IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in the United States 2013

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

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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 23 member countries. The European Commission also participates in the work of the Agency.

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 24 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Thailand (THA), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission (EC), the European Photovoltaic Industry Association (EPIA), the US Solar Electric Power Association (SEPA), the US Solar Energy Industries Association (SEIA) and the Copper Alliance are also members.

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 2013. 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 2013 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2013, although commissioning may have taken place at a later date**.

Data in this report is provided by the Solar Energy Industries Association (SEIA) and GTM Research, unless cited otherwise. SEIA and GTM survey over 200 utilities, state agencies, installers, and manufactures to establish current trends and provide quarterly updates on the status of the solar industry.

1.1 Applications for Photovoltaics

Growth in the United States' (U.S.) PV market has been propelled by grid-connected PV installations, with approximately 4 751 MW_{DC} of new grid-connected PV capacity added in 2013, bringing its cumulative total to approximately 12 079 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 2013, there were nearly 445 000 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 1 803 MW_{DC} installed in 2012 to 2 847 MW_{DC} installed in 2013.

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 (usually deep-cycle, lead-acid batteries) 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 2013

AC			**MW installed in 2013 (mandatory)**	**MW installed in 2013 (optional)**	**AC or DC**
Grid-connected	BAPV	Residential	1 904 MW_{DC}		DC
		Commercial			DC
		Industrial			DC
	BIPV (if a specific legislation exists)	Residential	Not available		
		Commercial			
		Industrial			
	Ground-mounted	cSi and TF	2 847 MW_{DC}		DC
		CPV			DC
Off-grid		Residential	Not available		
		Other	Not available		
		Hybrid systems			
		Total	4 751 MW		DC

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	NA
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

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

MW-GW for capacities and GWh-TWh for energy	2013 numbers	2012 numbers

Total power generation capacities (all technologies)	Not available	1 167 995 GW
Total power generation capacities (renewables including hydropower)	Not available	181 732 GW
Total electricity demand (= consumption)	28 583 582 GWh	27 842 848 GWh
New power generation capacities installed during the year (all technologies)	15 980 MW_{AC}[1]	29 914 MW_{AC}[2]
New power generation capacities installed during the year (renewables including hydropower)	6 247 MW_{AC}	15 158 MW_{AC}
Total PV electricity production in GWh-TWh	15 702 GWh[3]	9 526 GWh[4]
Total PV electricity production as a % of total electricity consumption	0,43 %	0,26 %

Source: data in this table are from the United States Energy Information Administration (EIA)[5]unless cited otherwise.

Table 4: Other informations

	2013 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	445 000
Capacity of decommissioned PV systems during the year in MW	Not available
Total capacity connected to the low voltage distribution grid in MW	6 277 MW_{DC} (includes all U.S. distributed PV)
Total capacity connected to the medium voltage distribution grid	2 691 MW_{DC} (includes all U.S. utility-scale PV below 20 MW_{AC})[6]

[1] Data from the United States Federal Energy Regulatory Commission reports, "Office of Energy Projects Energy Infrastructure Update for December 2013 & December 2012." http://www.ferc.gov/legal/staff-reports/2013/dec-energy-infrastructure.pdf. http://www.ferc.gov/legal/staff-reports/dec-2012-energy-infrastructure.pdf. Figures adjusted by reported solar values, which currently include figures reported by the Solar Electric Power Association (SEPA). http://www.solarelectricpower.org/media/169342/solar-rankings-infographic-2013.pdf. http://www.solarelectricpower.org/media/51302/final-2012-top-10-report-v2.pdf.

[2] IBID.

[3] Based on cumulative PV capacity at year end 2013, as reported by SEIA and GTM Research (March 2014). "U.S. Solar Market Insight Report: Q4 2013." Assumes 14.8 % average capacity factor.

[4] IBID.

