INTERNATIONAL ENERGY AGENCY

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task 1

Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in the United States 2010

Katie Bolcar

U.S. Department of Energy

Washington, DC 20585 USA

kathleen.bolcar@ee.doe.gov

Kristen Ardani

National Renewable Energy Laboratory

Washington, DC 20585 USA

Kristen.ardani@nrel.gov

With significant input from GTM Research and SEIA

May 2011

1. EXECUTIVE SUMMARY

1.1 Installed PV power

The United States (U.S.) added approximately 918 MW of PV generating capacity in 2010, bringing cumulative installed capacity to 2,5 GW.[i] This represents a 56 % growth in cumulative capacity over 2009. More than 50 000 PV systems were connected in 2010, compared to 34 000 in 2009, for a 47 % growth in the number of grid connected systems installed annually.[ii] At the state level, California represents 32 % of new capacity in 2010 compared to 49 % in 2009, indicating stronger growth in other states.

By the end of 2010, there were approximately 152 000 distributed, grid-connected solar electric systems installed in the United States[iii], with the United States adding 242 MW of utility-scale generation capacity that year alone.[1] The largest utility-scale project that came on line in 2010 was a 55 MW_{DC} thin-film photovoltaic installation known as Copper Mountain Solar in Boulder City, NV.[iv] Overtaking Florida Power and Light's 28 MW_{DC} DeSoto photovoltaic farm in Arcadia, FL, Copper Mountain Solar is the largest PV facility in the United States and consists of 775 000 First Solar panels.

1.2 Costs & prices

From Q1 2010 to Q4 2010, national weighted average system prices fell by 20,5 %, from a high of 6,45 USD/W_{DC} to 5,13 USD/W_{DC}. However, when examining system prices on a per-watt basis, it is important to highlight that much of this decline is attributed to an increased share of large-scale, utility PV installations in 2010.

The United States continues to be a leader in the production of polysilicon feedstock. Due to supply shortages, the spot price for polysilicon increased from 58 USD/kg to 68 USD/kg, from Q1 2010 to Q4 2010. Meanwhile, the price of modules declined from 2,21USD/W_{DC} to 1,92 USD/W_{DC} for the same period.

1.3 PV Production

In 2010, the United States produced approximately 6 % of the 17 339 MW_p of worldwide PV module shipments.[v] A breakdown of module production, by technology, is provided below:

Technology	**2010 Annual Capacity (MW_{DC})**	**2010 Annual Production (MW_{DC})**
c-Si	1 034	773
CdTe	353	256
CIGS	222	85
a-Si	75	91
Total	1 684	1 205

[1] According to SEIA-GTM Research methodology, utility PV is defined as a project over 100 kW on the utility side of the meter

1.4 Budgets for PV

The U.S. Department of Energy (DOE) allocated a research, development, and deployment (RD&D) budget of 172,4 MUSD in fiscal year (FY) 2010 (October 2009 to September 2010).[2] These funds financed RD&D activities in partnership with national laboratories, universities, private industry, sub-national governments, and non-governmental organizations. For Solar Energy Technologies Program (SETP) R&D funding, industry partners are required to provide 20 % to 50 % matching cost share and university partners a 0 % to 20 % matching cost share. The U.S. Department of Treasury dispersed 544 MUSD in grants in lieu of the Investment Tax Credit under Section 1603. The Department of Treasury also awarded 2,3 BUSD in tax credits for qualified investments in advanced energy projects to support new, expanded, or re-equipped domestic manufacturing facilities, of which 1 016 MUSD went toward PV projects. Under the Loan Program Office, the DOE made 2 099 in conditional loan guarantees for PV projects.

2 THE IMPLEMENTATION OF PV SYSTEMS

2.1 Applications for Photovoltaics

Growth in the United States' PV market has been propelled by grid-connected PV installations, with approximately 878 MW_{DC} of new grid-connected PV capacity added in 2010. With this increase in annual capacity, the market share of grid-connected systems, in terms of cumulative installed capacity, increased from 76 % in 2009 to 83 % in 2010. Of the 2,5 GW of cumulative installed PV capacity at the end 2010, an estimated 2,1 GW are grid-connected, while 440_{DC} MW are off-grid.[3]

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. A defining characteristic of distributed PV systems is that they typically include an inverter that permits the PV system to first serve the building's load and then to send excess power to the utility grid. By the end of 2010, there were more than 152 882 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 66 MW_{DC} installed in 2009 to approximately 242 MW_{DC} installed in 2010. The largest utility-scale PV plant in the United States is the Copper Mountain facility in Nevada, with 55 MW_{DC} of capacity.

[2] Figure amount cited includes SETP funding only. It does not include ARPA-E, BS, LPO, Sec. 48C, or Sec. 1603 grants.

[3] Barclays Capital

Several U.S. utilities in the 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: There was approximately 40 MW_{DC} of additional off-grid capacity added in 2010.[vi] 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 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 power 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.

2.2 Total Photovoltaic Power Installed

Figure 1 displays annual U.S. PV capacity additions in 2010 by state. California and New Jersey, the two largest and most established state markets, accounted for nearly 50 % of new PV capacity installed in the United States for the year (Figure 1).

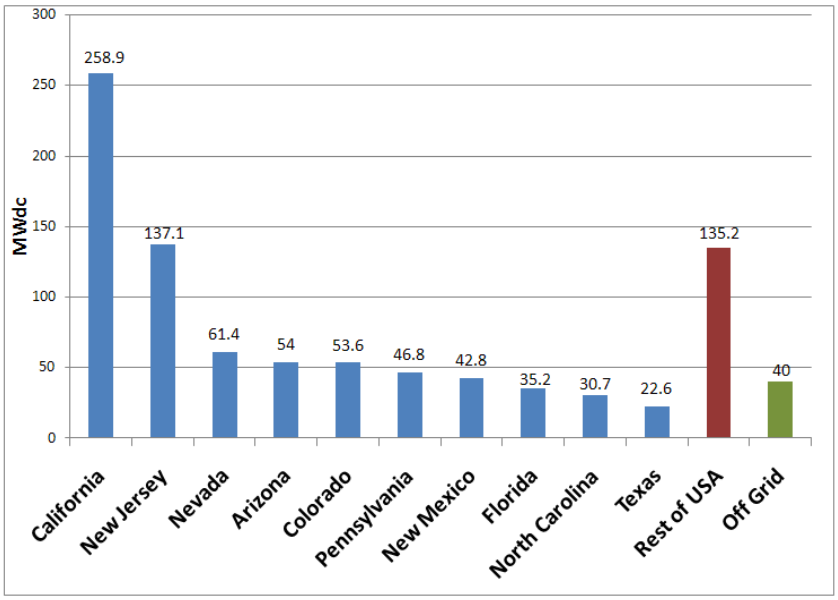

Figure 1: Annual Installed Capacity MW_{DC}, by State 2010

Table 1 displays annual installed PV capacity for 2010 across four sub-markets. Annual installed PV capacity totals 918 000 kW in 2010, with grid-connected capacity of 878 000 kW and off-grid capacity of 40 000 kW. For off-grid installations, domestic and non-domestic segmented data is unavailable for 2010.

