ITC was extended in 2015; rebates through the California Solar Initiative expired in 2015	Federal: 30 % Investment Tax Credit, State: At least 15 states offer capital subsidies.	The Federal ITC was extended in 2015
Green certificates	Many states with RPS requirements also allow the trading of renewable electricity credits, and at least 10 states allow for the trading of solar renewable energy credits.	N/A	Many states with RPS requirements also allow the trading of renewable electricity credits, and at least 10 states allow for the trading of solar renewable energy credits.	N/A	Many states with RPS requirements also allow the trading of renewable electricity credits, and at least 10 states allow for the trading of solar renewable energy credits.	N/A
Renewable portfolio standards (RPS)	29 states plus the District of Columbia,	N/A	29 states plus the District of Columbia,	N/A	29 states plus the District of Columbia,	N/A

with/without PV requirements	Guam, Puerto Rico, and Virgin Islands, have an RPS.		Guam, Puerto Rico, and Virgin Islands, have an RPS.		Guam, Puerto Rico, and Virgin Islands, have an RPS.	
Income tax credits	Federal: federal investment tax credit of 30 % for residential, commercial, and utility systems. State: 19 states offer tax credits for solar projects.	In 2015, the ITC was extended five years from its scheduled expiration at the end of 2016. Residential system owners personally claiming the tax credit will have until the end of 2019 claim the full 30% tax credit. It will then step down to 26% in 2020, 22% in 2021, and expire in 2022. [42]	N/A	In 2015, the ITC was extended five years from its scheduled reduction from 30% to 10% at the end of 2016. Commercial entities claiming the tax credit will have until the end of 2019 to begin construction on projects to claim the full 30% tax credit. It will then step down to 26% in 2020, 22% in 2021 for projects beginning construction, and 10% in 2023. All projects placed in service in 2024 or beyond are not eligible for the higher credits	N/A	In 2015, the ITC was extended five years from its scheduled reduction from 30% to 10% at the end of 2016. Commercial entities claiming the tax credit will have until the end of 2019 to begin construction on projects to claim the full 30% tax credit. It will then step down to 26% in 2020, 22% in 2021 for projects beginning construction, and 10% in 2023. All projects placed in service in 2024 or beyond are not eligible for the higher credits
Self-consumption	Most states use net metering as a process for compensating self-consumption. However, some states	California, Hawaii, and Nevada, all began to transition away from their current net metering policies in	Most states use net metering as a process for compensating self-consumption. However, some states	California, Hawaii, and Nevada, all began to transition away from their current net metering policies in	N/A	N/A

[42] Consolidated Appropriations Act, 2016 (H.R. 2029). 114th Cong. (2015).

	have recently moved to other systems for self-consumption as distributed solar has become a more sizeable portion of their load.	2015, moving customers to time of use, wholesale, and below wholesale rates respectively. Two states, Mississippi and South Carolina instituted new self-consumption policies.[43]	have recently moved to other systems for self-consumption as distributed solar has become a more sizeable portion of their load.	2015, moving customers to time of use, wholesale, and below wholesale rates respectively. Two states, Mississippi and South Carolina instituted new self-consumption policies.		
Net-metering	41 states plus the District of Columbia and Puerto Rico have net metering policies. See, "Freeing the Grid," for a review of best practices.[44]	18 states modified their net metering policies in 2015. While most of these were minor rule or process changes, 3 states increased their NEM caps, 3 states transitioned to a new compensation program, and two states implemented new self-consumption policies.[45]	N/A	18 states modified their net metering policies in 2015. While most of these were minor rule or process changes, 3 states increased their NEM caps, 3 states transitioned to a new compensation program, and two states implemented new self-consumption policies.	N/A	N/A
Net-billing	N/A	N/A	N/A	N/A	N/A	N/A
Commercial bank activities e.g. green	Connecticut, Hawaii, New York, California	N/A	Connecticut, Hawaii, New York, California	N/A	Connecticut, Hawaii, New York, California	N/A

[43] Data from DSIRE. Accessed May 24, 2016. http://programs.dsireusa.org/system/program?type=37&

[44] Interstate Renewable Council and Vote Solar. "Freeing the Grid 2015." http://freeingthegrid.org/, accessed May 24, 2016.

