IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in the United States 2014

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 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 2014. 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 2014 statistics if the PV modules were <u>installed and connected to the grid</u> between 1 January and 31 December 2014, 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 6 212 MW_{DC} of new grid-connected PV capacity added in 2014, bringing its cumulative total to approximately 18 317 MW_{DC}. Because a reliable data source for off-grid systems is no longer 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 2014, there were nearly 644 038 distributed PV systems interconnected across the United States.

Centralized PV systems (utility applications) generate electricity that is fed directly to the grid, without serving an on-site load. This sector expanded from 2 855 MW_{DC} installed in 2013 to 3 934 MW_{DC} installed in 2014.

Several utilities in the U.S. lease customer roof space for PV generation that is fed directly back to the grid, often with the goal of placing systems "strategically" on the grid for grid support benefits. This emerging utility business now blurs the line between utility-scale and distributed PV. One of the largest utility rooftop programs is in California and has a target capacity of 250 MW, all in 1 MW to 5 MW segments.

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.

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.

1.2 Total photovoltaic power installed

Table 1: PV power installed during calendar year 2014.

AC			MW installed in 2014 (mandatory)	MW installed in 2014 (optional)	AC or DC
Grid-connected	BAPV	Residential	2 277		DC
		Commercial			DC
		Industrial			DC
	BIPV (if a specific legislation exists)	Residential	Not avalable		
		Commercial			
		Industrial			
	Ground-mounted	cSi and TF	3 934		DC
		CPV			DC
Off-grid		Residential	Not avalable		
		Other	Not avalable		
		Hybrid systems			
		Total	6 212		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
	Additional comments on market and data collection, especially the estimated accuracy of data.

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

MW-GW for capacities and GWh-TWh for energy	2014 numbers	2013 numbers
Total power generation capacities (all technologies)	Not available	1 164 022 MW
Total power generation capacities (renewables including hydropower)	Not available	186 643 MW

Total electricity demand (= consumption)	Not available	3 868 526 GWh
New power generation capacities installed during the year (all technologies)	17 387 MW_{AC}[1]	17 385 MW_{AC}[2]
New power generation capacities installed during the year (renewables including hydropower)	9 666 MW_{AC}	8 336 MW_{AC}
Total PV electricity production in GWh-TWh	23 686[3]	15 702[4]
Total PV electricity production as a % of total electricity consumption	0,61%[5]	0,41%

Source: data in this table are from the United States Energy Information Administration (EIA)[6]unless cited otherwise.

Table 4: Other information.

	2014 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	644 038
Capacity of decommissioned PV systems during the year in MW	Not available
Total capacity connected to the low voltage distribution grid in MW	8 573 MW_{DC} (includes all US distributed PV)
Total capacity connected to the medium voltage distribution grid in MW	3001 MW_{DC} (includes all U.S. utility-scale PV below 20 MW_{AC})[7]

[1] Includes distributed PV capacity as reported by the Solar Electric Power Association report, "Utility Solar Market Snapshot: Sustained Growth in 2014." Data for utility-scale generation capacity from the United States Federal Energy Regulatory Commission report, "Office of Energy Projects Energy Infrastructure Update for December 2014." https://www.ferc.gov/legal/staff-reports/2014/dec-infrastructure.pdf.

[2] Ibid.

[3] Based on cumulative PV capacity at year end 2014, as reported by SEIA and GTM Research (March 2015). "U.S. Solar Market Insight Report: Q4 2014." Assumes 14.8 % average capacity factor.

[4] Ibid.

[5] Percentage is based off of 2013 total electricity demand and 2014 year end PV capacity.

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

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

Total capacity connected to the high voltage transmission grid	6 773 MW_{DC} (includes all U.S. utility-scale PV above 20 MW_{AC})[8]

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	N/A	N/A	110	9	149
2005	N/A	N/A	188	10	228
2006	N/A	N/A	293	10	333
2007	N/A	N/A	444	19	493
2008	N/A	N/A	726	35	791
2009	N/A	N/A	1 089	101	1 220
2010	N/A	N/A	1 672	368	2 070
2011	N/A	N/A	2 809	1 152	3 985
2012	N/A	N/A	4 375	2 955	7 351
2013	N/A	N/A	6 296	5 810	12 105
2014	N/A	N/A	8 573	9 744	18 317