Table 1: PV power installed during calendar year 2010 in four sub-markets.

Sub-market/ application	off-grid domestic and non-domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed in 2010 (kW)	40 000	636 000	242 000	918 000

Table 2 provides an estimate of cumulative PV capacity and annual installed PV capacity as percentages of cumulative and annual installed electricity generation capacity. Table 2 also depicts total PV energy production as a percentage of total electricity[4] consumption.

[4] 2010 retail sales of electricity was used to calculate the Total PV energy production as a percent of total electricity consumption.

Table 2: PV power and the broader national energy market.

Total national (or regional) PV capacity (from Table 2) as a % of total national (or regional) electricity generation capacity	New (2009) PV capacity (from Table 1) as a % of new electricity generation capacity (2009)	Total PV energy production as a % of total electricity consumption
0,003 %	0,05 %	0,06 %

A summary of the cumulative installed PV Power, from 1992-2010, broken down into four sub-markets is shown in Table 3**.** While domestic and non-domestic segmented data for off-grid installations is unavailable for 2009 and 2010, the cumulative off-grid PV capacity installed in the United States at the end of 2010 is approximately 440 MW.

Table 3: The cumulative installed PV power in four sub-markets

Sub-Market Application	1995 MW	1996 MW	1997 MW	1998 MW	1999 MW	2000 MW	2001 MW	2002 MW	2003 MW	2004 MW	2005 MW	2006 MW	2007 MW	2008 MW	2009 MW	2010 MW
Off-Grid Domestic	19,3	23,3	27,5	32	37,5	43,5	50,5	58,9	67,9	88	100	114	134	154	400	440
Off-Grid Non-Domestic	25,8	30,2	35	40,2	46,7	55,2	64,7	77,7	93,7	112	133	15	191	216		
Grid-Connected Distributed	9,7	11	13,7	15,9	21,1	28,1	40,6	63,6	95,6	154	219	322	465	735	1 103,6	1737
Grid-Connected Centralized	12	12	12	12	12	12	12	12	18	22	27	32	40,5	63,5	130	372
Total (GW)	66,8	76,5	88,2	100,1	117,3	138,8	167,8	212,2	275,2	376	479	483	830,5	1168.5	1633	2549

1. Details of key PV deployment activities in 2010

Market Drivers

In 2010, the solar PV installations in the United States grew by 97 % compared to 2009, for a total of approximately 918 megawatts MW_{DC} installed this year.

Federal

Two of the major federal policy drivers for growth in PV installations include the 30 % investment tax credit (ITC) and the five-year accelerated depreciation (modified accelerated cost recovery schedule or MARCS). The ITC applies to both residential and commercial installations and the MARCS applies only to commercial installations. To increase the benefits and accessibility of the ITC, in 2010 federal legislation was enacted that allows solar assets placed in service from 2009-2012 to receive a cash grant from the Treasury Department (1603 Cash Grant). Worth 30 % of qualified costs of a solar project, recipients can opt to receive a

grant in lieu of the ITC.[5] Under an amendment to MARCS, eligible PV property placed in service after 8 September 2010, and before 1 January 2012, qualifies for 100 % first-year bonus depreciation. For 2012, bonus depreciation is still available, but the allowable deduction reverts from 100 % to 50 % of the eligible basis.

Also spurring development was the DOE Loan Programs Office, which entered into several loan guarantees for solar manufacturing and power-generation projects. Awards under this program, which accelerates the domestic commercial deployment and manufacturing of innovative and advanced clean-energy technologies, were funded through the American Reinvestment and Recovery Act (Recovery Act).

In addition to the aforementioned financial incentives, the Advanced Energy Manufacturing Tax Credit (MTC), referred to as Section 48C of the Internal Revenue Code, was also a driver of PV development in 2010. With allocated funding totalling of 2,3 BUSD, the MTC provides a 30 % credit for investments in new, expanded, or re-equipped advanced energy manufacturing projects. The MTC will support total capital investments of almost 7,7 BUSD in new renewable and advanced energy manufacturing projects.

To facilitate the deployment of solar energy on public lands, the U.S. federal government engaged in two primary initiatives in 2010. First, the U.S. Department of the Interior (DOI) and the U.S. DOE announced an initiative to conduct a Programmatic Environmental Impact Statement (PEIS) to identify proposed "solar energy zones"—areas most suitable for environmentally sound, utility-scale solar energy production—on public lands in six western states[6]. This initiative establishes a path forward for longer term development of solar energy projects, though it did not have an immediate impact on PV deployment in 2010. Second, the DOI awarded priority processing for nine solar Right-of-Way permit applications under the Fast Track Initiative. Announced in 2009, the Fast Track Initiative expedites the permit approval process for proposed solar developments that demonstrate a strong likelihood to comply with environmental regulations. While selected projects still require rigorous reviews, they are subject to shorter approval times.

State, Local, and Utility

The diversity of state markets is a strength of the United States, making it less likely to see strong boom-bust cycles experienced in many European PV markets. From 2004 to 2005, California comprised 80 % of new PV installations; in 2010, California represented 28 % of new installations, with 16 states installing more than 10 MW_{DC} of PV.[vii] The U.S. market also supports robust growth in all three market segments (residential, commercial, and utility-scale), taking advantage of the relative strengths of each segment.

In addition to support from federal policies and agencies, solar energy also saw significant advances in the adoption of various state and local policy instruments, including improved net-

[5] One important exception is that the "passive loss" rules do not apply to the 1603 grant.

[6] The six states are Arizona, California, Colorado, Nevada, New Mexico, and Utah.

metering and interconnection rules, regulatory acceptance of third-party financing models, renewable portfolio standards (RPS), and performance-based incentives.[7] Net-metering activity included a new California law that raised the aggregate cap on net metering from 2,5 % to 5 % of a given utility's peak load. West Virginia adopted an improved net-metering policy that raised the capacity limit for commercial and industrial customers to 500 kW and 2 MW respectively, with an overall program capacity of 3 % of utility peak load. Utah improved its statewide interconnection rule by introducing standard interconnection agreements, based on system type, and raising the system capacity limit from 25 kW and 2 MW for residential and non-residential systems, respectively, to a uniform 20 MW. Meanwhile, by the end of 2010, 19 states and Puerto Rico explicitly allowed third-party financing, up from only eight states at the end of 2009.

