U.S. Solar Market Trends 2010

June 2011

Larry Sherwood

IREC
Interstate Renewable Energy Council

Photovoltaic installation on Molokai General Hospital, Hawaii

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EXECUTIVE SUMMARY

Solar markets are booming in the United States due to strong consumer demand and financial incentives from the federal government, states and utilities. Over 124,000 new solar heating, cooling, and solar electric installations were completed in 2010, an increase of 22% compared to the number of systems installed in 2009. The capacity of these installations is 981 MW_{DC} for electricity production and 814 MW_{TH} for thermal heating. The majority of the market share for each solar technology is concentrated in a few states. However, the number of states with a significant number of installations is growing.

Photovoltaic trends:

- The capacity of photovoltaic (PV) installations completed in 2010 doubled compared to the capacity installed in 2009.
- PV capacity installed in 2010 quadrupled in the utility sector and grew by over 60% in the residential and non-residential sectors. State renewable portfolio requirements are an important reason for the large growth in the utility sector.
- The amount of PV capacity installed in Arizona, Colorado, Massachusetts, Nevada, New Jersey, New Mexico, Pennsylvania and Texas installed in 2010 was at least double the capacity installed in each state in 2009. California remains the largest U.S. market, with about 28% of the U.S. installed capacity completed in 2010. However, this is a significant drop in market share from the 49% recorded in 2009.

Solar heating and cooling trends:

- There were 6% more solar water heating installations (low-temperature thermal) completed in 2010 than in 2009. Eighty-four percent of these installations are in the residential sector.
- The capacity of solar pool heating installations increased by 13% in 2010 compared with 2009. However, the annual capacity of solar pool installations is still 30% below the peak achieved in 2006.

Concentrating solar power trends:

- Two new concentrating solar power (CSP) plants were constructed in 2010, with a combined capacity of 76 MW. Most of this capacity was at a 75 MW Florida plant that was the largest U.S. CSP installation since 1991.

Over the near term, the prospect for growth in solar installations is bright. Early indicators point to continued market growth in 2011 due to the long-term extension of the federal solar investment tax credit (ITC), recent federal legislation that allows utilities to take advantage of the ITC, and a deadline to start construction by the end of 2011 to participate in the federal cash grant program. Companies have announced plans for many large solar electric projects, including both PV and CSP projects. Some of these projects are under construction and will come on-line between 2011 and 2014.

About the Interstate Renewable Energy Council

IREC is a non-profit organization accelerating the use of renewable energy since 1982. IREC's programs and policies lead to easier, more affordable connection to the utility grid; fair credit for renewable energy produced; best practices for states, municipalities, utilities and industry; and quality assessment for the growing green workforce through the credentialing of trainers and training programs.

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INTRODUCTION

Different solar energy technologies create energy for different end uses. Two solar technologies, photovoltaics (PV) and concentrating solar power (CSP), produce electricity. A third technology, solar thermal collectors, produces heat for water heating, space heating or cooling, pool heating or process heat.

Photovoltaic cells are semi-conductor devices that generate electricity when exposed to the sun. Manufacturers assemble the cells into modules, which can be installed on buildings, parking structures or in ground-mounted arrays. PV was invented in the 1950s and first used to power satellites. As PV prices declined, PV systems were installed in many off-grid installations — installations not connected to the utility grid. In the last decade, and especially in the last several years, grid-connected installations have become the largest sector for PV installations.

Concentrating solar power (CSP) systems use mirrors and collecting receivers to heat a fluid to a high temperature (from 300°F to more than 1,000°F), and then run the heat extracted from the fluid through a traditional turbine power generator or Stirling engine. CSP can also be paired with existing or new traditional power plants, providing high-temperature heat into the thermal cycle. These generating stations typically produce bulk power on the utility side of the meter rather than generating electricity on the customer side of the meter. CSP plants were first installed in the United States in the early 1980s, and installations continued through the early 1990s. Although many of these installations still generate power today, few new systems had been installed since the early 1990s until recently. Installations have resumed, with one large plant constructed in 2010 and a significant number of announcements for new plants projected to be completed between 2011-2015. In another application, concentrating solar thermal can provide high temperature solar process heat for industrial or commercial applications. A few systems are installed each year using this technology.

SEMPRA ENERGY

58-MW photovoltaic installation at Copper Mountain, Nevada

Solar thermal energy is used to heat water, to heat and cool buildings, and to heat swimming pools. A variety of flat plate, evacuated tube and concentrating collector technologies produce the heat needed for these applications. Solar water heating systems were common in Southern California in the early 1900s before the introduction of natural gas. Many systems were sold in the United States in the late 1970s and early 1980s. In the mid-1980s, the expiration of federal solar tax credits and the crash of energy prices led to an industry slow-down.

This report provides public data on U.S. solar installations by technology, state and market sector. Public data on solar installations help industry, government and non-profit organizations improve their efforts to increase the number (and capacity) of solar installations across the United States. Analysis of multi-year installation trends and state installation data helps these stakeholders learn more about state solar markets and evaluate the effectiveness of marketing, financial incentives and education initiatives. In addition, these data allow for a better understanding of the environmental and economic impact of solar installations.

For all solar technologies, the United States is only a small part of a robust world solar market. Product availability and pricing generally reflect this status. Germany is the top market for PV, Spain is the top market for CSP, and China is the largest market for solar thermal collectors. The grid-connected PV market in Ontario, Canada, ranks as one of the largest markets in North America. Ontario's market is discussed briefly on page 11. (Other than Ontario's market, this report does not analyze markets outside the United States.)

The data-collection methods and the assumptions used in this report are described in detail in Appendices A and B.

PHOTOVOLTAICS

Overall Trends in Installations and Capacity

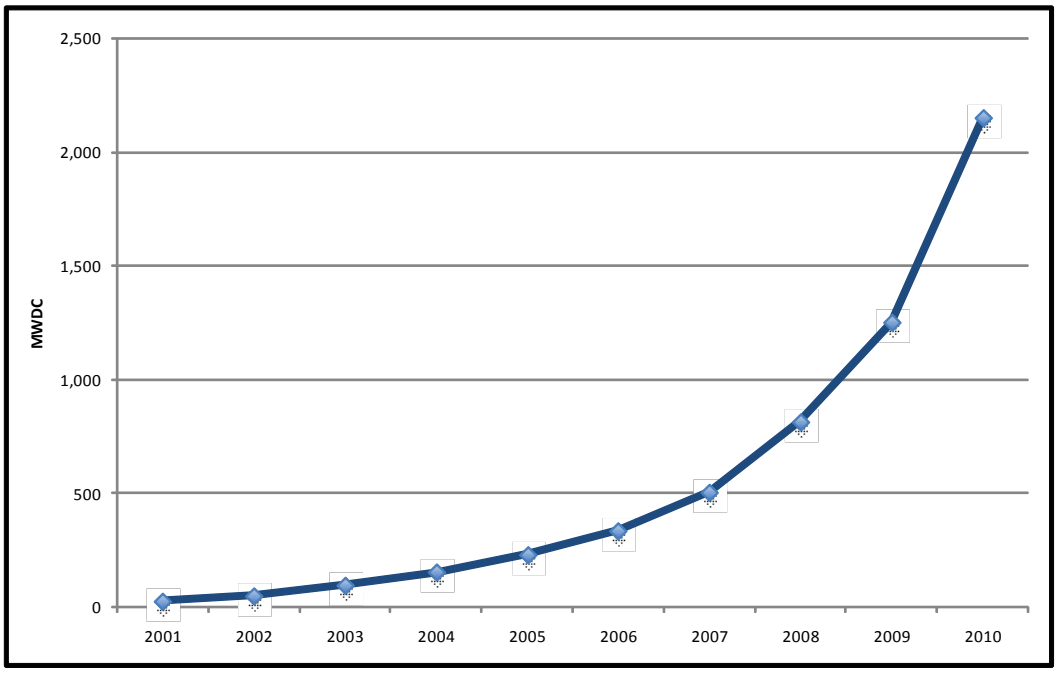
Annual U.S. grid-connected PV installations doubled in 2010 compared with installations in 2009 to 890 MW_{DC}, raising the cumulative installed grid-connected capacity to 2.15 GW_{DC} (see Figure 1). The capacity of PV systems installed in 2010 was over eight times the capacity of PV installed in 2006. More than 50,000 systems were installed in 2010, a 45% increase over the number installed the year before. In 2010, 262 MW_{DC} were installed on residential buildings, 347 MW_{DC} at non-residential sites and 284 MW_{DC} in the utility sector.

