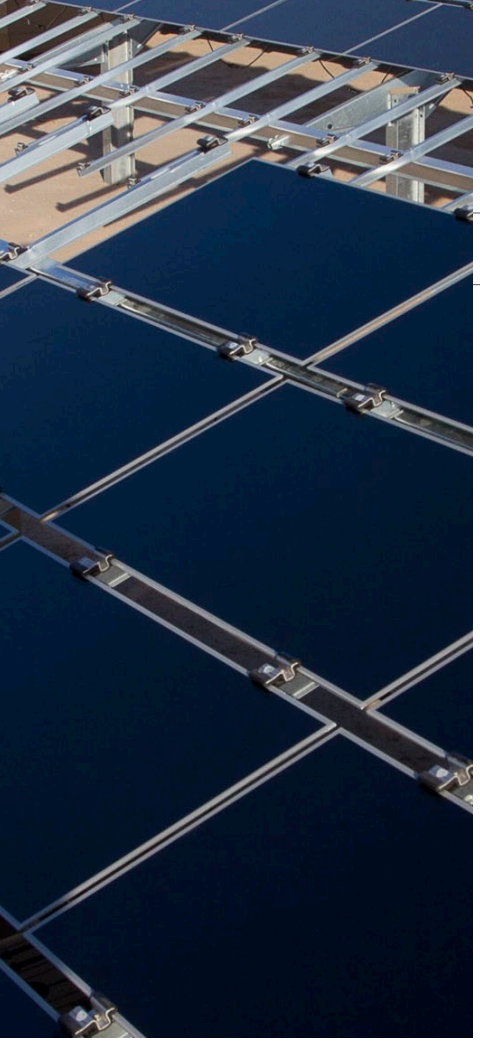
IREC
INTERSTATE RENEWABLE ENERGY COUNCIL

U.S. Solar MARKET TRENDS 2012

JULY 2013 *Larry Sherwood*



Agua Caliente Solar Project in Yuma County, Arizona

EXECUTIVE SUMMARY

Solar energy markets are booming in the United States due to falling photovoltaic (PV) prices, strong consumer demand, available financing, renewable portfolio standards (RPSs) in some states, and financial incentives from the federal government, states and utilities. The capacity of PV installations increased by 80 percent to 3.3 GW_{DC} compared with 2011 and, for the first time, over 50 percent of that capacity was in the utility sector.

The federal Investment Tax Credit (ITC) of 30 percent provides an important foundational incentive for most installations. Installed prices for distributed PV installations fell by at least 12 percent in 2012 and have fallen by 33 percent since 2009. The prices of some individual system components, especially modules, have fallen even more. Lower prices increase consumer demand for solar installations.

PV trends:

- Solar installations were 12 percent of all electric power installations in 2012.
- PV capacity installed in 2012 more than doubled for larger systems in the utility sector. State renewable portfolio requirements are an important reason for the large growth in the utility sector. Four of the largest 10 installations received a federal loan guarantee from the U.S. Department of Energy.
- The five largest installations all supply power to Pacific Gas and Electric Company (PG&E) in California. In fact, 30 percent (1 GW_{DC}) of the total U.S. photovoltaic capacity installed in 2012 goes to supply PG&E.
- The capacity of distributed grid-connected PV installed in 2012 increased by 36 percent compared with 2011. Nearly 95,000 distributed PV systems were installed in 2012. Residential installations grew by 61 percent, fueled by the increasing use of leases and third-party ownership of these systems.
- In 2012, more than two-thirds of grid-connected PV system installations were concentrated in California, Arizona, New Jersey and Nevada. Of the Top 10 states for 2012 installations, Arizona, Hawaii, Maryland, Massachusetts, Nevada, and North Carolina more than doubled the capacity installed the year before.

Concentrating solar power (CSP) trends:

- No new CSP plants were connected to the grid in 2012, though several plants are under construction for completion in 2013 and later years.

Over the near term, the prospect for growth in solar installations is bright. Early indicators point to continued market growth in 2013 due to the federal ITC, continued falling prices, state RPSs, and completion of installations begun by the end of 2012 in order to participate in the 1603 Treasury 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 2013 and 2016.