[8] Data represents GTM/SEIA of utility PV projects, including only those projects above 20 MW_{AC} 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 decreased 12 % from 2013 to 2014 and is 80 % below what it was 7 years ago, in 2007. In 2014 there was a wide variety in reported module price, with average global module prices reported between 0,66 USD/Wp and 0,85 USD/Wp for portions of the year.[9]

Table 6: Typical module prices for a number of years

Year	2007	2008	2009	2010	2011	2012	2013	2014
Standard module prices: mid-range	3,98	3,65	2,82	2,36	1,67	0,85	0,88	0,76
Standard module prices: large-quantity buyers	3,50	3,25	2,18	1,48	1,28	0,65	0,81	0,71
PV module price for concentration (if relevant)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Sources: SPV Market Research.[10]

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 and hundreds of individual systems have been installed for less than 2,0 USD/W_{DC}. This downward trend is somewhat masked by the increasing 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 2,89 USD/Wp in 2013 to 2,64 USD/Wp in 2014.

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

Category/Size	Typical applications and brief details	Current prices per W (Q4 2014)
OFF-GRID Up to 1 kW	N/A	N/A
OFF-GRID >1 kW	N/A	N/A
Grid-connected Rooftop up to 10 kW (residential)		4,61

[9] Bloomberg New Energy Finance. Solar Spot Price Index. Assessed April 6, 2015.

[10] Mints, Paula. "Photovoltaic Manufacturer Shipments: Capacity, Price & Revenues 2014/2015." SPV Market Research. April, 2015.

Grid-connected Rooftop from 10 to 250 kW (commercial)		3,44
Grid-connected Rooftop above 250kW (industrial)		N/A
Grid-connected Ground-mounted above 1 MW		1,77
Other category existing in your country (hybrid diesel-PV, hybrid with battery…)		

Sources: "Capacity-Weighted Average" price data for residential, non-residential, and utility systems from GTM/SEIA Solar Market Insight.[11]

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

2014 USD/W_{DC}	2006	2007	2008	2009	2010	2011	2012	2013	2014
Residential	9,08	9,20	8,84	8,44	7,12	6,32	5,40	4,69	4,23
Non-residential, ≤500kW	8,84	8,93	8,68	8,57	6,87	5,81	5,03	4,32	3,91
Non-residential, >500kW	7,81	7,51	7,43	7,56	5,75	4,72	4,33	3,50	2,76
Ground-mounted					4,23	3,63	3,09	2,69	2,36

Source: data from The Lawrence Berkeley National Laboratory.[12] Pricing for "residential" and "non-residential" represent the median 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.

2.3 Financial Parameters and programs

Table 11: PV financing scheme

Average Cost of capital per market segment	Tax-equity investor for utility-scale project: 8 - 9 %[13] Tax-equity investor for a portfolio of rooftop installations: 9 – 10 %[14]
Third Party Ownership	The up-front capital requirements of PV installations often deter PV adoption. 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 2014

[11] "U.S. Solar Market Insight Report: Q4 2014." GTM/SEIA. March 2015.
[12] Barbose, G.; Darghouth, N.; Weaver, S.; Wiser, R. (Forthcoming). "Tracking the Sun VIII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2014." Berkeley, CA: Lawrence Berkeley National Laboratory.
[13] Martin, K. (2014). "Solar Tax Equity Market: State of Play." *Chadbourne & Parke Project Finance News: May 2015*.
[14] IBID.

	approximately 60 %[15] of residential systems installed through the California Solar Initiative[16] used third-party financing arrangements.

2.4 Additional Country information

This paragraph provides additional information regarding the country's population and additional parameters linked to its electricity system.

Table 12: Country information

Retail Electricity Prices for an household (range)	Average: 0,12 USD. Range 0,09 USD (Washington) – 0,37 USD (Hawaii) / KWh[17]
Retail Electricity Prices for a commercial company (range)	Average: 0,10 USD. Range 0,07 USD (Idaho) –0,34 USD (Hawaii) / KWh[18]
Retail Electricity Prices for an industrial company (range)	Average: 0,07 USD. Range 0,04 USD (Washington) – 0,30 USD (Hawaii) / KWh[19]
Population at the end of 2014	320 087 963[20]
Country size (km^2)	9 826 675[21]
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 $kWh/m^2/day$[22]
Name and market share of major electric utilities.	Duke Energy (4 %), Pacific Gas & Electric (4 %), Edison International (4 %), Exelon Company (3 %), Next Era Energy, Inc. (3 %), Southern Company (3 %), American

[15] Based on data provided by the California Solar Initiative (CSI). http://www.californiasolarstatistics.ca.gov/current_data_files/, accessed June 18, 2015.