Some PV installations are off-grid. Based on anecdotal information, off-grid installations likely totaled 40-60 MW in 2010, but IREC has not collected data for these installations, and they are not included in this report's charts.

The following factors helped drive PV growth in 2010:

- There was stability in federal incentive policy. Tax credits for both residential and commercial installations are currently in place through 2016. In February 2009 as part of the American Recovery and Reinvestment Act (ARRA), Congress enacted the U.S. Treasury Grant in Lieu of the Investment Tax Credit Program (ITC). This program, commonly known as the Treasury cash grant program, provides commercial installations with the alternative of a cash grant instead of the tax credit. Although enacted in early 2009, the rules were not created until later that year. In 2010, the program operated for the entire year. The cash grant program was originally scheduled to expire at the end of 2010, but was extended through the end of 2011. The threatened expiration caused many projects to begin construction in 2010, in order to qualify for the grant program, but probably did not significantly affect the number of completed installations. Federal tax policy stability is good for solar markets. Developers and installers can plan and market their products and consumers can make rational decisions without arbitrary incentive deadlines.
- Capital markets improved. Installing solar requires significant capital investment. With the economic meltdown in 2008, many capital markets dried up, contributing to the lack of growth in non-residential solar installations in 2009 compared with 2008. In 2010, the capital markets recovery can be seen in the growth of 63% for non-residential installations compared with 2009.
- State renewable portfolio standard (RPS) requirements are encouraging investments in utility-scale solar plants. Utility sector investments increased by more than four times in 2010 compared with 2009 and this sector seems poised to continue its rapid growth over the next several years. In some states, RPS requirements have led to robust solar renewable energy credit (SREC) markets, which in

Fig. 1: Cumulative U.S. Grid-tied Photovoltaic Installations (2001-2010)



Residence with photovoltaics and solar hot water in Fitchburg, Wisconsin

turn have resulted in increased demand for and installation of distributed solar installations.

- State financial incentives continue to be an important factor, especially for residential and commercial distributed installations. Of the top ten states for PV installations, six have state or utility rebate programs that are the most significant driver in those markets. The federal incentives are important, but they are generally insufficient to create a market by themselves.
- Federal stimulus funding continued. ARRA provided funding that helped solar installations in a number of different ways. First, the state of the economy means that tax equity investors are in short supply. The cash grant program provided a stronger incentive for installations than the federal tax credit. The cash grant program provided $410 million in 2010 and funded at least 40% of the non-residential PV installations during the year. Second, ARRA funded many government solar installations at both the federal and state levels. Third, some states used their ARRA funding to create or enhance state financial incentive programs. Although the impact of ARRA programs will continue to be felt in 2011, this impact will begin to decrease as the funding is completed.
- PV modules prices declined. Based on price data for a sample of 2010 installations, total installed price dropped by 14% for residential installations and 20% for non-residential installations.

Grid-Connected Installations by Sector

The growth rate of grid-connected PV varied by market sector, with the largest growth occurring in the utility sector. Non-residential facilities include government buildings, retail stores and military installations. The larger average size of these facilities results in a larger aggregated capacity. Residential and non-residential installations are generally on the customer's side of the meter and produce electricity used on-site. In contrast, utility installations are on the utility's side of the meter and produce bulk electricity for the grid. Table 1 shows examples of installations in each sector.

Table 1: SAMPLE INSTALLATIONS BY SECTOR

Sector	Example Installations
Residential	• Residential installation owned by homeowner or building owner; electricity generated is used on-site • Residential installation owned by third party, with electricity sold to the homeowner or building owner
Non-Residential	• Non-residential installation owned by building owner; electricity generated is used on-site • Residential installation owned by third party, with electricity sold to the building owner and used on-site
Utility	• Installation owned by utility; electricity generated goes into bulk power grid • Installation owned by third party; electricity generated goes into bulk power grid • Installation owned by building owner; electricity generated goes into bulk power grid through a feed-in tariff or similar incentive

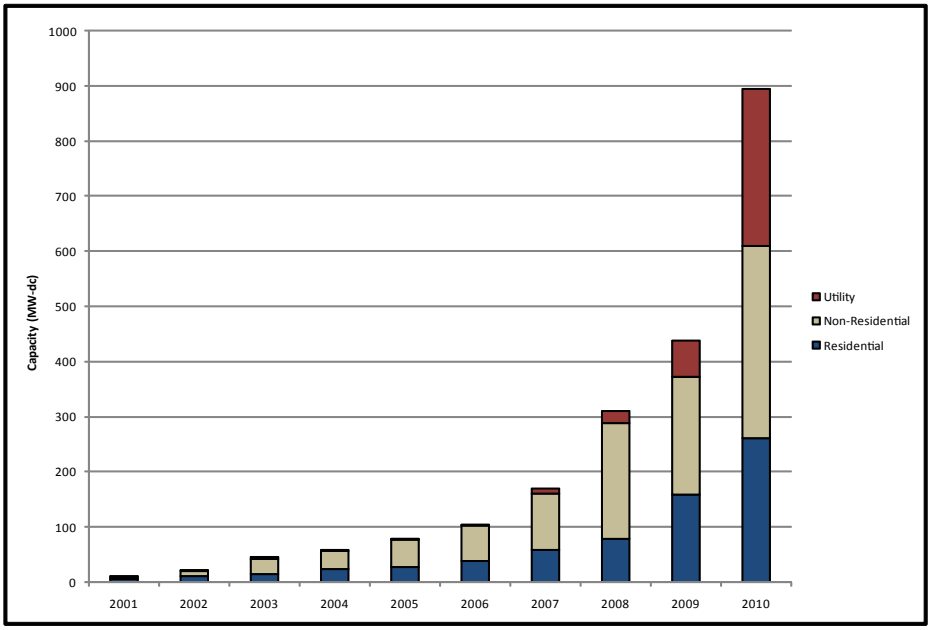


Fig. 2: Annual Installed Grid-Connected PV Capacity by Sector (2001-2010)

2010 marked the emergence of the utility sector photovoltaic market. Utility sector photovoltaic installations quadrupled over 2009 installations. Figure 2 shows the annual PV installation capacity data, segmented by residential, non-residential and utility installations. The share of utility sector installations of all U.S. grid-connected PV installations grew from virtually none in 2006 to 15% in 2009 and 32% in 2010. Of the ten largest PV installations in the U.S., six were installed in 2010. The two largest U.S. PV installations were installed in 2010. These are the 58 MW_{DC} Sempra/First Solar plant in Boulder City, Nevada, which supplies power to Pacific Gas and Electric customers in northern California and the 35 MW_{DC} Southern Company/First Solar plant in Cimarron, New Mexico, which supplies power to Tri-State Generation and Transmission Association customers in Colorado, Nebraska, New Mexico, and Wyoming.