About IREC

The Interstate Renewable Energy Council, Inc. (IREC) is a non-profit organization accelerating the use of renewable energy since 1982. Today, IREC is a nationally recognized thought leader, stakeholder coordinator, expert resource and facilitator of regulatory reform. Our work expands consumer access to clean energy; generates information and objective analysis grounded in best practices and standards; and leads national efforts to build a quality-trained clean energy workforce, including a unique credentialing program for training programs and instructors. www.irecusa.org.

COVER: Copper Mountain Solar Complex in Boulder City, Nevada

1. INTRODUCTION

The solar market, while relatively young, is an increasingly important and vital part of the American economy. What are the trends in this market, and what forces are at work? Which sectors of the market are strongest, and why? What are the prospects for solar energy in the near future?

This report answers these questions by providing public data on U.S. solar electric 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.

Different solar energy technologies create energy for different end uses. This report covers solar technologies that produce electricity, including PV and CSP. Other solar technologies provide hot water, space heat, and space cooling, but are not included in this report.

PV 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 prices declined, PV systems were installed in many off-grid installations, i.e., installations not connected to the utility grid. In the last decade, grid-connected installations have become the largest sector for PV installations. PV is used in large and small installations and in installations on either the customer or utility side of the meter.

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, until recently, few new systems had been installed since the early 1990s. Installations have resumed, with one large plant constructed in 2010 and a number of new plants are under construction for completion between 2013-2015. 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. Concentrating PV systems are classified in this report as PV installations and not as CSP installations.

For all solar technologies, the United States is only a small, but growing, part of a robust world solar market. Product availability and pricing generally reflect this status. Globally, Germany is the largest market for PV and Spain is the top market for CSP. In North America, Ontario, Canada, ranks as one of the largest PV markets and is discussed briefly in Section 2. (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.

2. PHOTOVOLTAICS

Overall Trends in Installations and Capacity

2012 was another banner year for solar, with large increases in both the number and capacity of PV facilities. The capacity of 2012 PV installations increased by 80 percent to 3.3 GW_{DC} compared with 2011 (Figure 1). The annual capacity growth rate has exceeded 40 percent for six straight years, and the compound annual growth rate for the last 10 years is an astounding 65 percent. The total installed capacity of utility installations increased by two-and-one-half times, and distributed installations, largely on residential, commercial and government buildings, increased by 36 percent.

The cumulative installed grid-connected PV capacity increased to 7.4 GW_{DC} (Figure 2).The capacity of PV systems installed in 2012, 3.3 GW_{DC}, was more than ten times the capacity of PV installed in 2008, just four years earlier. In 2012, 0.5 GW_{DC} were installed on residential buildings, 1.0 GW_{DC} at non-residential sites and 1.8 GW_{DC} in the utility sector (Figure 2).

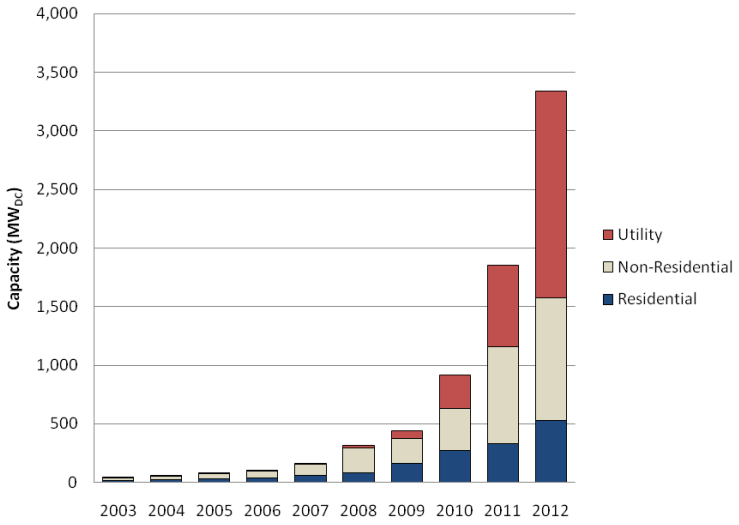


Figure 1: Annual Installed Grid-Connected PV Capacity by Sector (2003-2012)