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

[6] Data represents GTM/SEIA of utility PV projects, excluding all projects above 20 MW_{AC} which are tracked by an internal NREL utility-scale database.

in MW	
Total capacity connected to the high voltage transmission grid in MW	3 111 MW_{DC} (includes all U.S. utility-scale PV above 20 MW_{AC})[7]

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

Sub-market	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Stand-alone domestic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Stand-alone non-domestic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Grid-connected distributed	94	172	277	428	710	1 087	1 672	2 807	4 373	6 277
Grid-connected centralized	17	18	18	27	43	101	368	1 152	2 955	5 802
TOTAL (MW)	111	190	295	455	753	1 188	2 040	3 959	7 328	12 079

[7] Data represents all 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 increased 9 % from 2012 to 2013; however is still 75 % below what it was 5 years ago, in 2008. In 2013 there was a wide variety in reported module price, with average Chinese module prices reported at 0,65 USD/Wp for portions of the year, as noted below.

Table 6: Typical module prices for a number of years (USD/Wp)

Year	2007	2008	2009	2010	2011	2012	2013
Standard module price(s): Typical	3,50	3,25	2,18	1,48	1,37	0,75	0,82
Best price	NA	NA	NA	NA	0,89	0,64	0,65
PV module price for concentration (if relevant)	NA	NA	NA	NA	NA	NA	NA

Sources: "Standard module price" data from SPV Market Research.[8] *"Best Price" from Bloomberg New Energy Finance.*[9]

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 3,48 USD/W in 2012 to 2,89 USD/W in 2013.

A summary of typical system prices is provided in tables 7 and 8, below.

Table 7: **Turnkey Prices of Typical Applications**

Category/Size	Typical applications and brief details	Current prices, USD per W (Q4 2013)
OFF-GRID Up to 1 kW	NA	NA
OFF-GRID >1 kW	NA	NA
Grid-connected Rooftop up to 10 kW (residential)		4,59
Grid-connected Rooftop from 10 to 250 kW (commercial)		3,57

[8] Mints, Paula. "Photovoltaic Manufacturer Shipments: Capacity, Price & Revenues 2013/2014." SPV Market Research. April, 2014.

[9] Bloomberg New Energy Finance. Solar Spot Price Index. Accessed June 10, 2014. Represents lowest two-week average Chinese multi-crystalline module for each calendar year.

Grid-connected Rooftop above 250kW (industrial)		
Grid-connected Ground-mounted above 1 MW		1,96
Other category existing in your country (hybrid diesel-PV, hybrid with battery…)		

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

2013 USD/Wp	2006	2007	2008	2009	2010	2011	2012	2013
Residential PV systems < 10 KW	8,98	9,08	8,73	8,35	7.06	6,28	5,35	4,72
Commercial and industrial > 100 KW	8,02	7,69	7,75	7,79	5,88	4,99	4,62	3,96
Ground-mounted > 5MW					3,80	3,52	3,00	3,11

Source: data from The Lawrence Berkeley National Laboratory.[10] Pricing for "commercial and industrial" represents the median system price for behind-the-meter systems above 100 kW in size. Pricing for "ground-mounted" represents the capacity-weighted average price of systems 5 MW or greater.

2.3 Financial Parameters and programs

Table 9: PV financing scheme

Average Cost of capital	Tax-equity investor for utility-scale project: 8 %[11] Tax-equity investor for a portfolio of rooftop installations: 9%[12]
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 2013 approximately 69 %[13] of residential systems installed through the California Solar Initiative[14] used third-party financing arrangements.

[10] Barbose, G.; Darghouth, N.; Weaver, S.; Wiser, R. (Forthcoming). "Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2013." Berkeley, CA: Lawrence Berkeley National Laboratory.

[11] Martin, K. (2014). "Cost of Capital: 2014 Outlook." *Chadbourne & Parke Project Finance News: February 2014*.

[12] IBID.