State renewable portfolio standard (RPS) requirements are encouraging investments in utility-scale solar plants in some states. Federal tax incentives and grants and lower costs for PV modules also made these investments attractive. Construction has begun on many additional utility sector installations, and utilities and developers have announced even more projects to be built in the next few years. Installations in this sector seem poised for continued growth.

In 2010, annual distributed grid-connected PV installations in the United States grew by 62%, to 606 MW_{DC}. Distributed installations provide electricity, which is used at the host customer's site. Photovoltaics were installed at more than 50,000 sites in 2010, a 45% increase over the number of installations in 2009.

Residential installations increased by 64% and accounted for 29% of all PV installations in 2010. Residential installation growth has been dramatic each year for the past five years, with annual growth rates between 33 and 103%. Federal incentives for residential installations are stable, with no changes made in 2010 and current incentive levels set until 2016. Most installations occur in states with state or local incentives, in addition to federal incentives.

The non-residential sector, which includes sites such as government buildings, retail stores and military installations, also experienced dramatic growth in 2010, compared with 2009. After a year of no growth in 2009, non-residential installations increased by 62% in 2010 and accounted for 39% of 2010 installations on a capacity basis.

As part of the federal stimulus legislation passed in February 2009, commercial entities may receive the federal incentive as

Residential photovoltaic installation in Plymouth, Wisconsin

a cash grant instead of a tax credit. The rules governing the cash grant program were not created for several months, so the impact on 2009 installations was muted. In 2010, the program operated for the entire year. The cash grant program was originally scheduled to expire at the end of 2010, but in late 2010, was extended through the end of 2011. The threatened expiration caused many projects to begin construction late in 2010, in order to qualify for the cash grant program. These late 2010 project starts did not significantly affect the number of completed installations in 2010. They will be completed in 2011 or later.

Capital markets improved in 2010. Installing solar requires significant capital investment, yet the economic meltdown in 2008 caused many sources of capital to dry up. This was one factor in the lack of growth in non-residential solar installations in 2009, compared with 2008. In 2010, the capital market's recovery is reflected in the growth of non-residential installations.

Fig. 3: Average Capacity of U.S. Grid-Connected Residential PV Installations (2001-2010)

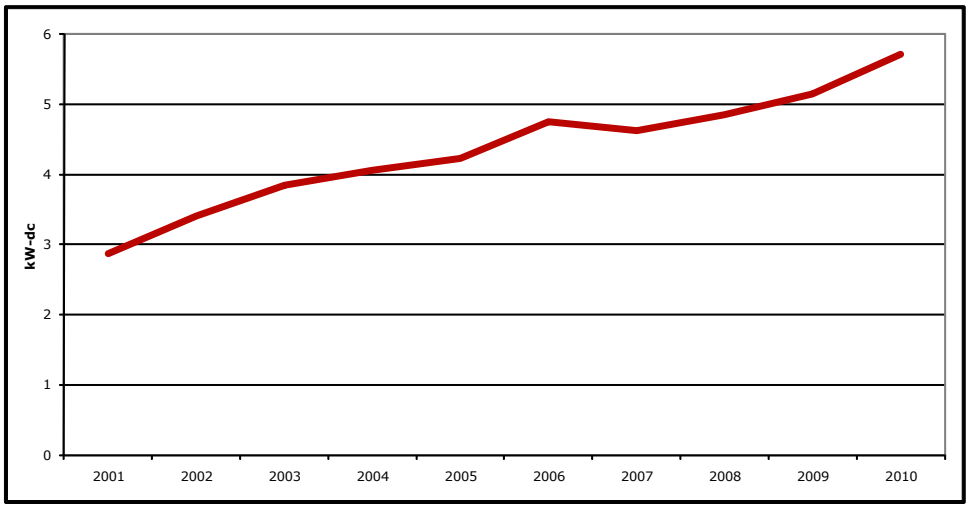
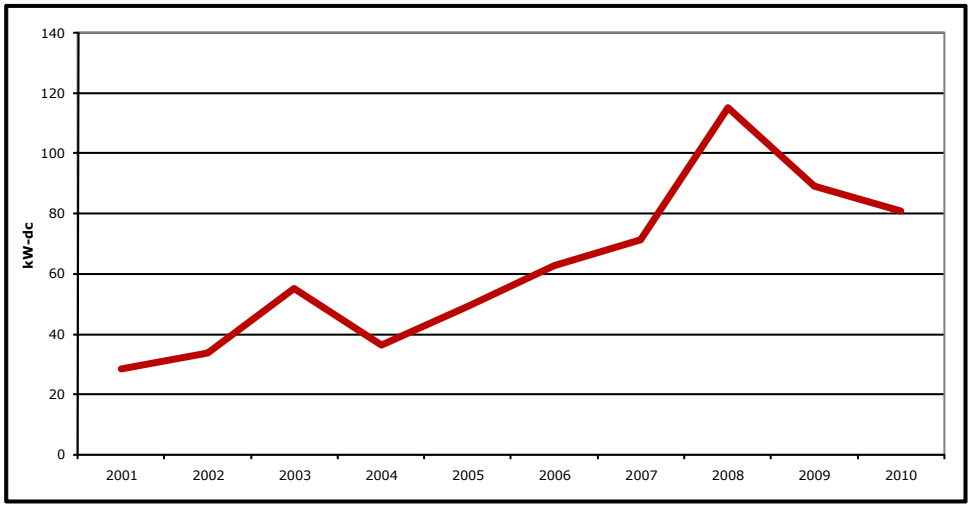


Fig. 4: Average Capacity of U.S. Grid-Connected Non-Residential PV Installations (2001-2010)



Size of Grid-Connected PV Installations

The average size of a grid-connected PV residential installation has grown steadily from 2.9 kW_{DC} in 2001 to 5.7 kW_{DC} in 2010 (see Figure 3). The average size of a non-residential system decreased to 81 kW_{DC} in 2010 from 89 kW_{DC} in 2009 and 115 kW_{DC} in 2008 (see Figure 4). This non-residential data does not include utility sector installations.

Although the number of utility PV installations remains small, the average system size is large (over 1,450 kW_{DC}), so these installations represent 32% of all installations on a capacity basis. Just 34 utility installations greater than 1 MW_{DC} totaled 239 MW_{DC}, or 27% of the capacity total of U.S. systems installed in 2010. In 2009, just six such installations totaled 60 MW_{DC}. Large utility installations attract significant attention, but small installations also occur in the utility sector. In New Jersey, PSE&G began installing 200-W PV systems mounted on power poles. These installations totaled more than 13 MW_{DC} in 2010.