Copper Ridge School in Scottsdale, Arizona

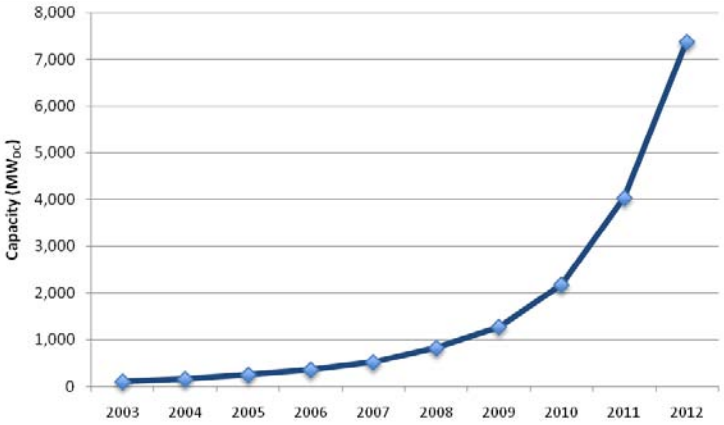


Figure 2: Cumulative U.S. Grid-Connected PV Installations (2003-2012)

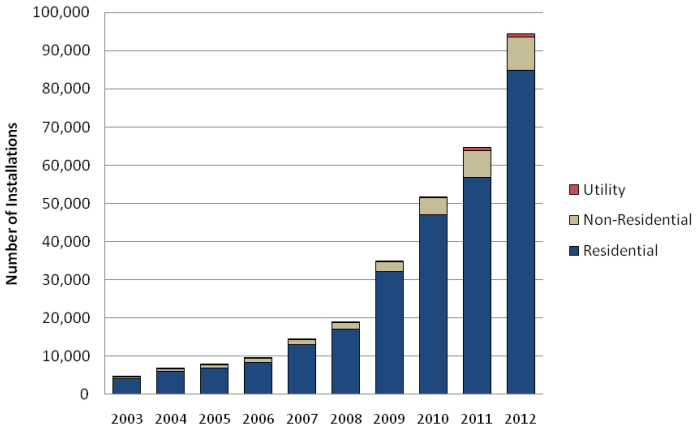


Figure 3: Number of Annual U.S. Grid-Connected PV Installations (2003-2012)

Residential PV Installations

Some PV installations are off-grid and are used to power facilities that are too expensive to interconnect to the grid, such as cabins, telecommunications facilities and road signs. Based on anecdotal information, the size of this market is very small compared with grid-connected installations. IREC has not collected data for these off-grid installations, and they are not included in this report's charts.

Almost 95,000 grid-connected PV installations were completed in 2012, a 46 percent increase over the number of installations in 2011. Residential systems accounted for 90 percent of these installations (Figure 3). By contrast, residential systems accounted for only 16 percent of the PV capacity installed in 2012. At the end of 2012, 316,000 PV installations were connected to the U.S. grid, including 283,000 residential installations.

In 2012, PV installations were 12 percent of new electricity generation installed during the year (Figure 4). In 2011, PV installations were eight percent of new additions. The electricity generated by PV and CSP installations was 0.3 percent of all electricity generation in the U.S. during 2012, 65 percent of which was used at the customer site. The remainder was shipped through the utility distribution system.

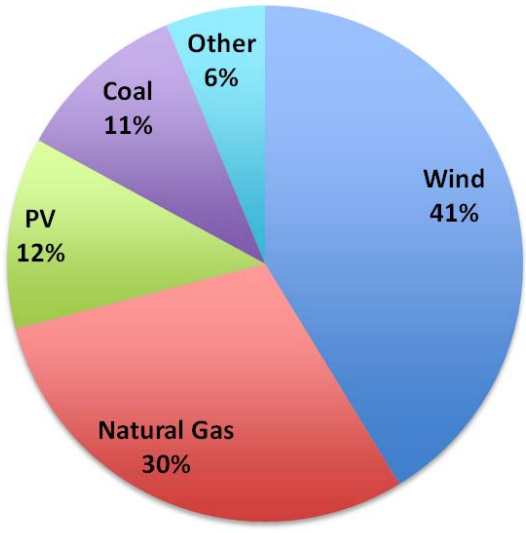


Figure 4: New U.S. Generation Installed in 2012 by Technology

Source: Energy Information Agency (EIA 2013) with IREC PV data

University of California at Davis West Village combines advanced energy efficient design features with a 4MW high efficiency SunPower solar system. It is the largest zero net energy development in the nation.