[16] In 2014, the California Solar Initiative composed 18 % of all California residential installed capacity, and 9 % of all U.S. residential installed capacity. Percentages based on GTM/SEIA installation figures and data from CSI, http://www.californiasolarstatistics.ca.gov/current_data_files/, accessed April 8, 2015.

[17] Data, as of 2013, from EIA, forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U. http://www.eia.gov/electricity/data/browser, accessed June 24, 2015.

[18] IBID.

[19] IBID.

[20] Annual Estimates of the Resident Population for the United States, States, Counties, and Puerto Rico Commonwealth and Municipios: as of December 31, 2014. Source: U.S. Census Bureau, Population Division. Release Date: June 2014. Census.gov, accessed June 18, 2015.

[21] Data from the CIA World Factbook, as of June 20, 2014. https://www.cia.gov/library/publications/the-world-factbook/geos/us.html, accessed July 10, 2014.

[22] Data from the National Renewable Energy Laboratory. http://www.nrel.gov/gis/images/eere_pv/national_photovoltaic_2012-01.jpg, accessed June 24, 2015.

	Electric Power (3 %), First Energy Corp. (2 %), Xcel Energy, Inc. (2, 5%), National Grid PLC. (2 %)[23]

[23] 2012 data from EIA, forms EIA-861- schedules 4A & 4D and EIA-861S, released December 12, 2013. http://www.eia.gov/electricity/data.cfm#sales, accessed July 10, 2014. Percentages based on total U.S. customers served.

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

Table 13: PV support measures (summary table)

	On-going measures	Measures that commenced during 2014
Feed-in tariffs (gross / net?)	6 States and 17 utilities offer some kind of feed in tariff	N/A
Capital subsidies for equipment or total cost	Federal: 30 % Investment Tax Credit, State: At least 22 states, the District of Columbia, and Puerto Rico offer capital subsidies.[24]	N/A
Green electricity schemes	To date, more than 860 utilities, including investor-owned, municipal utilities, and cooperatives, offer a green pricing option. For more information, visit www.eere.energy.gov/greenpower/.	N/A
PV-specific green electricity schemes	N/A	N/A
Renewable portfolio standards (RPS)	29 states plus the District of Columbia, Guam, Puerto Rico, and Virgin Islands, have an RPS.[25]	In June 2014, Ohio instituted a freeze to keep the state's RPS level flat for 2 years.
PV requirement in RPS	21 states and the District of Columbia have solar or distributed generation provisions.[26]	In June 2014 South Carolina passed an updated renewable goal allowing utilities to recapture costs related to deploying distributed sources of energy. In April 2014, Massachusetts' new solar carve out took effect, expanding the

[24] Data from the Database of State Incentives for Renewables & Efficiency (DSIRE). http://www.dsireusa.org/summarytables/finre.cfm, accessed July 10, 2014.

[25] Data DSIRE. http://www.dsireusa.org/rpsdata/, accessed July 10, 2014.

[26] IBID.

		state's goal from 400 MW to 1600 MW.
Investment funds for PV	Numerous utilities, venture capital firms and other financial companies offer public and private investors opportunity to invest in PV.	Investment in yieldcos has increased readily, as new funds have emerged. In 2014 three new ~~yeildcos~~ yieldcos that include substantial solar assets made their initial public offering (Teraform Power, NextEra Energy Partners, and Abengoa Yield). These funds currently have a market cap of over $15.8 billion
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.[27]	
Prosumers' incentives (self-consumption, net-metering, net-billing…)	44 states plus the District of Columbia and Puerto Rico have net metering policies. See the report, "Freeing the Grid," for a review of best practices.[28]	3 states (NY, SC, VT) expanded NEM caps, 8 modified their NEM Programs or have instituted new tariff designs
Commercial bank activities e.g. green mortgages promoting PV	Connecticut, Hawaii, New York, California and Vermont have created green banks	In Dec. '14 Fannie Mae released standards for loans they will buy, addressing both host-owned and TPO systems Some commercial banks have begun to offer solar-specific loans for customers. In 2015 Massachusetts announced a new public/private low interest loan system that began in early 2015.
Activities of electricity utility businesses	Several electricity utilities have begun engaging with PV development, either through direct	

[27] Data from DSIRE. http://programs.dsireusa.org/system/program/tables, accessed June 24, 2015.