[45] North Carolina Clean Energy Technology Center & Meister Consultants Group, *The 50 States of Solar: 2015 Policy Review and Q4 Quarterly Report*, February 2016.

mortgages promoting PV	and Vermont have created green banks		and Vermont have created green banks		and Vermont have created green banks	
Activities of electricity utility businesses	Several electricity utilities have begun engaging with PV development, either through direct ownership of centralized and distributed PV assets, community solar programs, partial ownership in PV development companies, or joint marketing agreements.	N/A	Several electricity utilities have begun engaging with PV development, either through direct ownership of centralized and distributed PV assets, community solar programs, partial ownership in PV development companies, or joint marketing agreements.	N/A	Several electricity utilities have begun engaging with PV development, either through direct ownership of centralized and distributed PV assets, community solar programs, partial ownership in PV development companies, or joint marketing agreements.	N/A
Sustainable building requirements	Federal: No federal codes exist, but DOE produces best-practices guides for sustainable building for both residential and commercial buildings	N/A	Federal: No federal codes exist, but DOE produces best-practices guides for sustainable building for both residential and commercial buildings	N/A	N/A	N/A
BIPV incentives	N/A	N/A	N/A	N/A	N/A	N/A

All data in this table is from the Database of State Incentives for Renewables & Efficiency (DSIRE)[46] cited otherwise.

[46] Database of State Incentives for Renewables & Efficiency (DSIRE). http://www.dsireusa.org/summarytables/finre.cfm, accessed May 23, 2015.

3.2 Self-consumption measures

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Savings on electricity bill
	3	Charges to finance Transmission & Distribution grids	In some states
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Retail electricity prices in most states, solar specific tariffs and TOU rates in others
	5	Maximum timeframe for compensation of fluxes	Varies by state
	6	Geographical compensation	On-site; at least 12 states have community solar or virtual net metering policies[47]
Other characteristics	7	Regulatory scheme duration	Unlimited
	8	Third party ownership accepted	Yes, at least 26 states + Washington DC and Puerto Rico
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Some states have implemented minimum bills for NEM customers
	10	Regulations on enablers of self-consumption (storage, DSM…)	ToU Tariffs in some states
	11	PV system size limitations	Most states restrict the size of the system of the amount of load a PV system can offset
	12	Electricity system limitations	In some states
	13	Additional features	Multiple other policies depending on the state or at federal level

[47] Solar Energy Industries Association. "Shared Renewables/Community Solar," accessed May 24, 2015.

3.3 Tenders, auctions & similar schemes

The majority of utility scale PV projects in the U.S. is owned by independent power producers, selling electricity to utilities under long-term power purchase agreements (PPAs). PPAs can provide stable cash flows and assist project developers in securing financing for their project. Utilities typically solicit PPA bids through requests for proposals or requests for offers (RFP/RFO), and select bids based on a number of factors including price, interconnection, curtailment, capacity factor, and contract terms.

Additionally, project owners may choose to bid into wholesale electricity markets. While the terms and structure of these markets can vary, many utilize reverse auction mechanisms, in which entities bid a specific amount of power into the market at a set price. The system operator will dispatch cheaper sources of energy first, moving to more expensive sources as demand increase. Finally, some utilities are able to directly own, finance, and ratebase utility solar systems, providing this practice is authorized by their regulator. Historically, many regulators have preferred to have utilities purchase renewables though PPA arrangements, as the RFP process can enable is greater price transparency and economic competitiveness.

3.4 Direct Support measures

3.5 Financing and cost of support measures

Financial incentives for U.S. solar projects are provided by the federal government, state and local governments, and some local utilities. Historically, federal incentives have been provided primarily through the U.S. tax code, in the form of an ITC (which applies to residential, commercial, and utility-scale installations) and accelerated 5-year tax depreciation (which applies only to commercial and utility-scale installations). For commercial installations, the present value to an investor of the combination of these two incentives—which can be used only by tax-paying entities—amounts to about 56 % of the installed cost of a solar project.[48]

Most solar project developers are not in a financial position to absorb tax incentives themselves (due to lack of sufficient taxable income to offset deductions and credits), and so they have had to rely on a small cadre of third-party "tax equity investors" who invest in tax-advantaged projects to shield the income they receive from their core business activities (e.g., banking). In doing so, these tax-equity investors monetize the tax incentives that otherwise could not be efficiently used by project developers and other common owners of the renewable energy plants.

Federal benefits can be used in combination with state and local incentives, which come in many forms, including—but not limited to—up-front rebates, performance-based incentives, state tax credits, renewable energy certificate (REC) payments, property tax exemptions, and low-interest loans. Incentives at both the federal and state levels vary by sector and by whether or not the systems are utility scale or distributed.