The important factors driving PV installation growth vary by sector and state.

The following factors helped drive PV growth in 2012.

- **Federal ITC**. There was stability in the federal ITC at 30 percent and the accelerated depreciation schedule for commercial installations was also unchanged. Tax credits for both residential and commercial installations are currently in place through 2016. With this stable incentive, developers and installers can plan and market their products and consumers can make rational decisions without arbitrary incentive deadlines.
- **Lower Installed Costs**. The total installed cost for distributed installations fell 12 percent in 2012 and has fallen 33 percent over the past three years. The cost decline is even greater for utility installations. Falling module costs is the primary reason for the cost declines, but all cost components have fallen, including inverter costs and soft costs such as permitting.
- **Federal Cash Grants**. In February 2009, as part of the American Recovery and Reinvestment Act (ARRA), Congress enacted the U.S. Treasury Grant in Lieu of Tax Credits Program. This program, commonly known as the 1603 Treasury Grant Program, provides commercial installations with the alternative of a cash grant instead of the tax credit. The Program was originally scheduled to expire at the end of 2010, but was extended through the end of 2012. This expiration caused many projects to begin construction late in 2012 to qualify for the Program, with completion scheduled in 2013 through 2016. In 2012, 3,460 completed projects were awarded $2.3 billion in cash grants (Treasury 2013). This is more than double the amount awarded in 2011. Solar projects received 35 percent of 1603 Treasury Grant funding in 2012 compared with only 17 percent in 2011.
- **State RPS Requirements**. States encourage investments in utility-scale solar plants with RPS policies. An RPS requires that a certain percentage of electricity generation come from renewable energy. Some states have a solar carve-out that additionally requires a certain percentage of the renewable generation come from solar energy. The terms of each state's RPS are different. In some states, RPS guidelines have led to solar renewable energy credit (SREC) markets, which in turn have resulted in increased demand for and installation of distributed solar installations. SREC markets are most developed in the Mid-Atlantic states and in Massachusetts. Of the 14 states and territories with more than 10 MW of utility sector installations in 2012, 12 have an RPS, usually with a solar requirement.
- **Federal Loan Guarantees**. As part of ARRA, the U.S. Department of Energy was authorized to offer loan guarantees for renewable energy and other energy projects. The program expired in September 2011, but projects that received loan guarantees by that date can still be completed. In 2012, the three largest PV installations each received loan guarantees from this program for at least a portion of the project's capital cost.
- **Third-Party Ownership** of solar installations has long been the dominant ownership model for utility and non-residential distributed installations. In recent years this ownership model has expanded to the residential sector and is now the dominant ownership model in all sectors. This structure is called a lease, a power purchase agreement (PPA) or third-party ownership. In each case, a third-party owns the system and the consumer makes regular payments to the owner. For distributed systems, the system is located at the consumer's facility or home and the consumer uses the electricity generated at their site. With a third-party owner, the consumer avoids paying the large up-front capital cost of a PV system.

- **Net Metering**. Net Metering is a simple option for consumers to offset their monthly electricity bills by producing their own energy. It allows customers to send excess energy from an onsite renewable energy system back to the grid, and receive a 1:1 kilowatt-hour credit for that energy. In 2012, 90 percent of distributed installed capacity was net metered. IREC provides summary tables of state net metering policies (IREC 2013).
- **State and Utility Rebates**. State and utility financial incentives have historically been one of the most important factors driving PV growth, especially for residential and commercial distributed installations. Of the 2012 Annual Top Ten States (Table 3), nine have state or utility rebate programs available for at least some of the installations. However, the importance of rebates is declining. The impact of these rebates varies greatly from state to state and, in general, rebates per watt have decreased as the cost of PV installations has decreased. The largest rebate program in the country, the California Solar Initiative (CSI), has been reducing rebates in a planned manner for years and the rebates will end in 2013. However, solar markets continue to grow in California. The Database of State Incentives for Renewables & Efficiency (DSIRE) provides summary tables of state and utility financial incentives (DSIRE 2013).