[28] Barnes, J.; Culley, T; Haynes, R.; Passera, L.; Wiedman, J; Jackson R. "Free the Grid 2014." Interstate Renewable Energy Council, The Vote Solar Initiative. November 2014. http://freeingthegrid.org/#download-ftg/, accessed June 24, 2015.

	ownership of centralized and distributed PV assets, partial ownership in PV development companies, or joint marketing agreements.	
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

3.2 Direct Support measures

3.2.1 Support measures exiting in 2014

3.2.1.1 Description of support measures excluding prosumers, 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 44 states plus the District of Columbia and Puerto Rico have net metering policies. Some states choose to couple net metering with feed-in tariffs to encourage deployment. Recently some jurisdictions have seen disputes between utilities and solar advocates over net metering, but utilities have not been successful in overturning NEM policies. That said, 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, many states will be required to adjust their NEM programs in the future, likely decreasing the value of energy put onto the grid by PV systems, in order to continue expanding their NEM programs. Areas without net metering may employ different practices to value solar energy while some do not compensate for gird pared solar.

3.2.1.2 Prosumers' development measures

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 44 states plus the District of Columbia and Puerto Rico have net metering policies. Some states choose to couple net metering with feed-in tariffs to encourage deployment. Recently some jurisdictions have seen disputes between utilities and solar advocates over net metering, but utilities have not been successful in overturning NEM policies. Areas without net metering may employ different practices to value solar energy while some do not compensate for gird pared solar.

3.2.1.3 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.[29]

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

3.2.1.4 *Rural electrification measures*

Nearly 99 % of Americans have access to electricity.[30] 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.

3.2.1.5 *Other measures including decentralized 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 1,62 USD/Wp. To-date it has funded approximately 9 MW of storage, however in 2014 over 89 MW of storage reserved rebates.[31] 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.[32]

3.2.2 Support measures phased out in 2014

The current U.S. federal incentives are in-place until at least 2017, however several state programs lowered PV incentive budgets, or exhausted funds, in 2014. For example, the California state-level PV incentive program, the California Solar Initiative, managed by the state's three largest electric utilities, has fully depleted or is in the tail-end of many of programs (note: California is the largest distributed PV market in the U.S.).

3.2.3 New support measures implemented in 2014

No new U.S. federal incentives were implemented in 2014, however many U.S. incentives are implemented at the state and local level. In 2014 New York and Massachusetts introduced new incentive programs that replaced former rebate or REC programs. Additionally, several states continued developing and/or implementing community shared solar programs that make PV available to customers without the ability to install onsite PV installations.

3.2.4 Measures currently discussed but not implemented yet

Several state public utility commissions and utilities are in the process of developing a Value-of-Solar Tariff (VOST) as an alternative to net metering. As of December 2014, 6 states (Arkansas, Missouri, Indiana, Kentucky, North Carolina and Maine) had pending changes to net metering rules and one state (Montana) had a pending net metering expansion. Additionally, several states have discussed but not yet implemented regulations that more easily allow community shared solar programs, such as virtual net metering bill-credit mechanisms.

3.2.5 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

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

[31] Data from the Center for Sustainable Energy California. "Quarterly Statewide Report." June 1, 2015. http://energycenter.org/programs/self-generation-incentive-program/program-reports, accessed June 19, 2015.

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

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.[33]

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 need to 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.

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 2014 approximately 60% of residential systems installed through the California Solar Initiative[34] used third-party financing arrangements. 24 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. Additionally, 30 states and the District of Columbia have Property Assessed Clean Energy (PACE) programs which allow energy efficiency or renewable energy improvements to be financed through property taxes.