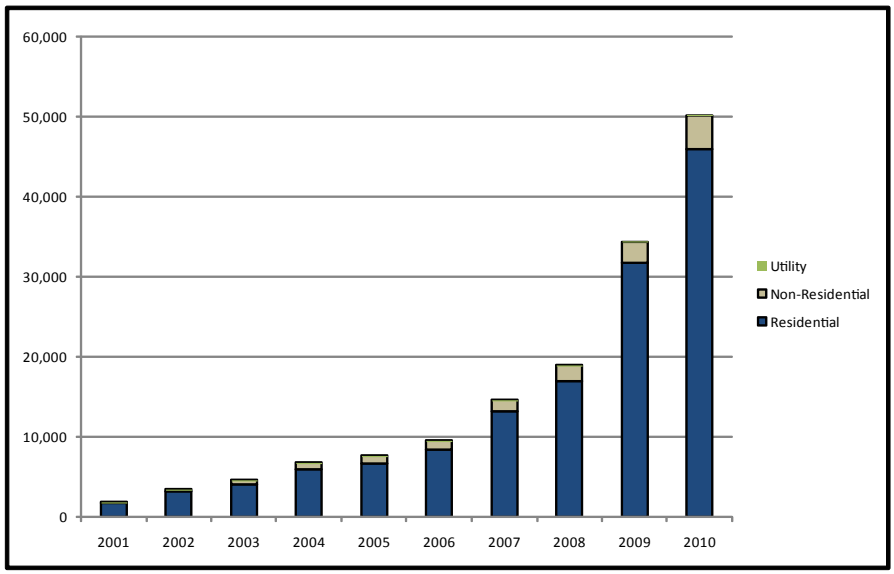
Feed-in tariff incentives generate electricity for the utility sector and currently represent just a small segment of the U.S. PV market. With a feed-in tariff, the utility purchases all the output of the PV system at guaranteed prices, which are typically higher than retail electricity prices.

The average size of grid-connected PV installations varies from state-to-state, depending on available incentives, interconnection standards, net metering regulations, solar

resources, retail electricity rates, and other factors. The Interstate Renewable Energy Council provides summary tables of state net metering and interconnection policies (IREC 2011a and IREC 2011b), and the Database of State Incentives for Renewables & Efficiency provides summary tables of state and utility financial incentives (DSIRE 2011)

Over 50,000 grid-connected PV installations were completed in 2010, with 91% of these at residential locations (see Figure 5). By contrast, residential systems accounted for only 29% of the PV capacity installed in 2010, as discussed previously. At the end of 2010, 154,000 PV installations were connected to the U.S. grid, including over 139,000 residential installations. The average size of non-residential systems is more than ten times the average size of residential systems.

Fig. 5: Number of Annual U.S. Grid-Connected PV Installations (2001-2010)



Grid-Connected Installations by State

In 2010, installations of grid-connected PV systems were concentrated in California, New Jersey, Nevada, Arizona, and Colorado, as shown in Table 2. The market more than doubled in all of the top ten states, except for California and Florida.

Nevada, New Mexico and Texas are new states on the top ten list this year due to one very large installation in each of those states. Pennsylvania made it onto the list because of installations driven by their rebate program, which began in mid-year 2009. With the exception of Nevada, all states on the 2010 top ten list made this list because of their state renewable portfolio or financial incentive programs. Although Nevada has a renewable portfolio standard and a solar rebate program, it makes the top ten list because of the single large 58 MW_{DC} installation that sells

Table 2: TOP TEN STATES
Ranked by Grid-Connected PV Capacity Installed in 2010

2010 Rank by State	2010 (MW_{DC})	2009 (MW_{DC})	09-10 % change	2010 Market Share	2009 Rank
1. California	252.0	213.7	18%	28%	1
2. New Jersey	132.4	57.3	131%	15%	2
3. Nevada	68.3	2.5	2598%	8%	15
4. Arizona	63.6	21.1	201%	7%	5
5. Colorado	62.0	23.4	165%	7%	4
6. Pennsylvania	46.5	4.4	947%	5%	13
7. New Mexico	40.9	1.4	2815%	5%	20
8. Florida	34.8	35.7	-2%	4%	3
9. North Carolina	28.7	6.6	332%	3%	10
10. Texas	25.9	4.2	517%	3%	14
All Other States	138.3	67.6	105%	15%	--
Total	893.3	438.0	104%	--	--

electricity to Pacific Gas and Electric in California to meet the California renewable portfolio standard.

On a per capita basis, six states (Arizona, Colorado, Hawaii, Nevada, New Jersey and New Mexico) had more installations than California in 2010, showing how the market is diversifying across the country. On a cumulative basis, Nevada, Hawaii and New Jersey now have more per capita installations than California (see Table 4).

2009 and 2010 columns include installations completed in those years. "2010 Market Share" means share of 2010 installations. "2009 Rank" is the state ranking for installations completed in 2009.

Table 3: TOP TEN STATES
Ranked by Grid-Connected PV Cumulative Installed Capacity through 2010

	MW_{DC}	Market Share
1. California	1,022	48%
2. New Jersey	260	12%
3. Colorado	121	6%
4. Arizona	110	5%
5. Nevada	105	5%
6. Florida	73	3%
7. New York	56	3%
8. Pennsylvania	55	2%
9. Hawaii	45	2%
10. New Mexico	43	2%
All Other States	264	12%
Total	2,153	--

Table 4: TOP TEN STATES
Ranked by Cumulative Installed PV Capacity per Capita (W_{DC}/person) through 2010

	Cumulative through 2010 (W_{DC}/person)	2010 Installations (W_{DC}/person)
1. Nevada	38.8	25.3
2. Hawaii	32.9	13.6
3. New Jersey	29.6	15.1
4. California	27.4	6.8
5. Colorado	24.1	12.3
6. New Mexico	21.0	19.9
7. Arizona	17.2	10.0
8. Dist of Columbia	7.4	5.8
9. Connecticut	6.9	1.4
10. Oregon	6.2	2.6
National Average	7.0	2.9

Above: Photovoltaic carport awning in Las Vegas, Nevada
Below: Photovoltaic installation at San Francisco International Airport

Incentives by State

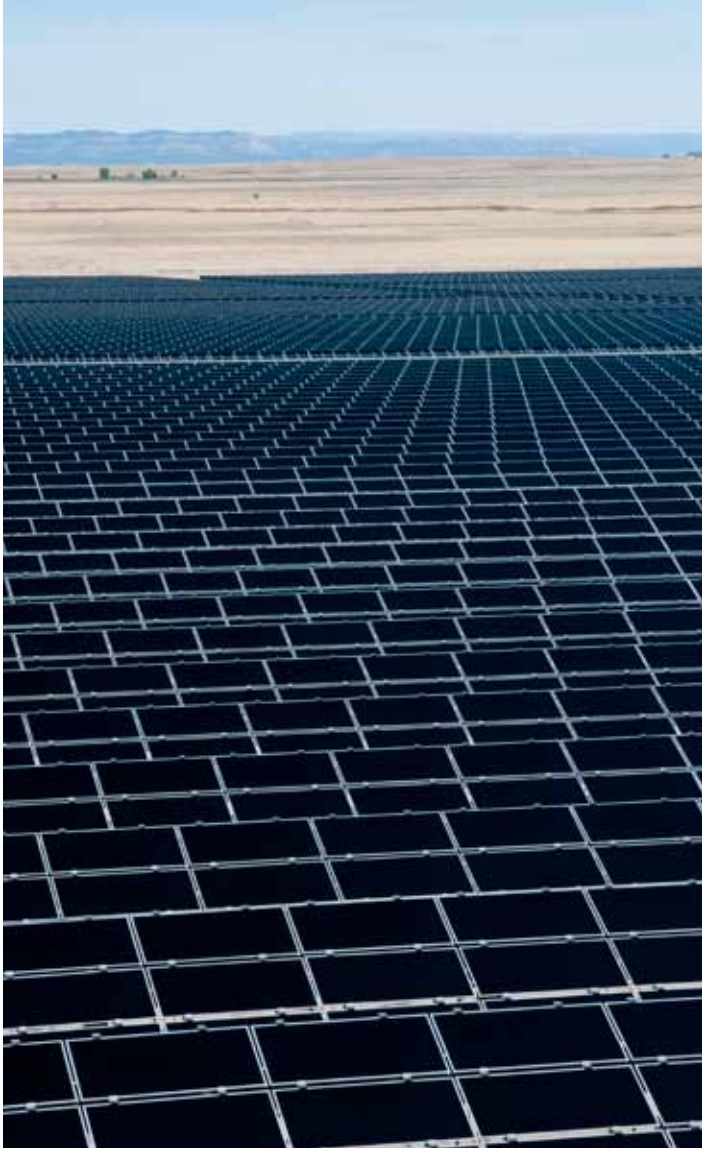
Solar electric market activity has more to do with state incentives and policies than with the amount of available solar resources. Most of the top states for grid-connected PV offer financial incentives and/or have an RPS policy with a solar mandate. The combination of state and/or local incentives and the federal ITC created strong markets for most of the installations around the country. There are relatively few installations in locations with no state, utility or local incentives and with no RPS policy with a solar mandate. This section describes the incentives offered in the states with the largest number of installations.