Grid-Connected Installations by Sector

The growth rate of grid-connected PV varies by market sector: residential, non-residential and utility. Distributed installations, on the customer's side of the meter, produce electricity used on-site and include both residential and non-residential facilities. Examples of non-residential facilities are government buildings, retail stores and military installations. 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.

Utility-Sector Installations

Utility-sector PV installations more than doubled in 2012 compared to 2011. The utility sector's share of all U.S. grid-connected PV installations grew from virtually none in 2006 to 15 percent in 2009, 32 percent in 2010, and 53 percent in 2012. The factors that influence the large growth in utility sector installations include RPSs, lower installed costs, and federal loan guarantees.

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 or used by the homeowner or building owner
Non-Residential	• Non-residential installation owned by building owner; electricity generated is used on-site • Non-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 (residential or commercial); electricity generated goes into bulk power grid through a feed-in tariff, PPA or other agreement

California Valley Solar Ranch, San Luis Obispo County, California

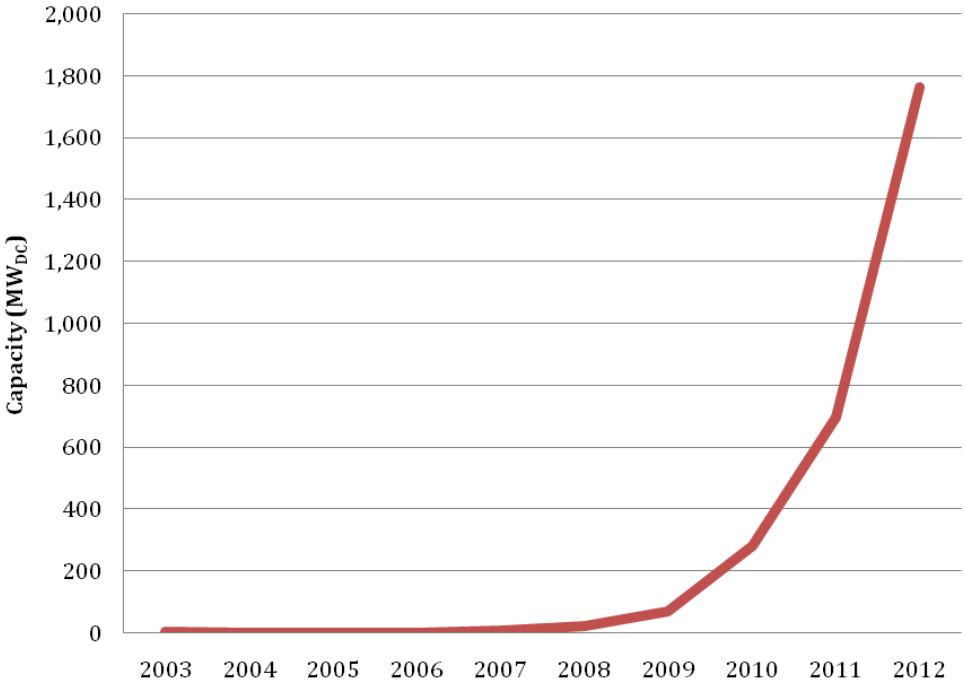


Figure 5: Annual Installed Grid-Connected Utility Sector PV Capacity (2003-2012)

Copper Mountain Solar Complex in Boulder City, Nevada

In 2012, 50 utility-sector plants larger than 5 MW_{DC} were installed with a total capacity of 1.5 GW_{DC}. These large facilities were 85 percent of the utility-sector installations in 2011. An additional 11 installations of 5 MW_{DC} or larger were installed in the non-residential sector with a combined capacity of 105 MW_{DC}. In total, these 61 generators larger than 5 MW_{DC} comprised 48 percent of the total PV capacity installed in 2012.

Of the 10 largest PV installations in the United States, eight were completely or partially installed in 2012 (Table 2). The five largest installations provide electricity for PG&E and are located in Arizona, California and Nevada.