[13] Based on data provided by the California Solar Initiative (CSI). http://www.californiasolarstatistics.ca.gov/current_data_files/, accessed August 4, 2014.

[14] In 2013, the California Solar Initiative composed 66 % of all California residential installed capacity, and 34 % of all U.S., residential installed capacity. Percentages based on GTM/SEIA installation

2.4 Additional Country information

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

Table 10: Country information

Retail Electricity Prices for an household (range)	Average: 0,12 USD. Range 0,08 USD (Louisiana) – 0,37 USD (Hawaii) / KWh[15]
Retail Electricity Prices for a commercial company (range)	Average: 0,10 USD. Range 0,07 USD (Idaho) – 0,35 USD (Hawaii) / KWh[16]
Retail Electricity Prices for an industrial company (range)	Average: 0,07 USD. Range 0,04 USD (Washington) – 0,31 USD (Hawaii) / KWh[17]
Population at the end of 2013 (or latest known)	316 128 839[18]
Country size (km^2)	9 826 675[19]
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[20]
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 Electric Power (3 %), First Energy Corp. (2 %), Xcel Energy, Inc. (2, 5%), National Grid PLC. (2 %)[21]

figures and data from CSI, http://www.californiasolarstatistics.ca.gov/current_data_files/, accessed August 4, 2014.

[15] Data, as of 2012, from EIA, forms EIA-861- schedules 4A-D, EIA-861S and EIA-861U. http://www.eia.gov/electricity/data/browser, accessed June 18, 2014.

[16] IBID.

[17] IBID.

[18] Annual Estimates of the Resident Population for the United States, States, Counties, and Puerto Rico Commonwealth and Municipios: as of July 1, 2013. Source: U.S. Census Bureau, Population Division. Release Date: June 2014. Census.gov, accessed July 10, 2014.

[19] 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.

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

[21] 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 11: PV support measures (summary table)

	On-going measures	Measures that commenced during 2013
Feed-in tariffs (gross / net?)	6 States and 17 utilities offer some kind of feed in tariff	Maine's tariff was passed in 2013 and takes effect in 2014
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.[22]	NA
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/.	NA
PV-specific green electricity schemes	NA	NA
Renewable portfolio standards (RPS)	29 states plus the District of Columbia, Guam, Puerto Rico, and Virgin Islands, have an RPS.[23]	none
PV requirement in RPS	17 states and the District of Columbia have solar or distributed generation provisions.[24]	In 2013 Minnesota amended their RPS to include a mandatory amount of solar energy
Investment funds for PV	Numerous utilities, venture capital firms and other financial companies offer public and private investors opportunity to invest in PV.	NRG's YieldCo's IPO in June 2013; at the end of 2013 (22 %) of its assets (in MW) were solar.[25] 2,5 BUSD

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

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

[24] IBID.

[25] Data from corporate public filings from NRG Yield.

		and 1,3 BUSD in tax equity raised for distributed and utility-scale PV funds.[26] SolarCity raised 54 MUSD note secured against cash flows from distributed PV.[27] Several crowd funding opportunities were introduced.
Income tax credits	Federal: federal investment tax credit of 30 % for residential, commercial, and utility systems. State: 22 states offer tax credits for solar projects.[28]	None
Prosumers' incentives (self-consumption, net-metering, net-billing…)	43 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.[29]	None
Commercial bank activities e.g. green mortgages promoting PV	Connecticut, Hawaii, New York and Vermont have created green banks	New York established an initial capitalization of 210 MUSD for its green bank[30]; Hawaii authorized a 100 MUSD in bonds to finance a renewable energy loan fund[31]; Vermont authorized a Clean Energy Loan Fund.
Activities of electricity utility businesses	Several electricity utilities have begun engaging with PV	About 3 GW of utility-scale solar was

[26] Data from Bloomberg New Energy Finance (BNEF), "H1 2014 US PV Market Outlook." March 28,2014.