In October 2010, Hawaii joined nine other jurisdictions and utilities in the United States that have adopted a feed-in tariff (FIT). The FIT structure employs a three-tier rate schedule differentiated by system capacity and technology, guarantees a fixed rate over a 20-year contract, and sets maximum system size caps by island and by technology. Colorado now allows community net metering or "solar gardens" in investor-owned utility service territory up to 2 MW, while California's Renewable Auction Mechanism will require regulated utilities to procure a minimum of 1 000 MW of capacity from renewable energy projects up to 20 MW in size.

Despite these successes, 2010 also yielded significant challenges for other state and local renewable energy policy instruments. In Florida, for example, four separate incentives for renewable energy expired: a capacity-based solar rebate program, a production-based tax credit, a capacity-based investment tax credit, and a sales-tax exemption for renewable energy equipment. Funding for the solar rebate program had been exhausted since mid-2010, with no extensions approved by the state legislature.

The Property Assessed Clean Energy (PACE) model, whose adoption by local jurisdictions had accelerated in 2009, experienced a significant setback following a determination in February 2010 by the Federal Housing Finance Authority (FHFA). As PACE programs require a priority lien over existing mortgages, the FHFA took the position that such loans present significant risk to lenders and secondary markets, while violating mortgage terms. Since the determination's release, local jurisdictions have placed their PACE programs on hold pending further clarification. The legality of feed-in tariffs had also been challenged before the Federal Energy Regulatory Commission (FERC) in proceedings involving the California Public Utilities Commission and three California utilities. A FERC order issued in October 2010 resolved the uncertainty by providing clarifying validation, within strict parameters, for a state-level feed-in tariff.

Utility/Public Stakeholder Developments

[7] See www.dsireusa.org for the most up-to-date information on state, utility, and local policies regarding renewable energy and energy efficiency.

Electricity utility interest continues to increase in the United States. The key drivers are policy—the 30 % ITC at the national level and renewable portfolio standards at the state level. As consumer demand increases and grid parity moves closer in different markets, cooperation and dialogue between the electricity utility industry and the solar industry is increasing.

2.3 PV implementation highlights, major projects, demonstration and field test programmes

Major Projects

The U.S. utility-scale market accelerated greatly in 2010. Nine utility-scale projects came on line in six different states. Of these nine projects, three were CdTe, two were multi c-Si, three were mono c-Si, and one was a-Si. As of mid-November 2010, 15 projects were under construction in 10 different states.

Figure 2 below depicts the projects commissioned or under construction in 2010, as of mid-November 2010.

Figure 2 – Mid-November 2010 landscape of utility-scale PV projects in the United States

*Project is expected to be constructed in phases over an extended period of time. The capacity value is for the full project.

The unit used in describing a facility's MW capacity may vary between Alternating Current (AC) and Direct Current (DC). The value in bold and underlined is the original unadjusted capacity value, while the other value was converted using an 80 % DC-to-AC derate factor.

All information was intended to be accurate as of 16 November 2010.

Also in 2010, President Obama announced plans to install solar panels on the White House in 2011, continuing to highlight the commercial readiness of solar.

Demonstration and Field Test Programs

The DOE invested in six High Penetration Solar Deployment projects with the following goals:

- Develop modelling tools and database of experience with high-penetration scenarios of PV on a distribution system;
- Develop monitoring, control, and integration systems to enable cost-effective widespread deployment of small modular PV systems; and
- Demonstrate integration of photovoltaics and energy storage into smart grid applications.

Awardees included: Arizona Public Service Company, Florida State University, National Renewable Energy Laboratory, Sacramento Municipal Utility District, University of California San Diego, and Virginia Polytechnic Institute and State University. The California Public Utility Commission also awarded eight grants for high-penetration research and demonstration projects. See https://solarhighpen.energy.gov/ for more information.

2.4 Highlights of R&D

DOE accelerates the research, development, and deployment of all solar energy technologies through its Solar Energy Technologies Program (SETP). In 2010, SETP held workshops with industry and other stakeholders to develop a roadmap to reach the goal of 1 USD per watt installed price of utility-scale PV systems by 2020. Information from these workshops was used to develop the SunShot Initiative, whose main objective is to enable solar energy to achieve grid parity in the United States without subsidies by the end of the decade, thus becoming competitive with fossil fuels throughout the United States and the world. The SunShot Initiative was formally launched in February 2011 and includes investments by the U.S. DOE's Advanced Research Projects Agency – Energy (ARPA-E), the Office of Science, and SETP. The goals of the SunShot Initiative are:

- By 2020, to demonstrate the commercial viability of the 75 % reduction approach for
  - PV
    - Utility (100 MW) - 1 USD/W
    - Commercial (200 kW) - 1,25 USD/W
    - Residential-scale) (5 kW) - 1,50 USD/W
  - CSP - Utility- 3,50 USD/W, including 16 hours storage (equivalent to 0,06 USD/kWh with 12-17 hours of storage

Throughout FY 2011, DOE will actively engage industry through additional workshops and will issue additional Funding Opportunity Announcements to meet these aggressive goals.

Photovoltaics Research and Development

To bridge the gap between basic and applied solar research, SETP in 2010 funded the third and final year of the Next Generation program projects—primarily at universities—to develop innovative, revolutionary, and highly disruptive PV approaches. DOE funded more than 20 projects in 11 different areas (see chart). For example, the University of Delaware worked on

the development of a highly efficient, wide bandgap CIS/CIGS technology, which is necessary for polycrystalline tandem devices.