In most cases, solar project developers combine several of these federal, state, and local incentives to make projects economically viable. Given the complexity of capturing some of these incentives—particularly in combination— solar financiers have adopted (and in some cases, modified) complex ownership structures previously used to invest in other tax-advantaged sectors in the United States, such as low-income housing, historical buildings, and commercial wind projects.

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[48] DOE (U.S. Department of Energy). (2012). *SunShot Vision Study*. DOE/GO-102012-3037. Washington, DC: U.S. Department of Energy. http://www1.eere.energy.gov/solar/pdfs/47927.pdf.

In most cases, utility-scale projects are owned by Independent Power Producers (in conjunction with tax equity investors), who sell the power to utilities under a long-term power purchase agreement (PPA). Distributed PV systems are either self-financed or third-party financed. Innovative third-party financing schemes that address high up front capital requirements, such as solar leases and power purchase agreements (PPA), are becoming more prevalent. In 2015 approximately 52% of residential systems installed in California used third-party financing arrangements.[49] At least 26 states, the District of Columbia, and Puerto Rico allow for third party financing of solar systems such as Power Purchase Agreements (PPAs) or solar leases (8 states apparently disallow the process or have legal barriers). Additionally, 30 states and the District of Columbia have enabled Property Assessed Clean Energy (PACE) programs which allow energy efficiency or renewable energy improvements to be financed through property taxes.

3.6 Indirect policy issues

In June 2014 the U.S. Environmental Protection Agency announced new air quality standards for new and existing power plants. Beginning in 2020 every State will have a goal establishing their carbon intensity and a plan to achieve those emission reductions.[50] While each state can decide how to achieve its goal, one of the major building blocks to achieving their target is, "expanding zero- and low-carbon power sources," which can include solar.[51] Additionally, the Clean Power Plan includes a Clean Energy Incentive Program (CEIP) designed to reward investment in renewable energy and demand-side energy efficiency, prior to the intended start of the Clean Power Plan. Under this program, EPA will provide allowances to eligible facilities that states can apply to their emissions reductions goals.[52]

[49] "U.S. Solar Market Insight Report: Q4 2015." GTM Research/SEIA. March 2016.

[50] The Supreme Court stayed the Clean Power Plan in February 2016, which may impact the timeline of the program.

[51] EPA. Fact Sheet: Clean Power Plan Framework. http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-framework, accessed May 23, 2016.

[52] EPA. Fact Sheet: Clean Energy Incentive Program. https://www.epa.gov/cleanpowerplan/fact-sheet-clean-energy-incentive-program, accessed May 23, 2016.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

The DOE is one of the primary bodies that support research, development, and demonstration (RD&D) of solar energy technologies. In February 2011, the Secretary of Energy launched the SunShot Initiative, a program focused on driving innovation to make solar energy systems cost-competitive with other forms of energy. To accomplish this goal, the DOE is supporting efforts by private companies, academia, and national laboratories to drive down the cost of utility-scale solar electricity to about USD 0.06 per kilowatt-hour, and distributed solar electricity to be at or below retail rates. This in turn could enable solar-generated power to account for 14 % of America's electricity generation by 2030 (assuming other systemic issues are addressed as well).[53] By funding selective RD&D concepts, the SunShot Initiative promotes a genuine transformation in the ways the U.S. generates, stores, and utilizes solar energy.

DOE's Solar Energy Technologies Office (SETO), Office of Science, and Advanced Research Projects Agency - Energy (ARPA-E) collaborate to accomplish the goals of the SunShot Initiative. The majority of RD&D funding under the initiative is provided by SETO, thus this summary focuses on the RD&D funded by SETO. The initiative focuses on removing the critical barriers for the system as a whole, including technical and non-technical barriers to installing and integrating solar energy into the electricity grid. In addition to investing in improvements in solar technologies and manufacturing, the department focuses on integrating solar generated energy systems into the electricity grid and reducing installation and permitting costs. The DOE focuses on innovative technology and manufacturing process concepts as applied to PV. It also supports PV systems integration, by developing radically new approaches to reduce the cost and improve the reliability and functionality of power electronics; by supporting industry development through test and evaluation standards; and by developing tools for understanding grid integration issues. Emphasis is also placed on market transformation areas to address non-hardware related balance-of-system costs including streamlined permitting, inspection, and interconnection as well as performing key analyses of policy options and their impact on the rapid deployment of solar technologies.