[27] Data from corporate public filings from SolarCity Corp.

[28] Data from DSIRE. http://www.dsireusa.org/summarytables/finre.cfm, accessed July 10, 2014.

[29] Barnes, J.; Culley, T; Haynes, R.; Passera, L.; Wiedman, J; Jackson R. "Free the Grid 2013." Interstate Renewable Energy Council, The Vote Solar Initiative. November 2013. http://freeingthegrid.org/#download-ftg/, accessed July 10, 2014.

[30] Press release from the New York Governor's Press Office. http://www.governor.ny.gov/press/12192013-funding-to-ny-green-bank, accessed July 10, 2014.

[31] K. Friedrich. "Hawaii Announces New Solar Financing Program." Clean Energy Finance Center. May 2, 2013. http://www.cleanenergyfinancecenter.org/2013/05/hawaii-announces-new-solar-financing-program, accessed July 10, 2014.

	development, either through direct ownership of centralized and distributed PV assets, partial ownership in PV development companies, or joint marketing agreements.	installed in 2013
Sustainable building requirements	Federal: No federal codes exist, but DOE produces best-practices guides for sustainable building for both residential and commercial buildings	NA

3.2 Direct Support measures

3.2.1 ***Support measures exiting in 2013***

3.2.1.1 Description of support measures excluding prosumers, BIPV, and rural electrification

The U.S. supports the domestic installation and manufacturing of PV generating assets for domestic consumption. Financial incentives for U.S. solar projects are provided by the national government, state and local governments, and some local utilities. Historically, national incentives have been provided primarily through the U.S. tax code, in the form of a 30 % Investment Tax Credit (ITC) (which applies to residential, commercial, and utility-scale installations) and accelerated 5-year tax depreciation (which applies to all commercial and utility-scale installations and to third-party owned residential, government, or non-profit installations).

State incentives in the U.S. have been driven in large part due to the passage of Renewable Portfolio Standards (RPS). An RPS, also called a renewable electricity standard (RES), requires electricity suppliers to purchase or generate a targeted amount of renewable energy by a certain date. Although design details can vary considerably, RPS policies typically enforce compliance through penalties, and many include the trading of renewable energy certificates (RECs). A clean energy standard (CES) is similar to an RPS, but allows a broader range of electricity generation resources to qualify for the target. In 2013 Minnesota amended their RPS to include a mandatory amount of solar energy. As of January 2014 seventeen states and Washington D.C. had RPS policies with specific solar provisions.

Several policy and financing mechanisms are emerging that have the potential to incite further solar market expansion through the establishment of widespread local and utility programs. Such policies include state level feed in tariffs and time of use rate structures. Third-party ownership has also gained significant popularity for financing the installation of PV systems, particularly in the residential sector, where in some markets it has achieved 70-80 % market penetration. In 2013 several third-party PV ownership companies issued innovative financing mechanisms to raise cheaper sources of capital through the public markets.

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 43 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.[32]

3.2.1.4 *Rural electrification measures*

Nearly 99 % of Americans have access to electricity.[33] 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/W. To-date it has funded approximately 3 MW of storage, however in 2013 over 11 MW of storage reserved rebates.[34]

3.2.2 ***Support measures phased out in 2013***

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 2013. 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 2013***

No new U.S. federal incentives were implemented in 2013, however many U.S. incentives are implemented at the state and local level. In 2013 Minnesota amended their RPS to include a mandatory amount of solar energy. Additionally, several states, such as California, Washington D.C. and Connecticut, signed legislation which enables community solar gardens implementation.

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. In 2013, U.S. senators reintroduced the Renewable Energy Standards Bill, which would require utilities to generate 25 % of their electricity from renewable energy by 2025. In 2013, the then Chairman of the U.S. Senate Finance Committee proposed overhauling clean-energy tax breaks. The proposal would wipe out all current incentives and offer a production tax credit (of 2,3 US cents/kWh) or an investment tax credit (of 20 %) for clean energy; incentives would phase out over four years once greenhouse gas intensity of each market has declined by 25 % of 2013 levels.