In 2007, **California** launched its 10-year, $3 billion Go Solar California campaign. The largest part of this campaign is the California Solar Initiative (CSI), overseen by the California Public Utilities Commission (CPUC). The CSI awards rebates and performance-based incentives for customers serviced by the state's three investor-owned electric utilities: Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric. With $227 million in CSI incentives, over 175 MW_{DC} of PV was installed in 2010 through this program.[1] These incentives are based on actual system performance for larger systems and expected system performance for smaller systems. Incentive levels are reduced over the duration of the program in 10 "steps," based on the aggregate capacity of solar installed. Because of these step reductions, the incentives paid decreased in 2010, but the capacity installed through the program increased. The CSI was prudently designed as a 10-year program, so the industry in California can rely on long-term policy stability.

In addition, the California Energy Commission (CEC) administers the New Solar Home Partnership program for PV installations on new homes and the CPUC manages the Multi-Family Affordable Solar Housing and the Single-Family Affordable Solar Housing Programs.

Beginning in 2008, California required municipal utilities to offer solar incentives. Installations in municipal utility service territories in California totaled over 44 MW_{DC} in 2010, more than double the 2009 installations. A number of municipal utilities have offered incentives for many years, and the larger municipal utilities in Sacramento and Los Angeles have installed a large number of PV systems over the past decade or more.

1 Note that California agencies typically report in MW_{AC} and the data are presented here in MW_{DC}.



FIRST SOLAR, INC.

30-MW installation in Cimaron, New Mexico

In addition, California has an RPS requirement of 20% by 2013 and 33% by 2020. This includes all renewable technologies and led to 90 MW_{DC} of utility sector photovoltaic installations in 2010. Some 58 MW_{DC} of these installations were in Nevada with the electricity produced flowing to California. The RPS requirement will lead to more utility-sector solar installations in future years.

In **New Jersey**, an RPS with a solar requirement built a strong PV market. The solar requirement is 306 GWh in 2011 increasing to 5,316 GWh in 2026. In the early years of the New Jersey program, rebates were the most important driver for solar installations. Rebate expenditures peaked in 2006 at $78 million. In 2010, rebate expenditures were $47 million for 30 MW_{DC} of installations. Now, for larger installations, the capacity-based rebate program has been converted into a performance-based incentive that involves payments based on the actual energy production of a PV system. This performance-based program created a market for solar renewable energy credits (SRECs), which New Jersey utilities use to comply with the RPS. In 2010,

new installations with a combined capacity of 102 MW_{DC} were selling SRECs, representing 77% of new installations in New Jersey.

Arizona's solar policy has evolved over the past several years. The current requirement is 15% renewable generation by 2025. Distributed generation must provide 30% of this requirement divided between half residential and half non-utility non-residential installations. Solar water heaters may also provide RECs for RPS compliance in Arizona. The current program has resulted in the tripling of annual installed capacity in each of the past two years. Arizona (along with California, Nevada, Colorado and New Mexico) is a very favorable site for future utility-scale PV and CSP plants and a number of such future plants have been announced.

In 2005, **Colorado** voters passed Amendment 37, which created an RPS with a solar mandate equal to 0.4% of retail electricity sales. Later, the legislature doubled the overall RPS requirements and the solar mandate. The current requirement is 3% distributed generation by 2020 with half of that total serving retail customers. Xcel Energy is by far the largest utility in the state; over 76% of 2010 Colorado PV installations were part of Xcel's programs. Xcel offers capacity-based rebates for smaller, customer-sited PV systems. For these systems, part of the capacity credit involves a purchase of the renewable energy credits (RECs) for 20 years, based on expected performance. For larger PV systems, Xcel purchases the RECs based on actual energy production. The Governor's Energy Office also funded rebates for some utilities around the state using Federal stimulus funds.

Florida offered state customer rebates for PV, solar water heating, and solar pool heating installations. However, this program expired on June 30, 2010. State funding allowed approved systems to be installed later in 2010 and into 2011. In addition, Gainesville Regional Utilities offers a feed-in tariff program. By themselves, these programs provided growth for Florida's PV market. In addition, the Florida Public Utilities Commission allowed utilities to include a small amount of solar in their rate base. This led to the installation of 29 MW_{DC} of utility sector PV installations in 2010 plus the installation of the 75 MW_{AC} concentrating solar power plant, which was the only installation of this type in 2010.

Pennsylvania offers rebates for PV and solar thermal systems through the Pennsylvania Sunshine Solar Rebate Program funded with $100 million in state bonds. The program began in

Residential solar installation in Columbus, Wisconsin

May 2009 and rebate levels decline over the life of the program. 2010 and 2011 are likely to be the two years with the most installations through this program.

Nevada, **New Mexico** and **Texas** each made the top ten state list due to a single large utility sector installation in each state. In Nevada, a 58 MW_{DC} installation is the largest single PV installation in the U.S. This plant provides power for Pacific Gas and Electric in California. In New Mexico, a 35 MW_{DC} installation provides power for Tri-State Generation customers in five states. And in Texas, a 17 MW_{DC} plant provides power for CPS Energy, the municipal utility for San Antonio.

Although this report covers U.S. installations, the market across the border in the province of **Ontario**, **Canada,** is also noteworthy. In 2010, Ontario installations added a total of about 168 MW_{DC}. If Ontario were a U.S. state, it would have ranked second on IREC's list of states. Some analysts believe that in 2011 Ontario installations could exceed California and make Ontario the largest North American market. A feed-in tariff program begun in 2008 jump-started the burgeoning Ontario market.