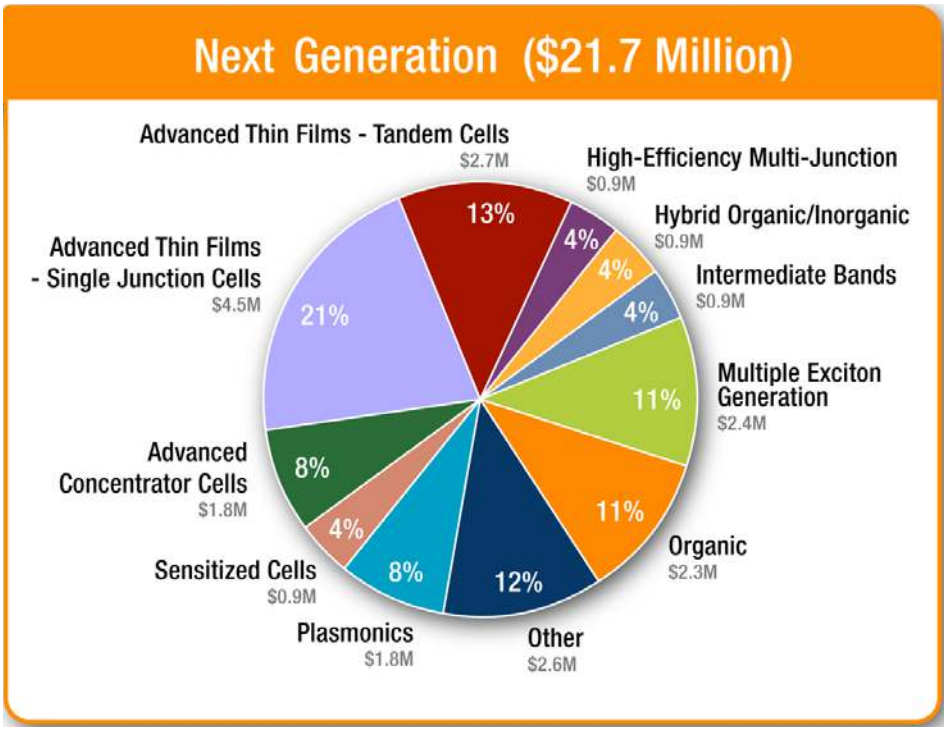

Figure 3. In 2010, the U.S. Department of Energy funded more than 20 Next Generation program projects in 11 different areas.

In 2010, SETP also continued to fund domestic PV startups through its PV Incubator Program for promising technologies that have been proven on a laboratory scale and are ready to transition to commercial production. SETP made four new PV Incubator awards; the recipients were Alta Devices, TeraSun, Solar Junction, and Sempris. Previous awardees, including Innovalight, Abound Solar, and CaliSolar, are rapidly scaling manufacturing capabilities toward hundreds of MW of annual production and the creation of hundreds of new jobs.
Through 24 new Supply Chain and Cross-Cutting technology projects, SETP partnered with industry and universities to develop technologies that provide cost reductions and performance improvements with broad application across the industry and can be adopted directly into the current manufacturing process. These technologies range from a new moisture-resistant polymeric ultra barrier to replace glass, to laser manufacturing techniques and novel solar printing mechanisms.

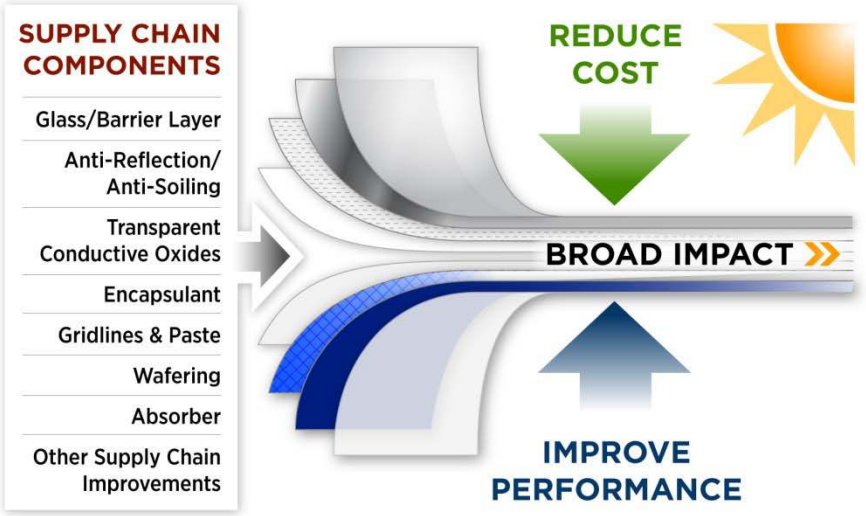

Figure 4. Supply Chain projects develop technologies that reduce cost, improve performance, and have broad application across the PV industry.

Over the course of three years, Technology Pathway Partnerships projects have accelerated industry's progress in developing specific system approaches that address total PV system lifecycle costs. Awardee accomplishments included the development by Dow Chemical of a shingle that integrates with asphalt shingle roofs for the residential market; high-performance utility-scale CPV systems by Amonix; and industry's highest performing one sun (non-concentrating) PV system by SunPower.

Figure 5. The Amonix 7700 Solar Power Generator received an R&D 100 Award for innovation in 2010.

In 2010, SETP released a Funding Opportunity Announcement for 112,5 MUSD for SunShot Advanced Manufacturing Partnerships to support the creation of a robust U.S. PV manufacturing base and supply chain, develop a highly trained workforce with the required technical skills, and speed the implementation of new cutting-edge technologies. The initiative intends to accelerate the coordination of stakeholders and fund technology development across the U.S. PV industry. Applicants could apply under either a university-focused topic for industry-relevant research and

development projects conducted by universities, or an industry-focused topic for collaborative or facility-based approaches to accelerate the development and implementation of PV manufacturing-related technologies.

Systems Integration

In 2010, SETP's Solar Energy Grid Integration Systems (SEGIS) project advanced into its third and final stage, with 9,2 MUSD of funding for demonstration of inverters with advanced functionality and communications to enable high grid-penetration levels for PV systems. Demonstrations were conducted by teams that included utilities and inverter, energy storage, and communications equipment suppliers.

With Recovery Act funding, SETP also continued funding for High Penetration Solar Deployment activities to study the effects of high penetration levels of PV on the electrical grid. Activities by project awardees included developing modelling tools and a database of experience with high-penetration scenarios of PV on a distribution system; developing monitoring, control, and integration systems to enable cost-effective widespread deployment of small modular PV systems; and demonstrating integration of PV and energy storage into smart grid applications.

DOE also established a new partnership with the National Oceanic and Atmospheric Administration to advance the utilization of atmospheric and oceanic renewable energy resources in energy generation by improving our understanding of these resources.

U.S. national laboratories continued work on testing and evaluation, component and system reliability, system modelling, and codes and standards. Through the funding of the Solar America Board for Codes and Standards (SolarABCs), SETP conducted research and published findings on wind loading, permitting, and flammability.