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

[33] Data from the World Bank. http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS, accessed July 10, 2014.

[34] Data from the Center for Sustainable Energy California. "Quarterly Statewide Report." April 2, 2014. http://energycenter.org/programs/self-generation-incentive-program/program-reports, accessed July 10, 2014.

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 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.[35]

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 2013 approximately 69 % of residential systems installed through the California Solar Initiative[36] used third-party financing arrangements. 22 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, 31 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

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[35] 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.

[36] In 2013, the California Solar Initiative composed 66 % of all California residential installed capacity, and 34 % of all U.S., residential installed capacity.

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.[37]

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."[38] If these determinations are made final it has the potential to impact the supply or price of PV modules sourced from China and Taiwan for U.S. PV installations.

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. States are tasked with creating their own implementation plan in order to meet the attainment goals.[39]

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.[40] 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)

NA

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

[38] A Notice by the International Trade Commission on March 4, 2014. "Certain Crystalline Silicon Photovoltaic Products From China And Taiwan." https://www.federalregister.gov/articles/2014/03/04/2014-04677/certain-crystalline-silicon-photovoltaic-products-from-china-and-taiwan, accessed July 10, 2014.

[39] EPA. "Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants." June 2014. http://www.epa.gov/ttn/ecas/regdata/RIAs/111dproposalRIAfinal0602.pdf, accessed July 10, 2014.

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

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

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 2013 OPIC agreed to provide over 200 MUSD for solar projects in South America and Sub-Saharan Africa.[41] 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) – will bring together experts from national laboratories, universities, and industry in both the U.S. and India. Consortia researchers will 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.[42]

[41] OPIC. "Annual Report 2013." http://www.opic.gov/sites/default/files/files/OPIC_AR_2013.pdf, accessed July 10, 2014.

[42] 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 July 10, 2014.

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, the DOE is supporting efforts by private companies, academia, and national laboratories to drive down the cost of solar electricity to about USD 0.06 per kilowatt-hour. This in turn will enable solar-generated power to account for 15–18 % of America's electricity generation by 2030. 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.

The SunShot Initiative is organized in five focus areas: PV, systems integration, technology to market, soft costs, and concentrating solar power (not covered in this report).

PV: SunShot funding supports transformative PV technology R&D with the potential to yield significant cost reductions, efficiency improvements, and improved reliability standards. SunShot also supports the development of next generation PV technologies to carry innovation in solar energy beyond 2020. An example of SunShot funding in this area for FY 2013 is the 16 MUSD F-PACE 2 awards which focus on the development of model systems to understand and overcome barriers to increasing efficiency in Si and thin film solar cells

Systems Integration: Systems integration funding supports strategies to dramatically increase solar penetration in the nation's electrical grid and enable safe, reliable, cost-effective, and widespread solar deployment. An example of SunShot funding in this area for FY 2013 is the 4 MUSD SUNRISE awards which focus on enabling utilities to develop long-term strategic plans that integrate high levels of renewable energy generation, and to ensure reliable real-time power system operations under high renewable penetration. Funding also provides technical assistance for capacity-building activities regarding utility-scale photovoltaic planning and installation.

Technology to market: Technology to market funding supports commercialization, market readiness, and domestic manufacturing supply chains. Small solar businesses selected to participate in SunShot's competitive Incubator program have earned more than $18 in follow-on funding for every $1 in government investment. The success of this program has spurred similar efforts throughout the DOE Office of Energy Efficiency and Renewable Energy (EERE). An example of SunShot funding in this area for FY 2013 is the 13 MUSD SolarMaT awards which assist in the development and demonstration of innovative manufacturing technologies in the PV industry that will increase the U.S. share of the global solar market and create competitive advantage for domestic manufacturers. This program aims to create the next generation of solar industry-standard manufacturing technology.