3.3 Indirect policy issues

In June 2014 the U.S. Environmental Protection Agency announced new air quality standards for new and existing power plants. By 2020 every State will have a goal establishing their carbon intensity and a plan to achieve those emission reductions. 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.[35]

[33] 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.

[34] In 2014, the California Solar Initiative composed 18 % of all California residential installed capacity, and 9 % of all U.S., residential installed capacity.

[35] EPA. Fact Sheet: Clean Power Plan Framework. http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-framework, accessed July 10, 2014.

3.3.1 International policies affecting the use of PV Power Systems

In December of 2012, in an effort to make U.S. PV manufacturing more competitive, and to settle claims by U.S. manufacturers that Chinese manufacturers "dumped" product into the U.S. market and received unfair subsidies from the Chinese government, the U.S. Department of Commerce issued orders to begin enforcing duties to be levied on products with Chinese made PV cells. The majority of the tariffs range between 23 % -34 % of the price of the product. However, some U.S. manufacturers believed that Chinese manufacturers were circumventing the tariffs by manufacturing modules with cells sourced from other countries such as Taiwan. In December of 2013 SolarWorld filed new antidumping and countervailing petitions with the U.S. Department of Commerce and the United States International Trade Commission (ITC) against Chinese and Taiwanese manufacturers of PV cells and modules. In March of 2014, the ITC made a preliminary determination, "that there is a reasonable indication that an industry in the United States is materially injured by reason of imports from China and Taiwan of certain crystalline silicon photovoltaic products."[36] In December of 2014 DOC issued its new tariffs for Chinese and Taiwanese cells ranging from 11-30% for Taiwanese companies and 75-91% for Chinese companies. [37] However, in early 2015 the US Department of Commerce released a preliminary review of the 2012 tariffs indicating that they may be reduced from approximately 31% to 18%.[38]

3.3.2 The introduction of any favourable environmental regulations

On the Federal Level, carbon emissions are regulated by the Environmental Protection Agency (EPA) to assist in cutting GHGs by 17 % by 2020. EPA has state-specific goals for emissions attainment in fossil fuel fired power plants. In 2014, the U.S. Environmental Protection Agency (EPA), which regulates power plant carbon emissions, issued proposed rules for carbon emissions reductions of 30 % (from 2005 levels) by a state-by-state approach to be implemented between 2020 and 2030. These rules are not finalized nor will there necessarily be specific solar adoption targets, however if implemented these regulations could encourage significant PV adoption in several areas of the United States.

3.3.3 Policies relating to externalities of conventional energy

Many states have implemented programs to help curb greenhouse gas (GHG) emissions. California began enforcing a cap and trade program in 2013, which aims to cut GHG emissions by 16 % by 2020.[39] Additionally, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont have formed a regional alliance called the Regional Greenhouse Gas Initiative (RGGI) to promote cap and trade. In 2014, RGGI will place a cap of 91 million tons, which will decline 2.5 percent each year from 2015 to 2020.

3.3.4 Taxes on pollution (e.g. carbon tax)

N/A

3.3.5 National policies and programmes to promote the use of PV in foreign non-IEA countries

[37] Federal Register (Vol. 79, No. 246 – notices 76970, 76962, 76966)

[38] J. Parnell. "Chinese solar firms boosted by reduced 2012 US trade tariffs." PVTech. January 5, 2015.

[39] Center for Climate and Energy Solutions. http://www.c2es.org/us-states-regions/key-legislation/california-cap-trade

The United States government has several institutions with the aim of supporting research for PV or financing the development of PV systems in foreign non-IEA countries. The Overseas Private Investment Corporation (OPIC) is the U.S. Government's development finance institution. It mobilizes private capital to help solve critical development challenges and in doing so, advances U.S. foreign policy. In 2014 OPIC provided over 700 MUSD for solar projects in South America, Asia and Africa.[40] The Export-Import Bank of the United States has provided loans to Indian companies to help build PV projects in India using U.S. PV modules. Additionally, the United States Department of Energy helps fund the 125 MUSD U.S.-India Joint Clean Energy Research and Development Center. These consortia – led in the U.S. by the National Renewable Energy Laboratory (NREL), the University of Florida, and Lawrence Berkeley National Laboratory (LBNL) – bring together experts from national laboratories, universities, and industry in both the U.S. and India. Consortia researchers leverage their expertise and resources in solar technology, advanced biofuels, and building efficiency to unlock the huge potential of clean energy technologies that can reduce energy use, cut dependence on foreign oil, and accelerate the deployment of renewable energy sources.[41]

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).[42] 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

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[40] OPIC. "Annual Report 2014." https://www.opic.gov/sites/default/files/files/opic-fy14-annual-report.pdf, accessed June 25, 2015.