Market Transformation

Under its Market Transformation Activities, SETP worked with DOI to complete a draft Programmatic Environmental Impact Statement (PEIS) designed to assess the environmental impacts of utility-scale solar projects on public lands and lands administered by the Bureau of Land Management. This inter-agency initiative was aimed at accelerating the deployment of large-scale solar installations on federal lands in six western states—Arizona, California, Colorado, Nevada, New Mexico, and Utah.

Under the Solar America Communities[8] (SAC) program, DOE used Recovery Act funding to facilitate the development and field testing in 16 cities of innovative deployment models for distributed PV, including community solar financing, group purchasing, PACE financing, and

[8] Formerly known as Solar America Cities, this program was rebranded to Solar America Communities in 2010 to recognize the importance of counties as well as cities in furthering solar market development.

public-private partnerships between local governments and solar lease/power purchase agreement (PPA) providers. For example, DOE worked with the cities of San Jose, California, and Portland, Oregon, to develop a group purchasing program that resulted in 1,7 MW of PV installed capacity at residential sites throughout these cities. DOE also began work with the City of Seattle, Washington, to implement a community solar program and conducted economic feasibility analyses of similar programs for New York, New York, and Houston, Texas.

Through its SAC program, DOE also issued an updated guide for U.S. communities to accelerate PV market development, including best practices for streamlining the solar permitting process and updating building and zoning codes for solar technologies.

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

Table 4. Public budgets for PV RD&D

	Total	R & D[9]	Demo/ Field test	Market incentives[10]
National/federal	3831,4	DOE: 172,4		Sec 1603: 544* AMTC: 1 016** LPO:2 099***
State/regional	Not Available			

3 INDUSTRY AND GROWTH

3.1 Production of feedstocks, ingots and wafers

In the United States there are three companies that produce silicon feedstock: Hemlock Semiconductor Group, MEMC Electronics, and Renewable Energy Corp. Together, these three companies produced 42 561 metric tons of polysilicon feedstock, with Hemlock Semiconductor Group producing 58 % of the U.S. total. All three rank among the world's top-five polysilicon

[9] DOE is the Department of Energy Solar Energy Technology Program. This does not include funding from ARPA-E or the Office of Science within DOE.

[10] * Sec 1603 is the 30 % grant in lieu of the Investment Tax Credit. ** AMTC is the Advanced Manufacturing Tax Credit. AMTC funding of 1 016 reflects total funding appropriated for qualifying projects in 2010. The actual amount of tax credits disbursed may be less than stated, as costing of appropriated funds is dependent on date of project completion. *** LPO is the Loan Guarantee Program. Actual cost to the U.S. treasury of the Loan Guarantee Program is assumed to be 5-10 % of finalized expenditures.

producers. The median estimate of global polysilicon production in 2010 is 148 750 MT, with the United States producing 29 % of global supply. This strong market position in raw materials for (c-SI) photovoltaics is bolstered by the United States' experienced workforce and national advancements in feedstock refinement.

Wafer manufacturing in the United States increased 97 %, from 317 MW in 2009 to 624 MW in 2010. There are four companies engaged in wafer manufacturing: Solar World America, Evergreen Solar, Solar Power Industries, and MEMC Electronics. All but MEMC Electronics are vertically integrated companies, with a large proportion of wafer production directed to cell manufacturing.

Table 5 depicts production and capacity for U.S. polysilicon feedstock and wafers. In 2010, the spot price for polysilicon was 80-90 USD/kg.

Table 5: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Total Production	Maximum production capacity
Hemlock Semiconductor Group	Silicon feedstock	25 025 tonnes	30 000 tonnes/year
MEMC	Silicon feedstock	6 089 tonnes	7 500 tonnes/year
Renewable Energy Corp.	Silicon feedstock	11 447 tonnes	17 000 tonnes/year
Total		42 561 tonnes	54 500 tonnes/year
Solar World America	wafers	251 MW	500 MW/year
Evergreen Solar	wafers	162 MW	187 MW /year
Solar Power Industries	wafers	60 MW	111 MW/year
MEMC	wafers	151 MW	220 MW/year
Total		624 MW	1 018 MW/year

3.2 Production of photovoltaic cells and modules

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers, or the processing of cells, in addition to fabricating the modules with frames,

junction boxes, etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

According to GTM Research, the United States produced 614,5 MW_{DC} of c-Si cells and 798 MW_{DC} of c-Si modules in 2010. With thin-film cell and module production totalling 484 MW_{DC} and 467 MW_{DC}, respectively, U.S. production of c-Si continues to outpace U.S. production of thin films. However, the United States is a leader in early stage thin-film PV technologies over other countries, as thin films are less labor intensive than c-Si modules and require a skilled workforce to maintain high efficiencies and production yields. Moreover, the United States has a well-established specialty gas infrastructure, including trichlorosilane, a byproduct of polysilicon feedstock production. Such gases can be used as inputs for thin-film manufacturing, furthering the United States' comparative advantage in thin-film PV.

Total PV cell and module manufacture together with production capacity information is summarised in Table 6 below.

Table 6: Production and production capacity information for 2010

Company	Technology	Total Production (MW/yr)		Production Capacity (MW/yr)	
		Cell	Module	Cell	Module
Crystalline Silicon Manufacturers					
1SolTech	Mono/Multi c-Si	0	4	0	15
Evergreen Solar	Mono/Multi c-Si	158	158	160	160
Kyocera	Mono/Multi c-Si	0	22	0	30
Motech	Mono/Multi c-Si	0	24	0	40
Schott Solar	Mono/Multi c-Si	0	86	0	85
Sharp	Mono/Multi c-Si	0	128	0	210
Siliken	Mono/Multi c-Si	0	21	0	30
Solar Power Industries	Mono/Multi c-Si	35	31	50	50
SolarWorld	Mono/Multi c-Si	251	219	500	500

Solon	Mono/Multi c-Si	0	80	0	80
Suniva	Mono c-Si	170	15	170	15
Suntech Power	Mono/Multi c-Si	0	3	0	30
Wanxiang	Mono/Multi c-Si	0	7	0	12
Total	***Crystalline Si***	***614***	***798***	***880***	***1 257***
Thin Film Manufacturers					
Abound Solar	CdTe	31	31	65	65
Applied Quantum Technology (AQT)	CIGS	0	0	15	15
Ascent Solar	CIGS	1	1	32	32
First Solar	CdTe	222	222	250	250
Global Solar	CIGS	17	0	40	0
Miasole	CIGS	20	20	60	60
Nanosolar	CIGS	2	2	40	40
Sencera	a-Si	1	1	25	25
SoloPower	CIGS	2	2	10	10
Solyndra	CIGS	67	67	70	70
United Solar	a-Si	120	120	150	150
Xunlight	a-Si	1	1	25	25
Total	***Thin Film***	***484***	***467***	***782***	***742***
Concentrating PV Manufacturers					
Spectrolab	CPV	30	0	200	0
Amonix	CPV	0	10	0	30
Emcore	CPV	5	0	250	0
Total	***CPV***	***35***	***10***	***450***	***30***
Grand Total		1 134	1 277	2 112	2 029

3.3 Module prices

Over the course of 2010, average module prices at the factory gate in the United States declined from a high of 2,21 USD/W in Q1 to 1,92 USD/W by the end of Q4. Table 7 displays average factory gate module prices from 1994 to 2010.