Soft Costs: And while recent technological advances have drastically reduced the cost of solar hardware, making soft costs a greater share of the overall cost of solar, SunShot soft costs funding supports market transparency, workforce training, local solutions, and process improvements to make solar deployment faster, easier, and cheaper. An example of SunShot funding in this area for FY 2013 is the 15 MUSD GEARED program designed to help support increased power system research, development, and analytical capacity nationwide at the university and graduate level while simultaneously growing the expertise and preparedness of current and incoming electric utility sector professionals for high penetrations of solar and other distributed energy technologies.

Other US R&D funding: Other areas of the federal government, as well as state governments, support PV R&D in the US. Among these are the Department of Defense, the National Science Foundation, the National Institute of Standards and Technology, the California Energy Commission, and the New York State Energy Research & Development Authority.

Substantial research also occurs in the private sector with companies like First Solar contributing heavily to in-house research and development. First Solar spent 134 MUSD on R&D in 2013, roughly 15 % of its gross profit. IBM, GE and Boeing also made strides in solar panel efficiency in 2013.

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

Table 12: Public budgets for R&D, demonstration/field test programmes and market incentives.[43]

	R & D	Demo/Field test
National/federal	194 399 945 USD	74 323 461 USD
State/regional	NA	NA
Total	268 723 407 USD	

[43] Figures only capture the FY 13 R&D activities of the U.S. Department of Energy's Solar Energy Technologies Program. Source: U.S. Department of Energy.

5 INDUSTRY

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

Table 13: 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)
Total	Wafer	103 MW		NA
Total	Polysilicon	39 988 MT		NA

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)

The United States produced 988 MW_{DC} of modules and 478 MW_{DC} of cells in 2013.

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

Table 14: Production and production capacity information for 2013

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		*478*	*617*	*670*	*992*
Thin film manufacturers					
Total			*371*		*704*
Cells for concentration					
Total		NA		NA	
TOTALS[44]		**478**	**988**	**670**	**1 612**

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

Tables 13 and 14 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

[44] Company specific information is not available. While there are only a few U.S. manufacturers with large-scale production in the U.S. (namely: SolarWorld (c-Si), Suniva (c-Si), First Solar (CdTe)), there are approximately 100 other companies in the U.S. producing small amounts of product for sale or for the development of their technology.

manufacturing operations located abroad. In 2013 First Solar produced 1,6 GW of PV modules and SunPower produced approximately 1 GW of PV modules.[45]

5.3 Manufacturers and suppliers of other components

U.S. companies shipped approximately 3,6 GW_{AC} of PV inverters in 2013; approximately 95 % of all U.S. systems installed during that time period. Supporting structures of U.S. systems are primarily domestically manufactured. Battery implementation does not represent a significant portion of the overall U.S. PV deployment market.

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

6 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

6.1 LABOUR PLACES

Table 15: Estimated PV-related labour places in 2013

Research and development (not including companies)	NA
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	Manufacturing: 29 851
Distributors of PV products	Distribution: 19 771
System and installation companies	Installation: 69 658
Electricity utility businesses and government	Government: 588
Other	11 248
Total	142 698[46]

6.2 Business value

The value of U.S. PV Installations in 2013 was approximately 13,7 BUSD, 13 % higher than the 12,1 BUSD installed in 2012.

Table 16: Value of PV business

Sub-market	**Capacity installed *in 2012* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	NA	NA	NA	NA
Off-grid non-domestic	**NA**	**NA**	NA	NA
Grid-connected distributed	*1 905*	*4,19*	*8,0 BUSD*	*8,0 BUSD*
Grid-connected centralized	*2 847*	*2,02*	*5,7 BUSD*	*5,7 BUSD*
				13,7 BUSD
Export of PV products				*NA*
Change in stocks held				*NA*
Import of PV products				*NA*
Value of PV business				***13,7 BUSD***

U.S. PV manufacturing, which had grown in shipments 10x from 2003-2010, continued to have challenges in 2013. Due to overcapacity issues in global PV manufacturing, which caused a rapid decline in price, many U.S. companies have found it challenging to stay competitive. In 2013 U.S. PV cell production was 478 MW, on par with 2011 and 2012 but 22 % below the 2010 peak of 611 MW.