State RPS requirements with solar carve-outs are encouraging investments in utility-scale solar plants in some states. Although

Table 2: TEN LARGEST U.S. PV INSTALLATIONS

Plant Name	Location	Size (MW_{DC})	Year Built	Owner	Utility Purchaser
1. Agua Caliente	Yuma, AZ	289*	2012	NRG & MidAmerican Solar	PG&E
2. Mesquite Solar 1	Arlington, AZ	207	2011-12	Sempra U.S. Gas & Power	PG&E
3. Copper Mountain Solar 1 & 2	Boulder City, NV	192	2010 & 2012	Sempra U.S. Gas & Power*	PG&E
4. California Valley Solar Ranch	San Luis Obispo County, CA	130**	2012	NRG Energy	PG&E
5. Alpaugh	Alpaugh, CA	66	2012	Consolidated Edison Development	PG&E
6. Silver State Nevada	Primm, NV	58	2012	Enbridge	NV Energy
7. Kammerer	Sacramento, CA	38	2012	Google & Suntap Energy	SMUD
8. San Luis Valley Solar Ranch	Mosca, CO	35	2012	Iberdrola Renewables	Xcel
9. Cimarron	Cimarron, NM	35	2010	Southern Co. & Turner Renewables	Tri-State
10. Webberville	Webberville, TX	35	2011	FRV AE Solar LLC	Austin Energy

* Copper Mountain Solar 2 is also owned by Consolidated Edison Development. ** Includes amount constructed through 2012. Plant still under construction and final size will be larger.

the California RPS does not have a solar carve-out, it is still encouraging many utility solar installations. In 2012, 1.6 GW_{DC} or 94 percent of the utility-sector installations were in states with RPS requirements. Over three-quarters of utility installations are located in just four states: Arizona, California, Nevada and North Carolina.

Financing is also important. The three largest utility sector installations received a federal loan guarantee for at least a portion of their installation costs, and these loan guarantees supported 574 MW_{DC} of installations. Although this program is known for high profile failed loans to Solyndra and other manufacturers, none of the guaranteed loans for specific solar installations failed and these loan guarantees are a crucial component of the overall financial package for these projects. Federal tax incentives, grants and the lower cost of PV modules also made these investments attractive.

Figure 6: Ownership Status for 2012 Utility Sector PV Installations

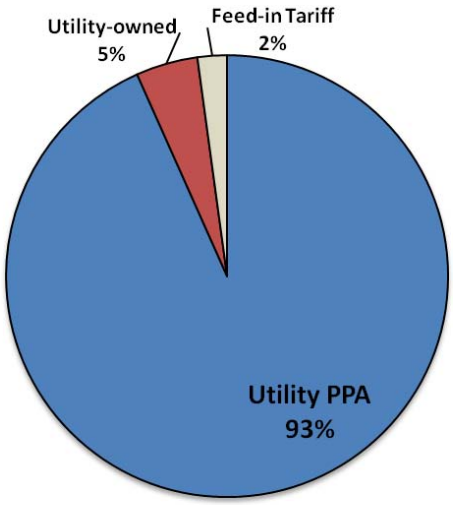


Figure 6 shows the ownership status of utility-sector installations, 93 percent of which are PPAs. In this arrangement, a third-party builds and owns the PV facility and the electricity is sold to a utility through a long-term power purchase agreement. The use of PPAs in the utility sector is growing and the capacity of utility-owned installations completed in 2012 decreased by 58 percent compared with 2011.

About two percent of the utility-sector installations are through feed-in tariff programs or similarly structured programs. The capacity installed through feed-in tariff programs decreased by 12 percent in 2012 compared with 2011 installations. In these programs, the utility pays the customer for the PV electricity produced and then sells the electricity as part of their regular electricity sales. These are defined as utility-sector installations because the electricity serves utility customers generally rather than the customer where the installation is located. However, the size of these installations is more similar to the size of distributed installations with an average size of 66 kW_{DC}. By contrast, the average size of the other utility-sector installations is 4,300 kW_{DC}.

Construction began or continued in 2012 on many additional utility-sector installations, and utilities and developers have announced plans for even more projects to be built in the next few years. Installations in this sector seem poised for continued growth.