[41] DOE. "Energy Department Announces Selections for U.S.-India Joint Clean Energy Research and Development Center." April 13, 2012. http://energy.gov/articles/energy-department-announces-selections-us-india-joint-clean-energy-research-and-development, accessed June 26, 2015.

[42] 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

transformation areas to quantitatively 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 2014 include:

- Working with small businesses to eliminating market barriers and reduce non-hardware costs and to encourage technology innovation to support SunShot goals.

- Working with industry, national laboratories and university researchers to advance the state of the art for solar forecasting, speed solar energy innovation, and lower costs and improve grid inter-connection.

- Working with utilities to develop adaptable and replicable practices, long-term strategic plans, and technical solutions to sustain reliable operations with large proportions of solar power on the grid.

It is estimated that the RD&D funding provided by SETO accounts for approximately 50% of all public RD&D in the U.S. In addition, U.S. RD&D funding also comes 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.

	R & D	Demo/Field test
National/federal	MUSD 432	MUSD 26
State/regional	MUSD 7[43]	
Total	MUSD 466	

[43] Includes only published solar grant opportunities or budget line items for Solar R&D

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)
Hemlock, SunEdison, REC	Polysilicon feedstock	49 059 tonnes	N/A	N/A
SolarWorld, SunEdison	Wafers	21 MW	N/A	N/A

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

SunEdison, one of the largest U.S. wafer manufacturers, also has significant manufacturing capacity in Malaysia and China.

5.2 Production of photovoltaic cells and modules (including TF and CPV)

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 997 MW_{DC} of modules and 400 MW_{DC} of cells in 2014.

Total PV cell and module production, together with production capacity information, is summarised in Table 16, below.

Table 16: Production and production capacity information for 2014

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		400	*523*	*538*	*733*
Thin film manufacturers					
Total			*475*		*687*
Cells for concentration					
Total			*N/A*		*N/A*
TOTALS		**400**	**997**	**538**	**1 419**

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 2014 First Solar produced 1,8 GW of PV modules and SunPower produced approximately 1,2 GW of PV modules.[44]

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

5.3 Manufacturers and suppliers of other components

U.S. companies shipped approximately 4,2GW_{AC} of PV inverters in 2014; approximately 93 % of all U.S. systems installed during that time period. 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 the first half of 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.

6 PV IN THE ECONOMY

6.1 Labour places

Table 17: Estimated PV-related labour places in 2014

Research and development (not including companies)	Not available
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	32 490
Distributors of PV products	20 158
System and installation companies	15 112
Electricity utility businesses and government	1 034
Other	7 955
Total	173 807[45]

6.2 Business value

Table 18: Value of PV business

Sub-market	**Capacity installed *in 2014* (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	*2 277*	*4,05*	*BUSD 9,2*	*BUSD 9,2*
Grid-connected centralized	*3 934*	*1,83*	*BUSD 7,2*	*BUSD 7,2*
				BUSD 16,4
Export of PV products				*N/A*
Change in stocks held				*N/A*
Import of PV products				*N/A*
Value of PV business				***BUSD 16,4***

U.S. PV manufacturing, which contracted in 2011-13 after having shipment growth of 10x from 2003-2010, began to recover in 2014. At least seven companies announced in 2014 that they would be adding manufacturing capacity in the U.S. over the next five years which could more than double U.S. cell and module manufacturing capacity.

[45] The Solar Foundation. "2014 National Solar Job Census." January 2015. http://thesolarfoundation.org/research/national-solar-jobs-census-2013, accessed June 22, 2015.