Table 7: Typical module prices for a number of years

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Price	4,00	3,75	4,00	4,15	4,00	3,50	3,75	3,50	3,25	3,00	3,50	3,60	3,75	3,75	3,65	2,10	1,92

3.4 Manufacturers and suppliers of other components

Market conditions were favourable to U.S. inverter manufacturing in 2010, with both capacity and production increasing more than fourfold over 2009.[11] With global PV growth of 130 % for the year, European inverter suppliers failed to keep pace with demand, spurring increased lead times and periodic unavailability of European inverter supplies. As a result, U.S. integrators and distributors looked to U.S. suppliers to meet increased demand.

Micro-inverters and power-optimizers grew to approximately 17 % market share of the residential sector. Over 50 % of the companies that manufacture micro-inverters and power-optimizers are headquartered in the United States, although less than 5 % of inverters are manufactured in the U.S. 2010 factory-gate prices ranged from 0,39 USD to 0,46 USD/W_{AC} for residential, 0,30 USD to 0,35 USD/W_{AC} for commercial, and 0,22 USD to 0,24 USD/W_{AC} for utility-scale projects.

3.5 System prices

Installed PV system prices in the United States varied widely across states and market segment, while decreasing module prices continued to put downward pressure on PV system prices in 2010. Residential-scale PV system prices declined by 8 %, while utility-scale PV system prices declined by 15,6 %. Table 8 displays national weighted average, turnkey prices (excluding VAT/TVA/sales tax) per W_{DC} for grid-connected installations. Prices do not include recurring charges after installation, such as battery replacement or operation and maintenance.

Table 8: Turnkey Prices of Typical Applications

Category/ Size	Typical applications and brief details	Current prices per W

[11] SEIA-GTM

OFF-GRID Up to 1 kW	Telecommunications, traffic signals, pumps, clock towers, etc.	Not Available
OFF-GRID > 1 kW	Park facilities, housing in remote areas, lighthouses, agricultural facilities, etc.	Not Available
ON-GRID Domestic Systems	Residential applications with an average system size of 5,5 kW	**6,68 USD/ W**
ON-GRID Non-domestic Systems	Commercial, government, and non-profit applications (including warehouses, commercial buildings, large-scale public facilities, railway facilities, etc.) with an average system size of 82,7 kW	**5,88 USD/ W**
ON-GRID Centralized	Large, utility-scale application with an average system size of 5,5 MW	**4,24 USD/ W**

Table 8a displays a range of national weighted average system prices from 1994 to 2010.

Table 8a: National trends in system prices (current) for PV systems.

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Price /W:	12	11–12	10–12	10–12	10–11	9–11	8–10	7–9	6,50–9	6,50–8	6,50–8	6,50–8	7-9	7–9	6,5–9	6,45-9	4,05-7,51

3.6 Labour Places

2010 is the first year that the U.S. has undertaken empirical measurement of labour places related to solar. Labour places are defined as those workers who spend at least 50 % of their time on solar, and include employment for concentrating solar power and solar heating and cooling.

Table 9: Estimated solar-related labour places in 2010

Subsector	# of solar workers
Installation	43 934
Manufacturing	24 916
Wholesale Trade	11 744
Other	21 902
Total	**102,496**

Source: National Solar Jobs Census 2010, undertaken by The Solar Foundation and the National Renewable Energy Laboratory.

3.7 Business value

Table 10 provides the value of PV business in the United States for grid-connected systems. Due to availability of data, off-grid installations are not included in the country's value of PV business. Thus, the value of total PV business is higher than stated. However, with only an estimated 40 MW of off-grid capacity installed in the United States in 2010, the effect of excluding off-grid installations on the value of PV business is relatively small.

Table 10: Value of PV business

Sub-market	Capacity installed *in 2010* (kW)	Price per W *(from table 7)*	Value	Totals
Off-grid domestic	*No Data*			
Off-grid non-domestic				
Grid-connected domestic	264 000	6,68 USD	1 763 520 BUSD	
Grid-connected non-domestic	372 000	5,88 USD	2 187 360 BUSD	

Grid-connected centralized	242 000	4,24 USD	1 026 080 BUSD	
				4 976 960 BUSD
Export of PV products *(including information from Tables 4 & 5)*				2 314 000 BUSD
Change in stocks held *(including information from Tables 4 & 5)*				***N/A***
Import of PV products *(including information from Tables 4 & 5)*				- 1 591 000 BUSD

(SEIA-GTM 2010)

2. FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

The rate of PV deployment is subject to various non-technical factors in the U.S. Such factors include, but are not limited to, access to capital, federal government policies and support for PV projects, state-level policy initiatives, utility programs, and building codes.Table 11 lists the support measures for PV in the U.S. during 2010 and depicts the non-technical framework for PV deployment.

Table 11: 2010 U.S. PV Support Measures

	Ongoing measures
Enhanced feed-in tariffs (gross/net)	The legality of feed-in tariffs was challenged before the Federal Energy Regulatory Commission (FERC) in proceedings involving the California Public Utilities Commission and three California utilities. A FERC order issued in October resolved the uncertainty by providing clarifying validation, within strict parameters, for a state-level feed-in tariff.
Capital subsidies for equipment or total cost	Federal: 30 % Investment Tax Credit, which can be taken as a grant in lieu of the credit if the system meets certain requirements. State: 20 states, the District of Columbia, and Puerto Rico offer capital subsidies
Renewable Energy Credit (REC) purchase programmes purchased separately from electricity	There are seven REC regional tracking systems or registries and at least 30 REC products available.
Green electricity schemes	Green pricing programs are offered by utilities in 41 states. More than 20 states have environmental disclosure policies in place, requiring electricity suppliers to provide information on fuel sources used and, in some cases, emissions associated with electricity generation. For more information, visit www.eere.energy.gov/greenpower/.
PV-specific green electricity schemes	Data not available
Renewable portfolio	36 states plus the District of Columbia, Guam, Puerto Rico, and