Distributed Installations

Distributed installations provide electricity for use at the host customer's site, like a home or business. In 2012, the amount of distributed grid-connected PV capacity installed annually in the United States increased by 36 percent to 1.6GW_{DC}. Nearly

Construction of Agua Caliente Solar Project in Yuma County, Arizona

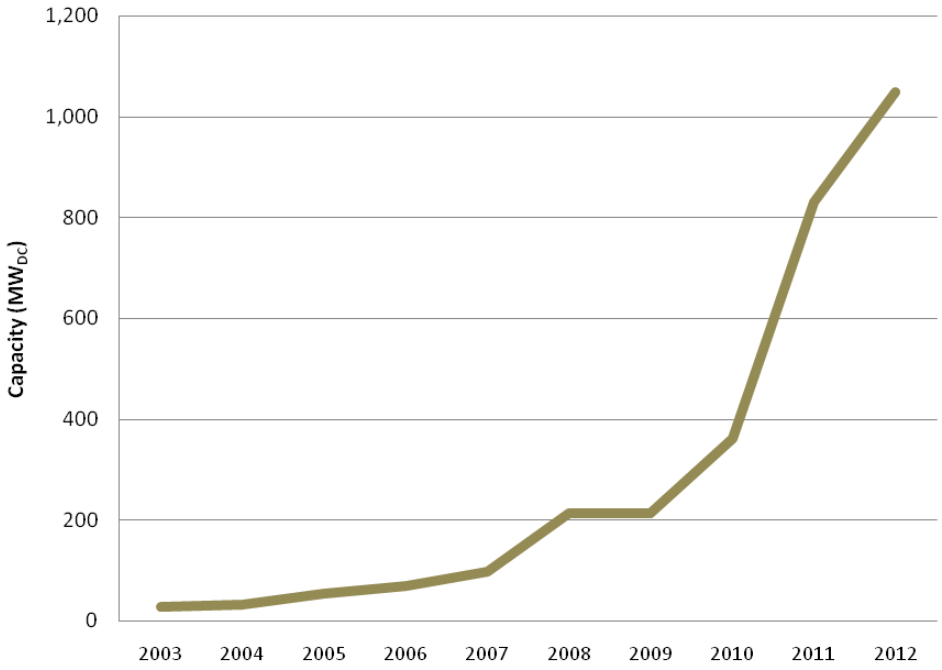


Figure 7: Annual Installed Grid-Connected Non-Residential Sector PV Capacity (2003-2012)

94,000 distributed PV systems were installed in 2012, a 46 percent increase over the number of distributed PV systems installed in 2011. The distributed growth was strongest in the residential sector in 2012, a change from the previous year when non-residential installations were surging.

Non-Residential Sector Installations

The capacity of non-residential sector installations, which includes sites such as government buildings, retail stores and military installations, increased by 26 percent in 2012 compared with 2011 (Figure 7). The average size of a non-residential distributed installation remained virtually the same at 120 kW_{DC}. The largest 2012 installations in this sector were a 20 MW_{DC} installation at an Apple data center in Maiden, NC, and a 16 MW_{DC} installation at Maryland's St. Mary's University with power sold to the Maryland Department of General Services and the University of Maryland System. Factors that influence the growth in non-residential installations include the federal ITC and the cash grant program, lower installed costs, net metering and state and utility rebates.

The 1603 Treasury Grant Program expired at the end of 2012. Projects begun by the end of 2012 can still qualify for this grant program, but new installations begun in 2013 and later will not qualify. One-third to one-half of non-residential sector installations received a grant through this program.

Residential Sector Installations

The number of residential installations increased by 61 percent in 2012 compared with 2011 (Figure 8). Residential installations are 16 percent of the total U.S. market on a capacity basis, but 90 percent of the number of installations. The average size of a residential PV system increased seven percent to 6.2 kW_{DC}. Factors that influence the growth in residential installations include the federal ITC, lower installed costs, retails PPAs and solar leases, net metering and state and utility rebates.