Residential PV solar installation in Minnesota

CONCENTRATING SOLAR POWER

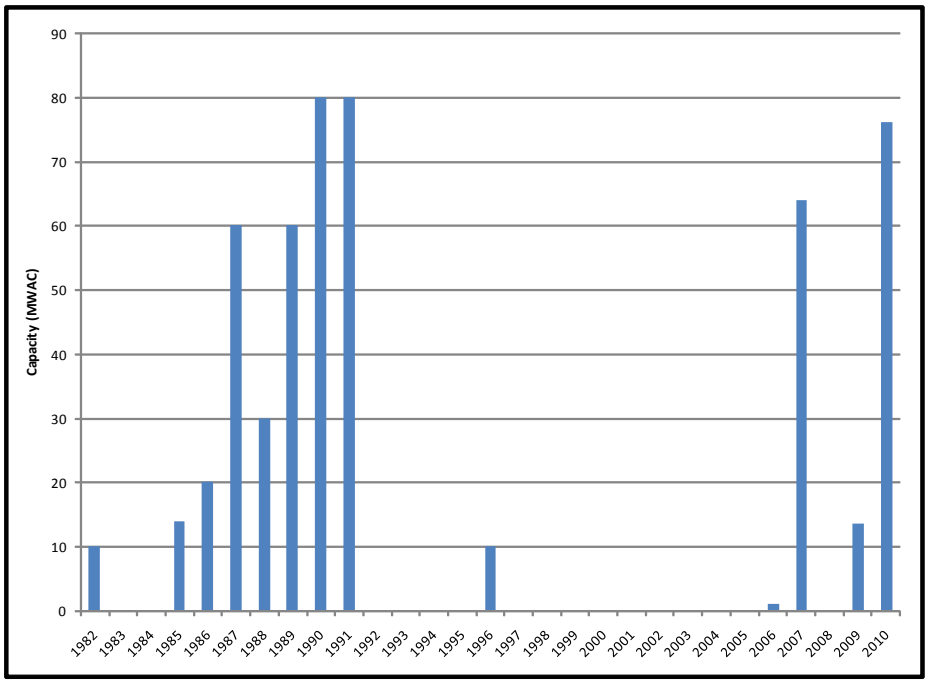
In 2010 the largest concentrating solar power plant since the 1980s was completed when Florida Power and Light installed a 75 MW_{AC} CSP plant near Indiantown, Florida. In addition, one small CSP plant was installed in Colorado. This plant provides supplemental heat to an existing coal-fired power plant.

The future prospects for CSP plants look bright. Several different companies have announced plans totaling over 10,000 MW of generating capacity, and some received required permits and financing in 2011. These plants will be constructed over the next few years.

75-MW Martin Solar Plant near Indiantown, Florida

Construction of 75-MW Martin Solar Plant

Fig. 6: Annual Installed U.S. CSP Capacity (1982-2010)

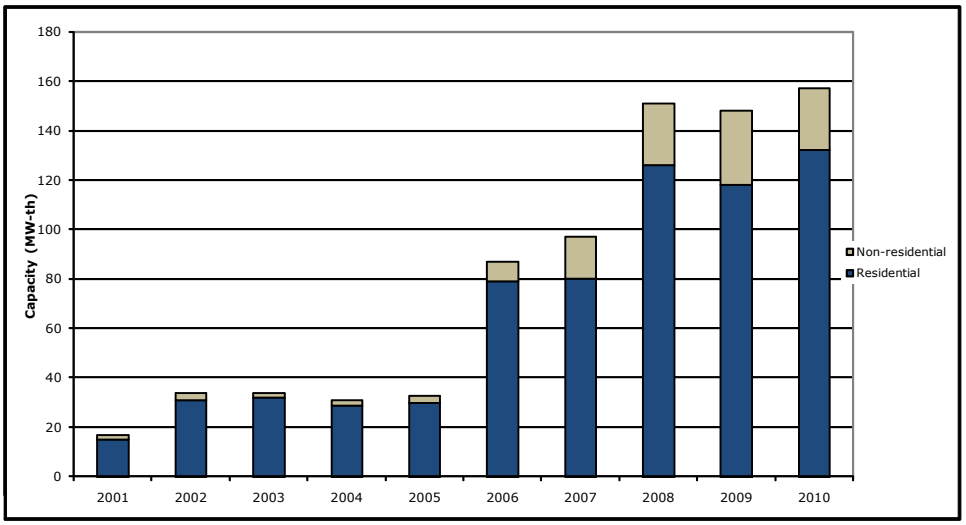


SOLAR HEATING AND COOLING

Solar thermal collectors can heat hot water for domestic or commercial use, or heat spaces such as houses or offices. Solar thermal collectors can also provide heat for industrial processes or space cooling.

GreenTech Media and the Solar Energy Industries Association estimate that solar water-heating installations increased by 6% in 2010, compared with 2009 (GTM/SEIA 2011). Solar water heating has shown only two years of strong growth in the last 10 years. In 2006, solar water heating installations more than doubled compared with 2005. That year, the residential federal ITC was established and the commercial ITC increased. Then in 2008, installations grew by 56% compared with 2007. In 2008, the cap on the amount of the federal ITC a residential customer could receive was removed. The solar water-heating markets respond when federal incentives are increased, but, unlike photovoltaic installations, market demand does not sustain high growth rates (see Figure 7).

Fig. 7: Annual Installed U.S. Capacity for Solar Heating and Cooling (2001-2010)



Based on analysis of collector shipment data from EIA and GTM/ SEIA.

State rebates and other incentives for solar hot water have increased in recent years. Arizona, California, Connecticut, Florida, Hawaii, Maryland, Oregon, Pennsylvania, Vermont and Wisconsin all provided rebates for over 100 systems in 2010. However, these programs are not spending enough money to affect much growth in national installations. California has a new solar thermal program as part of its California Solar Initiative. Although the program only operated for a few months in 2010, it is expected to rapidly increase the number of solar hot water installations in the state.

Seventy-nine percent of total solar water heating installations in 2009 was on residential buildings. Contrast that with photovoltaics where residential installations were only 29% of the total installations in 2010. Diversification in different market sectors has helped PV growth sustain itself year after year.

A positive development for solar thermal is the emergence of a market for solar thermal process heating systems, which use solar thermal energy to provide energy for industrial process uses. This market in 2009 was about one-quarter of the solar hot water market. These are installations on industrial or commercial establishments and include some third party power purchase agreement (PPA) systems. Since this ownership model has been key to the growth of the non-

Solar thermal installation at the Allison Inn, Oregon

residential PV market, it will be interesting to see how it affects the solar thermal market's growth in the next few years.

Solar Pool Heating

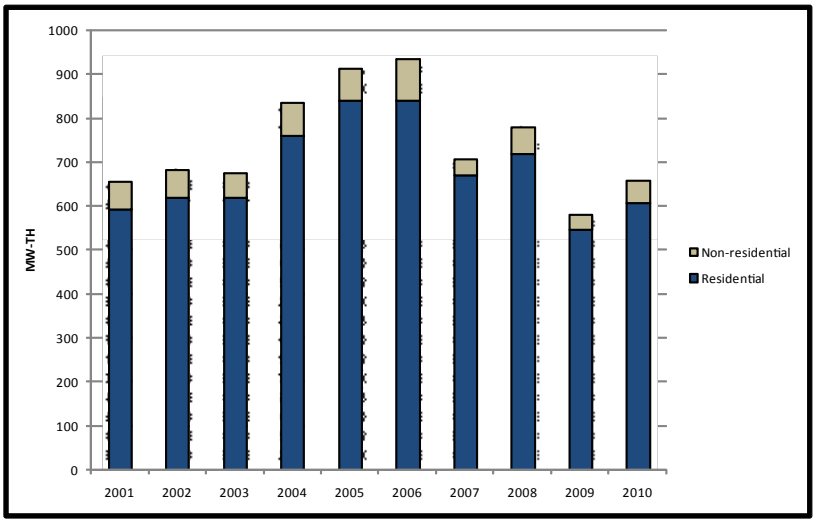
In the other major solar thermal sector, pool-heating installations increased by 13%, the largest improvement in five years (see Figure 8). Even though growth was good in 2010, the annual capacity installed is 30% less than the installations in 2006, the best year for pool heating installations. The solar pool-heating market has been soft for years, due to the weak real estate markets in California and Florida. The economic decline in the real estate markets in Florida and California led to the decrease in pool installations and thus the decline in the installed capacity of new solar pool systems in recent years.