Examples of SETO funded research and development activities in 2015 include:

- Working with small businesses to eliminate market barriers, reduce non-hardware costs, and to encourage technology innovation to support SunShot goals.
- Working with industry, national laboratories, and university researchers to enable the development and demonstration of integrated, scalable, and cost-effective technologies for solar that incorporates energy storage and works seamlessly to meet both consumer needs and the needs of the electricity grid, enable widespread sustainable deployment of low-cost, flexible, and reliable PV generation, and provide for successful integration of PV power plants with the electric grid.
- Working with researchers in physics, chemistry, and advanced data analysis to gain a better understanding of how and why solar PV modules degrade to enable evaluation of module reliability and improved prediction of performance over time.[54]

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[53] U.S. Department of Energy (DOE). (2012). *SunShot Vision Study*. DOE/GO-102012-3037. Washington, DC: U.S. Department of Energy. Accessed 2013: http://www1.eere.energy.gov/solar/pdfs/47927.pdf

[54] Attional information on SETO funded projects is available at http://energy.gov/eere/sunshot/sunshot-initiative.

It has been previously estimated that the RD&D funding provided by SETO, accounts for approximately 50% of all public RD&D in the U.S. directly focused on solar energy technologies.[55] In addition, U.S. RD&D funding has also come from the Department of Energy's Office of Science and ARPA-E, as well as the National Science Foundation, the Department of Defense, the National Aeronautics and Space Administration, and states such as California, New York, Florida and Hawaii.

4.2 Public budgets for market stimulation, demonstration / field test programmes and R&D

Table 14: Public budgets for R&D, demonstration/field test programmes and market incentives.[56]

	R & D	Demo/Field test
National/federal	110,8 MUSD	130,8 MUSD
State/regional	N/A	N/A
Total	241,6 MUSD	

[55] Based on publically accessible state and federal budgets and agency funding databases

[56] Figures only include funding for US Department of Energy Solar Energy Technologies Office for Fiscal Year 2016

5 INDUSTRY

5.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 15: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Total Production	Product destination (if known)	Price (if known)
SunEdison, REC Silicon, Hemlock	Polysilicon feedstock	34 853 tonnes	N/A	N/A
SunEdison	Wafers	24 MW	N/A	N/A

Describe briefly the overseas activities of any key companies also operating in other countries.

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

The United States produced 1 321 MW_{DC} of modules and 628 MW_{DC} of cells in 2015.

Total PV cell and module production, together with production capacity information, is summarised in Table 14, below.

5.2 Production of photovoltaic cells and modules

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

Table 16: Production and production capacity information for 2015

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Total		*628*	*751*	*696*	*993*
Thin film manufacturers					
Total		N/A	*570*	N/A	*717*
Cells for concentration					
Total		N/A	*N/A*	N/A	N/A
TOTALS		**628**	**1 321**	**696**	**1 710**

Tables 15 and 16 summarize the production of PV products within the United States, however the two largest U.S. based PV module manufacturers (First Solar, SunPower) have a majority of their manufacturing operations located abroad. In 2015 First Solar produced 2,5 GW of PV modules and

SunPower produced approximately 1,2 GW of PV modules.[57] All other information from the above tables is from GTM Research/SEIA's Solar Market Insight.[58]

5.3 Manufacturers and suppliers of other components

U.S. companies shipped approximately 5,2 GW_{AC} of PV inverters in 2015; approximately 89 % of all U.S. systems installed during that time period.[59] Supporting structures of U.S. systems are primarily domestically manufactured. Battery implementation represents a small but growing portion of the overall U.S. PV deployment market; in 2014 and 2015 several large U.S. PV developers announced the acquisition of battery technology or introduction of such products into their commercial and residential offerings. Additionally, micro-inverters and DC optimizers represent a growing portion of the U.S. market.

[57] Data from corporate public filings from First Solar and SunPower.

[58] "U.S. Solar Market Insight Report: Q4 2015." GTM Research/SEIA. March 2016.

[59] Ibid.