standards (RPS)	Virgin Islands have an RPS.
PV requirement in RPS	22 states and the District of Columbia have solar or distributed generation provisions.
Investment funds for PV	U.S. private sector capital investment reached 6,8 BUSD in 2010.
Income tax credits	- Federal: federal investment tax credit of 30 % for residential, commercial, and utility systems. - About 1,1 BUSD in income tax credits were awarded to solar manufacturers under the Advanced Energy Manufacturing Tax Credit program. - State: 21 states offer tax credits for solar projects.
Net metering	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. http://www.newenergychoices.org/uploads/FreeingTheGrid2010.pdf
Commercial bank activities	Federal: DOE Loan Program Office administers two loan programs that are applicable to solar energy: 1) Title XVII Section 1703 of the Energy Policy Act of 2005 – Provides loan guarantees to innovative clean technologies, where obtaining conventional private financing is difficult due to high technology risk and capital-intensive nature of investment. 2) Title XVII Section 1705 of the Energy Policy Act of 2005 – Provides loan guarantees to commercial-scale renewable energy projects, including those employing more mature technologies, that begin construction prior to 30 September 2011. Although 25 states plus the District of Columbia authorize Property Assessed Clean Energy (PACE), the Federal Housing Financing Agency (FHFA) issued a statement in July 2010 concerning the senior lien status associated with most PACE programs. In response to the FHFA statement, most local PACE programs have been suspended until further clarification is provided. Commercial banks are engaged in all aspects of PV financing. Through their project finance arms, they provide project-level debt, construction and term, equity, and tax equity for solar projects. Commercial banks also invest in solar companies engaged in project development and manufacturing along the supply chain.
Electricity utility interest	Policy is the key driver for electric utility activity—the federal tax credit (30 %) at the national level and renewable portfolio standards at the state level.
Sustainable building requirements	Federal: No federal codes exist, but DOE produces best-practices guides for sustainable building for both residential and commercial builders.

	State and Local: Some states and local jurisdictions have sustainable building requirements.

4.1 Indirect policy issues

Overall, clean energy has broad electoral and bipartisan support. Several Renewable Energy or Clean Energy Standards have been proposed by the U.S. House, Senate, and president. See below for a summary of these proposals.

Proposal (Source: Clearview Energy)	Latest Target Specified	Target	Solar & Wind	Retired Coal	Natural Gas	Clean Coal	Nuclear	Other
Waxman-Markey H.R. 2454	2020-2039	20%	X					X
Sen. Bingaman's S. 1462	2021-2039	15%	X					X
Sen. Grahams Clean Energy Act	2025	25%	X	X		X	X	X
Sen. Lugar's S. 3464	2050	50%	X	X		X	X	X
Pres. Obama's CES	2035	80%	X		X	X	X	n/a

Near the conclusion of 2010, the U.S. Supreme Court was preparing to hear arguments in Connecticut vs. American Electric Power Co. et al., which examines the extent to which states may utilize tort law and regulate CO_2 emissions as a public nuisance.

The Environmental Protection Agency's (EPA) authority to regulate greenhouse gas emissions under the Clean Air Act has continued to receive significant attention, with multiple proposals introduced in the U.S. Congress to revise their regulatory authority by one of three routes: De-fund—require that no appropriated funding may be used to create or enforce rules; Delay—suspend any rules for a period of time (e.g., 2 years); or Disapprove—rescind the previous greenhouse gas endangerment finding and/or amend federal environmental laws to redefine "pollutants."

4.2 Electricity utility interest

Electricity utility interest continues to increase in the U.S. The key drivers are policy—the federal tax credit (30 %) at the national level and Renewable Portfolio Standards at the state level. As of this writing, 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.[12]

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

[12] 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

planning, siting, operating, and maintaining the solar facilities. The variety of ownership explored in the U.S. 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, and
    - "flip" transactions that can take various forms.

The issues related to utility ownership include:

- Some state restructuring rules that do not allow generation utility 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 with solar revenue streams and ratebased shareholder loans

Development of Customer Programs are utility programs 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 that specific classes of participating customers can be allocated a proportional share of the output from to offset their electric consumption bill directly (remote net metering) or offered a fixed-rate tariff that is competitive with retail rates or will be in the near future is electric prices increase.

Utility Purchase of Solar Output is a business model often applied by publically owned utilities to create value to their communities through local solar development. Some publicly owned utilities have developed a feed-in tariff (FIT) to purchase solar power. Solar power purchases through an FIT are often instead of net metering, thus mitigating revenue erosion while

providing a clear contractual understanding for purchase that supports financial viability for solar developers.

4.3 Standards and codes

In 2010, the DOE PV program continued to fund a significant level of involvement in the standards and codes area. The National Renewable Energy Laboratory (NREL) and Sandia National Laboratories (Sandia) staff served on panels establishing codes and standards for nearly every solar-related code or standard. The DOE-funded Solar ABCs completed its fourth year of activities focused on supporting the centralized development of codes and standards that facilitate and accelerate the installation of high-quality, safe photovoltaic (PV) systems. In addition, the National Institute for Standards and Technology is leading an effort to develop new standards for the smart grid, some of which impact PV systems.

The United States paid particular attention to the IEEE and UL standards revisions that are required to accommodate high penetrations of distributed generation on the grid. These standards will need to be revised to allow inverters to provide the correct grid support characteristics when high penetrations of distributed resources are deployed.

Grounding problems and problems interpreting grounding requirements continued to plague the industry. During 2010 a group of industry stakeholders prepared a proposal for changes to UL Standard 1703 to help clarify this issue. Solar ABCs started a project to recommend new test procedures for grounding systems.

In addition, Solar ABCs released an interim report on research into the impact of PV modules on the fire class ratings of roofs. The research highlights problems with the current fire class rating requirements and outlines areas required for future research on this increasingly complex topic.

3. HIGHLIGHTS AND PROSPECTS

> This is our generation's Sputnik moment. Two years ago, I said that we needed to reach a level of research and development we haven't seen since the height of the Space Race. And in a few weeks, I will be sending a budget to Congress that helps us meet that goal. We'll invest in biomedical research, information technology, and especially clean energy technology…an investment that will strengthen our security, protect our planet, and create countless new jobs for our people….
>
> -President Obama, 25 January 2011

In February 2011, Secretary of Energy, Steven Chu announced the SunShot Initiative, a collaborative national initiative to make solar energy technologies cost-competitive with other forms of energy by reducing the cost of solar energy systems by about 75 % before 2020. In addition to investing in improvements in solar technologies and manufacturing, SunShot focuses

on integrating systems into the electricity grid and reducing hardware and non-hardware balance of system costs.