For solar pool heating systems, installations are concentrated in just a few states, notably Florida and California. Unlike other solar technologies, only a few states offer incentives for solar pool heating systems, and those incentives are modest.

Solar heated pool in California

Fig. 8: Annual Installed Capacity for Solar Pool Heating (2001-2010)

Based on collector shipment data from EIA and GTM/ SEIA.



Solar hot water installation at Fire Station in Madison, Wisconsin

Residential solar hot water with ground-mounted PV in Viola, Wisconsin

NUMBER OF INSTALLATIONS

The number of all solar installations completed in 2010 grew by 22% to over 124,000 installations (compared to the number completed in 2009), as shown in Figure 9. This figure includes grid-connected and off-grid PV, solar heating and cooling, solar pool heating and solar thermal-electric. Through 2005, over half of these installations were for solar pool heating. However, because of the expanded federal ITC and the slump in the new pool market, the market shares of the different solar technologies have changed significantly since 2006. Grid-connected PV and solar water heating installations experienced the largest growth during this period and in 2010 together represented 74% of all solar installations.

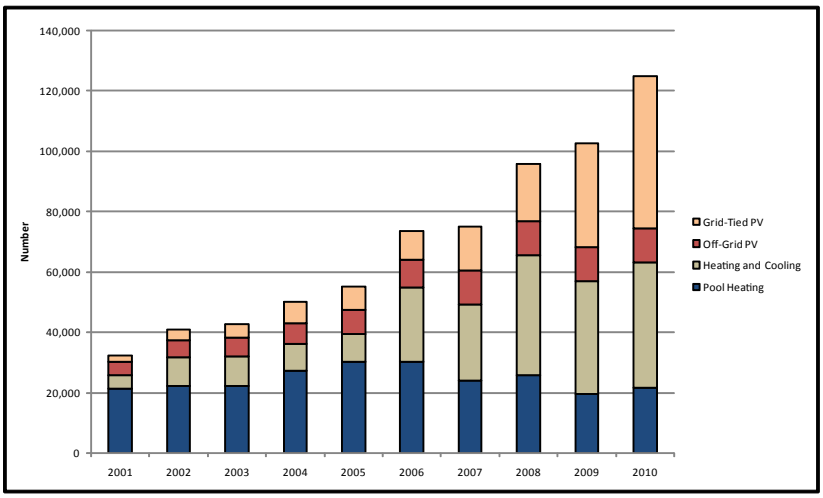
Table 5 shows that the cumulative total of U.S. solar installations from 1994-2010 is 886,000 systems. Figure 9 and Table 5 show only the number of installations for each technology, not the relative energy contribution. Since grid-connected PV installations are larger on average, the energy contribution from PV installations will be larger than the relative number of installations.

TABLE 5: CUMULATIVE U.S.SOLAR INSTALLATIONS BY TECHNOLOGY, 1994-2010

Solar Pool Heating	354,000
Solar Heating and Cooling	274,000
Grid-Connected Photovoltaics	154,000
Off-grid Photovoltaics	104,000
Total	886,000

Note: There are less than 100 Concentrating Solar Power Plants and they are not included in this table.

Fig. 9: Number of Annual U.S. Solar Installations by Technology (2001-2010)



Photovoltaic installation on commercial building in Madison, Wisconsin

Photovoltaic awning at parking structure in Madison, Wisconsin

PROSPECTS FOR 2011

What can we expect in U.S. solar markets this year? Early indicators point to continued grid-connected PV growth and the continuation of the 2010 trend of higher growth rates for utility sector installations. Reductions in PV modules prices, long-term extension of the federal ITC, new rules that allow electric utilities to use the ITC and the continuation of the cash grant alternative to the commercial ITC will all help drive market growth. In addition, improved capital availability will allow customers to take advantage of these financial incentives.

Companies have announced plans for many large solar projects, including solar thermal electric projects, utility-owned projects and third party-owned projects. Some of these projects will be completed in 2011, and many more will start construction in 2011 to take advantage of the federal cash grant program. Completion of these later projects will likely occur in 2012 and 2015.

Prices for PV modules fell in 2009 and 2010, and many analysts expect prices to continue to fall in 2011. Lower PV prices increase the potential of installations in states without state or local incentives. The number of states with strong markets continues to grow, although installations in 2011 will continue to be concentrated in states with strong financial incentives. Strong solar policies remain critical to market growth.

SEMPRA ENERGY

58-MW photovoltaic installation at Copper Mountain, Nevada

CONCLUSION

Solar markets continue to grow in the United States due to consumer interest in green technologies, concern about energy prices, and financial incentives available from the federal government, states, local governments and utilities. Over 124,000 solar installations were completed in 2010. The markets for each solar technology are concentrated in a few states.

Led by a quadrupling of utility sector installations, the capacity of new grid-connected PV installations doubled in 2010 compared with the number installed in 2009. The two largest PV systems installed in 2010 together accounted for 9% of the annual installed PV capacity. The PV market is expanding to more states, and installations doubled in more than nine states. California remains the largest market.

Solar water heating installations have grown moderately since the enhanced federal ITC took effect in 2006 and grew by an additional 6% in 2010. Solar pool heating grew by 13%, the largest growth in a number of years.

A 75 MW CSP plant in Florida marked the largest such installation in the U.S. since 1991. The future prospects for CSP look bright, with thousands of megawatts of installations planned for the next five years.

U.S. market growth will continue in 2011, especially for grid-connected PV installations. Federal and state policies will drive this accelerated market growth.

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Residence with photovoltaics and solar hot water in Fitchburg, Wisconsin
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Residential photovoltaic installation in Plymouth, Wisconsin
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Photovoltaic installation at San Francisco International Airport
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Photovoltaic carport awning in Las Vegas, Nevada
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Residential solar installation in Columbus, Wisconsin
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Residential PV solar installation in Minnesota
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75-MW Martin Solar Plant near Indiantown, Florida
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Residential solar hot water with ground-mounted PV in Viola, Wisconsin
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Photovoltaic awning at parking structure in Madison, Wisconsin
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58-MW photovoltaic installation at Copper Mountain, Nevada
Photo courtesy of Sempra Energy

APPENDIX A

DATA SOURCES

Grid-Connected Photovoltaics

State data were obtained for grid-connected photovoltaic (PV) installations from state agencies or organizations administrating state incentive programs and utility companies.

GreenTech Media, in cooperation with the Solar Energy Industries Association, now collects solar installations data on a quarterly basis (GTM/SEIA 2011). The Solar Electric Power Association publishes an annual report on installation by utility that is based on an annual utility survey. For 2010, IREC collaborated with the authors of both of these other installations reports and exchanged data. This collaboration resulted in better and more extensive installation data than in past years. With the growth of the PV market, data collection becomes more complex and multiple sources help improve data quality.

The data quality depends on the source. Certainly, this study misses some installations. Data based on incentives paid are usually the most reliable. Since grid-connected PV is the technology most reliant on incentives, the state-by-state installation data for grid-connected PV are the best.

Off-Grid Photovoltaics

In 2010, off-grid installations likely totaled 40-60 MW, but IREC has not collected data for these installations and they are not included in this report's charts.