6 PV IN THE ECONOMY

6.1 Labour places

Table 17: Estimated PV-related labour places in 2015[60]

Research and development (not including companies)	Not available
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	30 282
Distributors of PV products	24 377
System and installation companies	119 931
Electricity utility businesses and government	Not available
Other	11 816
Total	208 859[61]

6.2 Business value

Table 18: Value of PV business

Sub-market	Capacity installed *in 2015* (MW)	Price per W	Value	Totals
Off-grid domestic	*N/A*	*N/A*	*N/A*	*N/A*
Off-grid non-domestic	**N/A**	**N/A**	*N/A*	*N/A*
Grid-connected distributed	**3 110**	**3,02**	*BUSD 9,40*	*BUSD 10*
Grid-connected centralized	**4 150**	**1,45**	*BUSD 6,02*	*BUSD 6,02*
Export of PV products				*N/A*
Change in stocks held				*N/A*
Import of PV products				*N/A*
Value of PV business				***BUSD 15,42***

U.S. PV manufacturing, which had grown in shipments 10x from 2003-2010, followed by a period of contraction caused by rapid decline in prices in 2011 and 2012, continued to recover in 2015. In 2015, U.S. PV cell production was 628 MW, a 35% increase over 2014. Additionally the U.S. produced 1 321 MW of PV modules, a 24% increase over 2014.

U.S. manufacturing also has a significant presence in other part of the PV value chain, including polysilicon, encapsulants, wiring, and fasteners. Thus, between 2010 and 2015 the number of U.S.

[60] Refers to the number of employees in the following sectors

[61] Solar Foundation. (2016). National Solar Jobs Census 2015. Washington, DC: The Solar Foundation.

solar manufacturing jobs has increased by 18%, from 24 916 to 30 280.[62] Furthermore, manufactured hardware is only a portion of the total solar value chain. Industry-wide, approximately 115 000 jobs relating to solar were added from 2010 to 2015, growing from 93 500 to 208 000 employees. The growth rate from 2014 to 2015 is nearly twelve times faster than what the overall U.S. economy experienced during that same time period.[63]

[62] Solar Foundation. (2016). National Solar Jobs Census 2015. Washington, DC: The Solar Foundation.

[63] Ibid.

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Short description of the electricity industry landscape	The US has a diverse deregulated utility landscape in which roughly 68% of consumers are served by an investor owned utility and the remaining customers are served by municipal utilities or cooperatives. Utilities are regulated at the local, state, and federal level to ensure they provide fair and reliable service to their customers by PUCs, ratepayer groups and federal agencies such as the Federal Energy Regulatory Commission (FERC). Transmission is regulated by Independent System Operators (ISO) or Regional Transmission Organizations, depending on region

7.2 Interest from electricity utility businesses

Electricity utility interest in solar continues to increase in the United States. The key drivers are policy—the federal tax credit (30 %) at the national level and RPSs at the state level, as well as the declining cost of PV. As utility scale solar has become increasingly competitive with retail generation, four broad categories of utility solar business models have emerged in the United States: utility ownership of assets, utility financing of assets, development of customer programs, and utility purchase of solar output.[64]

Utility ownership of assets allows the utility to take advantage of the tax policy benefits and earn a rate of return on the asset (for investor-owned utilities), while providing control over planning, siting, operating, and maintaining the solar facilities. The variety of ownership explored in the United States is:

- Ratebasing solar on non-residential customer sites
- Ratebasing solar at substations and utility facilities
- Owning community solar equipment
- Owning inverters on customer sites
- Acquiring existing or new solar projects from developers in the present or future:
    - turnkey acquisition, or purchase and sale agreement
    - power purchase agreement with buy-out option
    - acquisition of sites for development
    - “flip” transactions that can take various forms.

[64] The Smart Electric Power Alliance (formally the Solar Electric Power Association) has continued to define, research, and track utility solar business models since early 2008. These business models are differentiated from general market activity by the short- or long-term economic value (or future potential) they bring the utility and its ratepayers, relative to traditional market activity that often has negative utility value.

The issues related to utility ownership include:

- Some state restructuring rules that do not allow generation utilities to own distributed generation
- State or commission policy or guidelines that prohibit or specifically limit utility ownership to specific conditions
- Regulatory or stakeholder concern about the rate impacts, utilities' costs relative to private market pricing and capabilities, ensuring that the utility operates in a fair and competitive environment, and related issues.

Utility Financing of Solar Assets is a solar business option for utilities that do not choose to own solar assets for tax, cost, regulatory, or competitive considerations. To be successful, regulators treat the financing and lost revenue costs associated with a solar project as assets, allowing the utility to earn a rate of return on "investment". Some of the options for this solar business model include:

- Ratebasing solar loans and recovering lost revenues
- Supporting turnkey installations and ratebasing shareholder loans
- Supporting a feed-in tariff (FIT) with solar revenue streams and ratebased shareholder loans.