[46] The Solar Foundation. "2013 National Solar Job Census." February 2014. http://thesolarfoundation.org/research/national-solar-jobs-census-2013, accessed July 10, 2014.

In 2013 U.S. PV module production was 988 MW, on par with 2012 but 25 % below the 2011 peak of 1 323 MW.

However, U.S. manufacturing has a significant presence in other part of the PV value chain, including polysilicon, encapsulants, wiring, and fasteners. Thus, between 2010 and 2013 the number of U.S. solar manufacturing jobs has increased by 20 %, from 25 000 to 30 000.[47] Additionally, manufactured hardware is only a portion of the total solar value chain. Industry-wide, approximately 50 000 jobs relating to solar were added from 2010 to 2013, growing from 93 500 to 143 000 employees (48 % of which were added in 2013 alone). The growth rate from 2012 to 2013 is ten times faster than what the overall U.S. economy experienced during that same time period.[48]

[47] The Solar Foundation. "2013 National Solar Job Census ." February 2014. http://thesolarfoundation.org/research/national-solar-jobs-census-2013, accessed July 10, 2014.

[48] Ibid.

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Short description of the electricity industry landscape	The US has s 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 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
    - acquisition of sites for development
    - “flip” transactions that can take various forms.

[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

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 2013 IEEE worked to amend IEEE 1547 standards to facilitate the implementation of smart inverters for PV systems, among other things. Similarly, the California Public Utilities Commission and California Energy Commission, prepared changes to rule 21 to enable smarter inverters. 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.

Finally, in late 2013 FERC amended and approved their Small Generator Interconnection Procedures (SGIP) and their Small Generator Interconnection Agreement (SGIA), which set the terms and conditions for interconnecting facilities of 20MW or smaller. The Commission stated that the revisions will, "reduce the time and cost to process small generator interconnection requests . . . , maintain reliability, increase energy supply, and remove barriers to the development of new energy resources."[50]

9 HIGHLIGHTS AND PROSPECTS

From 2010-2013, the U.S market increased its annual installation by approximately 1 GW more than the previous year; growing in annual installations from 0,9 MW in 2010 to 4,8 MW in 2013. 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, each with more than 1 GW of cumulative installed PV. However, this trend is changing slowly as 15 states currently have 100 MW or more of PV capacity and 11 states each installed more than 50 MW in 2013 alone. With more than 3,6 GW of PV projects under construction as of February 2014, that have individual capacities above 1 MW in size, total installations in 2014 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 2014 than in previous years, encouraging more growth within the market.

U.S. PV cell/module shipments in 2013, after five years of growth from 2006-10, declined for the third year in a row. Overcapacity issues persist in the global PV manufacturing, and many U.S. PV cell/module manufacturers have been unable to compete with lower-priced foreign manufacturers who were able to scale-up their production capacity more rapidly. However, U.S. manufacturers were able to compete effectively in other areas of the value-chain in 2012, such as PV inverters and polysilicon. Industry-wide, approximately 50 000 jobs relating to solar were added from 2010 to 2013, growing to 143 000 employees (48 % of which were added in 2013 alone). The growth rate from 2012 to 2013 is ten times faster than what the overall U.S. economy experienced during that same time period.

[50] FERC Small Generator Interconnection Agreements and Procedures Final Rule, issued November 22, 2013. http://www.ferc.gov/whats-new/comm-meet/2013/112113/E-1.pdf, accessed July 10, 2014.

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 DC current of the modules into AC 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