Solar Heating and Cooling

Some sources report data on state solar heating and cooling applications, but many do not. The U.S. Energy Information Administration (EIA) annually reports the shipments of solar thermal collectors to each state and the total shipments to the U.S. by market sector, but they do not report shipments to each state by market sector (EIA 1994-2009). However, the EIA does not report shipments by state and market sector (i.e. shipments to California for pool heating use). The pool heating market is very different from the hot water and space heating markets, and the goal of this analysis is to learn the distribution of installations for both of these market segments. EIA did not design its survey to provide this information.

In past years, EIA provided the author with more detailed data that allowed the calculation of shipments by state and market sector. However, EIA no longer provided that data and their survey on 2009 installations is the last solar thermal survey and report they will publish.

APPENDIX B

ASSUMPTIONS

Solar Capacity

Capacity measures the maximum power that a system can produce. For a solar energy system, the capacity is the output under "ideal" full sun conditions. Capacity is typically measured in watts (W) or kilowatts (kW). A kilowatt of one technology usually does not produce the same amount of energy, commonly measured in kilowatt-hours (kWh) for electricity, as a kilowatt of another technology. Thus, capacity for one energy technology is not directly comparable to the capacity for another technology.

Occasionally, data are only reported in terms of capacity or the number of installations, but not both. In these cases, typical data from other sources are used to obtain both pieces of data.

Photovoltaics

This study reports PV capacity in direct current (DC) watts under Standard Test Conditions ($W_{DC\text{-}STC}$). This is the capacity number that manufacturers and others typically report; it is also the basis for rebates in many states.

A number of states and utilities report capacity in alternating

current (AC) watts. The California Energy Commission calculates AC watts by multiplying DC watts under PVUSA Test Conditions by the inverter efficiency at 75% of load. The resulting capacity ($W_{AC\text{-}PTC}$) is a more accurate measure of the maximum power output under real world conditions.

The California Solar Initiative (CSI) reports installation capacity in both DC and AC watts. Therefore, the average ratio between AC and DC watts can be determined for each year. According to the CSI data, in 2007 AC watts were 84% of DC watts, in 2008 the ratio was 85.5%, and in 2009 the ratio was 86.2%. In cases where the data reported to IREC was in AC watts, IREC used the CSI ratios to convert the data to DC watts.

Solar Thermal

Data sources usually report solar thermal capacity in area (square feet). Representatives from the International Energy Agency's Solar Heating and Cooling Programme and several major solar thermal trade organizations developed a factor to convert aperture area of solar thermal collector to capacity (W_{TH}) (IEA 2004). The factor is 0.7 kW_{TH}/m^2 (.065 kW_{TH}/ft^2). This study uses the IEA factor to convert EIA data reported in square feet to MW_{TH}.

Number of Installations

Many data sources report installed capacity rather than the number of installations. This is especially true for solar thermal systems. So, a method is needed to convert capacity to installations.

This study uses the following average installation sizes:

Off-Grid Residential PV: 2 $kW_{DC\text{-}STC}$
Off-Grid Non-Residential PV: 10 $kW_{DC\text{-}STC}$
Solar Water Heating Residential: 50 ft^2 (4.6 m^2)
Solar Water Heating Non-Residential: 500 ft^2 (46 m^2)
Solar Space Heating: 250 ft^2 (23 m^2)
Solar Pool Heating Residential: 432 ft^2 (40 m^2)
Solar Pool Heating Non-Residential: 4,320 ft^2 (401 m^2)

For grid-connected PV installations, this study uses actual data on the number of installations. For the data, which show residential and non-residential installations, real data are used whenever possible. For data sources which only report the size of the installations, this study assumes all installations less than 10 kW_{DC} are residential installations. Analysis of data from the California Solar Initiative (CSI), which do include both residential and commercial data, indicates that the 10 kW_{DC} assumption probably under estimates the number of residential installations. In the CSI program, about 20% of the residential installations by capacity are larger than 10 kW_{DC}. The number of non-residential installations smaller than 10 kW_{DC} is considerably smaller.

For solar thermal installations, an estimate was made of residential and non-residential installations based on EIA data.

The results for cumulative installations include all new installations for the past 15 years. No accounting was made for systems that are no longer operational.

Date of Installation

This report uses the best data available on the date of installation. Ideally for grid-connected PV installations, this is based on the date when the installation was connected and producing power.

In some cases, data are available for when the applicant finished the installation and applied for the incentive payment. When this information is available, it was used as the installation date.

In many cases, the agency that administers an incentive program reports the date on which the incentive payment was made. This is the date used for the installation date in past editions of this report. This is usually a month or more after the installation was complete. However, if these are the only data available, this is the installation date used in this report.

Calendar Year (CY) is used as the year basis for all data. When data is reported on a Fiscal Year (July 1 – June 30), this report assumes that half of the installations are in the first CY and half are in the second CY.

Changes from Last Year's Report

This edition of this report uses the best available data for all years at the time of publication. Some data from past years were updated. Thus, the number of installations in 2009 and earlier does not always agree with the numbers published in the 2009 edition of this report.

APPENDIX C

GRID CONNECTED PHOTOVOLTAIC INSTALLATIONS BY STATE

State	Capacity Installed in 2009 (MW_{DC})	Capacity Installed in 2010 (MW_{DC})	Cumulative Installed Capacity (MW_{DC})
Alabama	0.1	0.2	0.4
Alaska	*	*	*
Arizona	21.1	63.6	109.8
Arkansas	0.2	0.6	1.0
California	213.7	252.0	1,021.7
Colorado	23.4	62.0	121.1
Connecticut	8.7	4.8	24.6
Delaware	1.4	2.4	5.6
District of Columbia	0.3	3.5	4.5
Florida	35.7	34.8	73.5
Georgia	0.1	1.6	1.8
Hawaii	12.7	18.5	44.7
Idaho	0.1	0.2	0.4
Illinois	1.7	11.0	15.5
Indiana	0.3	0.2	0.5
Iowa	*	*	*
Kansas	*	*	*
Kentucky	*	0.2	0.2
Louisiana	0.2	*	0.2
Maine	*	*	0.3
Maryland	4.7	3.4	10.9
Massachusetts	9.6	20.4	38.2
Michigan	0.3	1.9	2.6
Minnesota	0.9	1.7	3.6
Mississippi	*	0.1	0.3
Missouri	0.1	0.5	0.7
Montana	*	*	0.7
Nebraska	*	0.2	0.2
Nevada	2.5	68.3	104.7
New Hampshire	0.5	1.3	2.0
New Jersey	57.3	132.4	259.9
New Mexico	1.4	40.9	43.3
New York	12.1	21.6	55.5
North Carolina	6.6	28.7	40.0
North Dakota	*	*	*
Ohio	0.6	18.7	20.7
Oklahoma	*	*	*
Oregon	6.4	9.8	23.9
Pennsylvania	4.4	46.5	54.8
Rhode Island	*	*	0.6
South Carolina	0.1	*	0.2
South Dakota	*	*	*
Tennessee	0.5	3.8	4.7
Texas	4.2	25.9	34.5
Utah	0.4	1.4	2.1
Vermont	0.6	1.2	2.9
Virginia	0.3	2.1	2.8
Washington	2.1	2.9	8.0
West Virginia	*	*	*
Wisconsin	2.1	3.5	8.7
Wyoming	*	0.1	0.2

* = less than 100 kWdc or data not available