Development of Customer Programs refers to utility programs that are designed to increase access to solar energy by lowering costs, for both the utility and the customer, compared to a traditional customer-sited photovoltaic system. Community solar programs involve a community or centralized 0,1 MW to 20 MW PV system. Specific classes of participating customers can be allocated a proportional share of the output from the system to directly offset their electric consumption bill (remote net metering) or the customers are offered a fixed-rate tariff that is competitive with retail rates or will be in the near future as electric prices increase.

Utility Purchase of Solar Output is a business model often applied by publically owned utilities (POUs) to create value to their communities through local solar development. Some POUs have developed a FIT to purchase solar power. Solar power purchases through a FIT are often made available instead of net metering, thus mitigating revenue erosion while providing a clear contractual understanding for purchase that supports financial viability for solar developers.

7.3 Interest from municipalities and local governments

Permitting and regulatory requirements for PV installations in the United States can vary greatly across the country's more than 18 000 authorities having jurisdiction (AHJ) and over 5 000 utility service territories. To date, the lack of standardization has posed a barrier to the rapid deployment of solar technology, though state and local governments are working to address this challenge. For example, Vermont has implemented a pre-defined permitting process for solar installations of 10 kW and under, to decrease paperwork processing times and regulatory uncertainty. Now, an installer or homeowner in Vermont can apply for all necessary permits for a proposed PV system with one, single registration form which specifies system components, configuration, and compliance with interconnection requirements. At the municipal level, the City of Los Angeles has moved towards decreasing permitting barriers by eliminating building height restrictions for roof mounted PV systems, as long as the system under consideration adheres to set-back requirements. Meanwhile, the City of Santa Cruz has demonstrated genuine leadership in promoting residential solar by eliminating building permits for PV systems that are not visible from public thoroughfares and do not extend more than 12 inches in height from the building's roof. As an increased number of states and cities adopt similar, streamlined permitting and interconnection models, greater PV deployment will likely be achieved.

8 HIGHLIGHTS AND PROSPECTS

In 2015, the U.S market increased its annual installations by approximately 1 GW, from roughly 6,2 GW in 2014 to 7,3 GW in 2015.[65] U.S. annual installations have been growing rapidly during the past five years, from 0,9 MW in 2010 to 7,3 MW in 2015. Much of the recent growth came from utility-scale installations, though the residential market has also increased in size. PV capacity continues to be concentrated in a small number of states, such as California, Arizona, Nevada, North Carolina, and New Jersey, which comprise roughly two-thirds of the market. However, this trend is changing slowly as 28 states currently have 50 MW or more of PV capacity and 17 states each installed more than 50 MW in 2015 alone.[66] With more than 18 GW of contracted utility scale PV projects in the pipeline as of October, total installations in 2016 are expected to increase yet again.[67] Though some incentive programs in the U.S. have expired or been reduced, many projects currently under construction have already qualified to receive an award. In addition, due to the continued reduction in system pricing as well as the availability of new loan products and third-party ownership arrangement with lower financing costs, a significant portion of PV systems have recently been installed without any state incentives. Finally, state RPS targets require a larger amount of renewable energy additions in 2016 than in previous years, encouraging more growth within the market.

U.S. PV manufacturing, which contracted in 2011-13 after having shipment growth of 10 times from 2003-2010, continued to recover in 2015. Module production has increased 32% from 2014 to 2015, and growth is expected to continue in 2016.[68] Additionally, U.S. manufacturing has a significant presence in other parts of the PV value chain, including polysilicon, encapsulants, wiring, and fasteners. In 2015, the U.S. solar manufacturing sector employed 30 282 people, a 6,8 % decrease since 2014. However, the sector is expected to recoup those losses and expand in 2016, with an expected job growth of 12,7 %.[69] Additionally, manufactured hardware is only a portion of the total solar value chain. Industry-wide, approximately 115 000 jobs relating to solar were added from 2010 to 2015, growing to a total of nearly 209 000 employees (35 000 of which were added in 2015 alone). The growth rate from 2014 to 2015 of 20 % was twelve times faster than what the overall U. S. economy experienced during that same time period.[70]

[65] "U.S. Solar Market Insight Report: Q4 2015." GTM Research/SEIA. March 2016.

[66] Ibid.

[67] Ibid.

[68] Ibid.

[69] Solar Foundation. (2016). National Solar Jobs Census 2015. Washington, DC: The Solar Foundation.

[70] Ibid.

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