Additionally, U.S. manufacturing has a significant presence in other parts of the PV value chain, including polysilicon, encapsulants, wiring, and fasteners. U.S. solar manufacturing jobs increased by 9 % from 2013-14, to a total of approximately 2 500 employees. In 2015, this number is projected to increase another 14 %.[46] Additionally, manufactured hardware is only a portion of the total solar value chain. Industry-wide, approximately 80 000 jobs relating to solar were added from 2010 to 2014, growing to a total of 174 000 employees (31 000 of which were added in 2014 alone). The growth rate from 2013 to 2014 of 22 % was twenty times faster than what the overall U.S. economy experienced during that same time period.[47]

[46] Solar Foundation. (2015). *National Solar Jobs Census 2014*. Washington, DC: The Solar Foundation.

[47] 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 65 % of consumers are served by an investor owned utility and the remaining customers are primarily served by municipal utilities, cooperatives, and power marketers.[48] 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 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. To date, 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.[49]

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

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48 Data, as of 2013, from EIA, forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U. http://www.eia.gov/electricity/data/browser, accessed June 24, 2015.

49 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. See the following websites for more information. http://www.solarelectricpower.org/media/156968/usbm%20executive%20summary.pdf and http://www.solarelectricpower.org/media/84333/sepa%20usbm%201.pdf

- acquisition of sites for development
- “flip” transactions that can take various forms.

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 STANDARDS AND CODES

Model building codes in the United States are developed by the International Code Council. During the current revision cycle, there are many PV-related changes being considered, both for residential and commercial systems. The Solar Energy Industries Association, the Solar America Board of Codes and Standards, and the industry at-large is involved in the development process.

In 2014 the California Public Utilities Commission began exploring mandating smart inverter use in new solar installations. They outlined a schedule to pilot test advanced functions in 2014, with the goal of making them mandatory by 2015. Other changes to standards and codes within the PV industry were made in the National Electric Code (NEC) 2014, which requires new approaches toward ensuring safety of PV systems and PV reliability. More states are adopting and moving to the 2014 NEC standard, increasing the need to meet rapid shutdown requirements. Additionally, new International Building Code requirements around fire safety have required module and racking manufacturers to seek additional testing.

9 HIGHLIGHTS AND PROSPECTS

From 2010-2014, the U.S market increased its annual installation by approximately 1,3 GW more than the previous year; growing in annual installations from 0,9 MW in 2010 to 6,2 MW in 2014. Much of the growth came from utility-scale installations. PV capacity continues to be concentrated in a small number of states, such as California, Arizona and New Jersey, which comprise 2/3rds of the market. However, this trend is changing slowly as 25 states currently have 50 MW or more of PV capacity and 15 states each installed more than 50 MW in 2014 alone. With more than 3,4 GW of PV projects under construction as of February 2015, that have individual capacities above 1 MW in size, total installations in 2015 are expected to increase yet again. 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, PV component pricing, globally, has reached historic lows, which should further drive U.S. demand in the near future. Finally, state RPS targets require a larger amount of renewable energy additions in 2015 than in previous years, encouraging more growth within the market.

U.S. PV manufacturing, which contracted in 2011-13 after having shipment growth of 10x from 2003-2010, began to recover in 2014. At least seven companies announced in 2014 that they would be adding manufacturing capacity in the U.S. over the next five years which could more than double U.S. cell and module manufacturing capacity.

Additionally, U.S. manufacturing has a significant presence in other parts of the PV value chain, including polysilicon, encapsulants, wiring, and fasteners. U.S. solar manufacturing jobs increased by 9 % from 2013-14, to a total of approximately 2 500 employees. In 2015, this number is projected to increase another 14 %.[50] Additionally, manufactured hardware is only a portion of the total solar value chain. Industry-wide, approximately 80 000 jobs relating to solar were added from 2010 to 2014, growing to a total of 174 000 employees (31 000 of which were added in 2014 alone). The growth rate from 2013 to 2014 of 22 % was twenty times faster than what the overall U.S. economy experienced during that same time period.[51]

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[50] Solar Foundation. (2015). *National Solar Jobs Census 2014*. Washington, DC: The Solar Foundation.

[51] Ibid.

Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, electricity utility businesses etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is USD

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams

Compensation schemes (self-consumption, net-metering, net-billing…)	These schemes allow consumers to reduce their electricity bill thanks to PV production valuation. The schemes must be detailed in order to better understand if we are facing self-consumption schemes (electricity consumed in real-time is not accounted and not invoiced) or net-billing schemes (the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle). The compensation for both the electricity self-consumed and injected into the grid should be detailed. Net-metering schemes are specific since they allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development