Several financial analysts have projected U.S. PV installations to increase to 3,25 GW per year by 2012. Sustained growth in U.S. installations is likely to be driven by a confluence of factors, including state-level policies, the Grant in Lieu of the Investment Tax Credit (Sec.1603), and the 100 % first-year bonus depreciation for eligible property under the Modified Accelerated Cost-Recovery System (MACRS). Eligibility for both the Sec. 1603 Grant and the 100 % bonus depreciation were set to expire at the end of 2010, but were extended.

With over 600 MW_{AC} of new utility-scale projects expected to come under operation in 2011, this sector is expected to dominate the market, growing to close to 50 % of market share. While total megawatts in the residential sector are expected to grow, residential market share is expected to decline to less than 25 %.

After an approximate 10 % decline in 2010, the U.S. global market share of thin-film module manufacturing is expected to rebound in 2011 and exceed 40 %. Concurrently, the U.S. global market share of c-Si PV production is expected to remain steady for the near term and then decline over the next 5 years. Despite the relative decline in the share of U.S. c-Si production, U.S. manufacturing capacity is expected to make absolute gains. For instance, by 2012, cumulative manufacturing capacity in the U.S. is expected to rise from 1,01 GW to 1,19 GW for wafers; from 1,6 GW to 2,8 GW for cells; and from 1,6 GW to 2,69 GW for modules.

Annex A. Method and accuracy of data

The data in this report are taken primarily from data collected by the Energy Information Administration, the U.S. Department of Energy, the Solar Energy Industries Association, the Prometheus Institute, GTM Research, and PV Energy Systems, Inc. These data are believed to be accurate to ±10 %. The accuracy of the U.S. installation data is also estimated to be in the ±10% range. The currency used in this report is U.S. dollars (USD).

Sources for more information:

U.S. Department of Energy's Solar Energy Technologies Program
www.eere.energy.gov/solar/

GTM Research
http://www.gtmresearch.com/

Database of State Incentives for Renewable Energy
www.dsireusa.org/

Solar Electric Power Association
www.solarelectricpower.org

Solar America Board for Codes and Standards
www.solarabcs.org

Solar Energy Industries Association
www.seia.org

PV Research at the National Renewable Energy Laboratory
www.nrel.gov/pv/

PV Research at Sandia National Laboratories
http://photovoltaics.sandia.gov/

PV Research at Brookhaven National Laboratories
www.pv.bnl.gov/

Annex B. Country information

This information gives the reader some background about the national environment in which PV is being deployed. It is neither guaranteed to be 100 % accurate, nor intended for analysis.

1) Retail electricity prices (Annual Average 2010)
All sectors: 0,0988 USD/kWh
Household: 0,1158 USD/kWh
Commercial: 0,1026 USD/kWh
Industrial: 0,0679 USD/kWh
Transportation: 0,1096 USD/kWh
Source: U.S. Department of Energy, Energy Information Administration
http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html

2) Typical household electricity consumption (kWh)
In 2009, the latest year with information available, the average monthly electricity consumption was 920 kWh.
Source: U.S. Department of Energy, Energy Information Administration,
http://www.eia.doe.gov/cneaf/electricity/esr/table5.html

3) Typical metering arrangements and tariff structures for electricity customers.
These rules vary from state to state and utility to utility.

4) Typical household income
In 2009, the latest year with data available, real median annual household income was 50 221 USD.
Source: http://www.census.gov/prod/2010pubs/acsbr09-2.pdf

5) Typical mortgage interest rate (Freddie Mac)
30-year fixed: ranged from 5,03 % to 4,23 %; average: 4,69 %
15-year fixed: ranged from 4,44 % to 3,66 %; average: 4,10 %
Source: Freddie Mac – Historical Rate Tables
http://www.freddiemac.com/pmms/index.html?year=2009

6) Voltage (household, typical electricity distribution network)
Approximately 110 V_{AC}.

7) Electricity industry structure and ownership
The United States' utility industry structure and ownership model is diverse and varies between deregulated and regulated markets. A brief overview is provided below:
Investor-owned electric companies. Sell power at retail rates to several different classes of customers and at wholesale rates (for resale) to state and local government-owned utilities,

public utility districts, and rural electric cooperatives. Account for about 73 % of total kW/h sales in the United States.
Source: http://www.nreca.org/members/Co-opFacts/Pages/default.aspx

Publicly-owned electric utilities. Owned by the city or municipality in which they operate and are financed through municipal bonds. They are self-regulated. Approximately 11 % of the kilowatt-hours sold each year come from the 2 000 municipally-owned systems. Publicly-owned utilities also include public utility districts and public power districts, State authorities, irrigation districts, and joint municipal action agencies which supply another 4 % of sales.
Sources: http://www.nreca.org/members/Co-opFacts/Pages/default.aspx
http://www.eia.doe.gov/cneaf/electricity/page/prim2/toc2.html

Electric cooperatives. Private, independent electric utilities that are owned by the members they serve. Democratically governed businesses, electric cooperatives are organized under the Cooperative or Rochdale Principles, which anchor them firmly in the communities they serve and ensure that they are closely regulated by their consumers. Deliver 10 % of the total kilowatt hours sold in the United States each year.
Source: http://www.nreca.org/members/Co-opFacts/Pages/default.aspx

Federally owned utilities. Agencies of the federal government involved in the generation and/or transmission of electricity, usually sold at wholesale prices to local government-owned and cooperatively owned utilities and to shareholder-owned companies. These government agencies are the Army Corps of Engineers and the Bureau of Reclamation, which generate electricity at federally owned hydroelectric projects. The Tennessee Valley Authority transmits electricity to the Tennessee Valley. Federally owned utilities account for about 1 % of total kilowatt-hour sales in the United States.
Source: http://www.eia.doe.gov/cneaf/electricity/page/prim2/toc2.html

8) Price of diesel fuel
2,99 USD per gallon in 2010
Source: http://www.eia.doe.gov/steo

9) Typical values of kWh/kW for PV systems in parts of your country
Typical solar radiation in the United States is from 3 to 7 kWh/m^2/day
Source: http://www.solar-estimate.org/solar_radiance.pdf

---

[i] SEIA-GTM Solar Market Insight and Barclays Capital
[ii] Larry Sherwood
[iii] Ibid.
[iv] http://seia.org/galleries/pdf/Major%20Solar%20Projects.pdf

[v] Navigant

[vi] Barclays Capital
[vii] SEIA-GTM Research