An increasing number of residential systems are financed using the leasing or third-party ownership model. For example, in

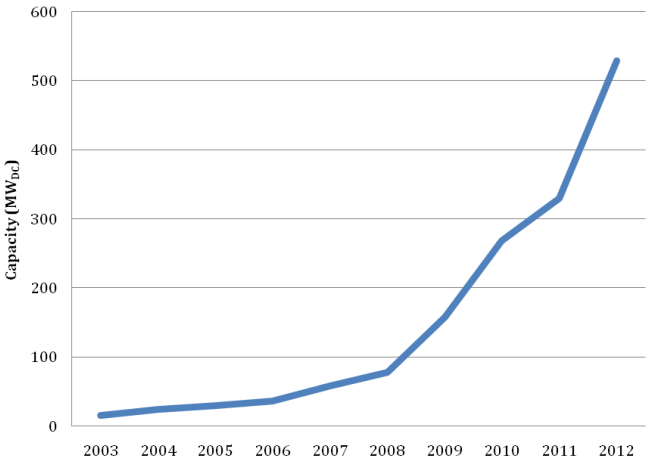


Figure 8: Annual Installed Grid-Connected Residential Sector PV Capacity (2003-2012)

Residential PV Installation in Massachusetts

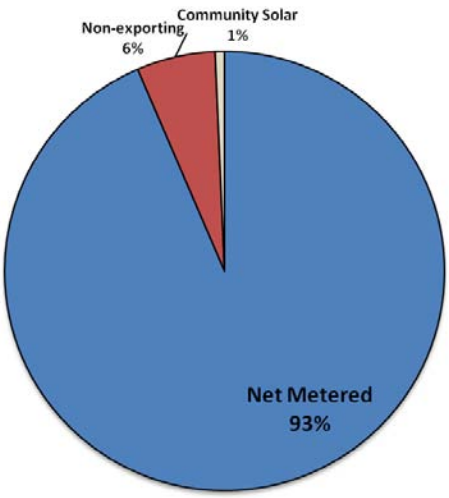
In states with high-cost electricity, the combination of lower installed costs, stable federal tax incentives, and favorable net metering policies are growing the residential market.

the California Solar Initiative, the capacity-basis percentage of residential systems owned by a third-party has increased from seven percent in 2009 to 28 percent in 2011 to 40 percent in 2012. In states with high-cost electricity, the combination of lower installed costs, stable federal tax incentives, and favorable net metering policies are growing the residential market, even with declining local incentives. California and Hawaii were the two largest residential markets in 2012; 57 percent of all residential installations were in these two states. Both rely less on rebate incentives than in the past.

For residential consumers not using the lease or third-party ownership model, federal incentives remained stable in 2012. Stable incentives encourage more homeowners to purchase solar (incentive levels are set through 2016). In addition to federal incentives, most residential installations occur in states with state or local incentives.

In 2012, 93 percent of the residential and non-residential distributed PV installations were net-metered as shown in Figure 9. This market share for net-metered systems has remained consistent for the past few years. The rules governing net metering transactions vary widely from state-to-state and utility-to-utility. About six percent of the distributed PV systems are non-exporting, meaning that all of the solar generated electricity is used on the customer's grid-connected site.

Figure 9: Generation Status for 2012 Distributed PV Installations



About one percent of distributed PV systems use a community share solar model. A community share solar installation is a facility interconnected to the utility distribution system, and the electricity generated is credited to subscribers of the installation. Community share solar allows customers who are otherwise unable to have a solar system, such as renters or property owners with poor solar access, to receive solar electricity.

Grid-Connected Installations by State

In 2012, more than two-thirds of grid-connected PV system installations were concentrated in California, Arizona, New Jersey and Nevada, as shown in Table 3. Of the Top 10 states for 2012 installations, Arizona, Nevada, Massachusetts, North Carolina, Hawaii and Maryland more than doubled their installed capacity from the prior year. Nevada, Hawaii, and Maryland joined the Top 10 Installation list for 2012, replacing New Mexico, Pennsylvania, and Texas. In Nevada, four large utility installations totaling 215 MW_{DC} were completed in 2012 and represent most of the Nevada capacity installed last year. Nevada is a popular location for utility installations. Its ranking in the Top 10 Installation list fluctuates wildly, depending on how many utility installations are completed in a given year. Hawaii and Maryland made the Top 10 Installation list due to large growth in distributed installations. New Mexico and Pennsylvania both saw large drops in capacity installed last year. In New Mexico, utility sector installations dropped significantly, and in Pennsylvania, distributed installations dropped due to the end of the Pennsylvania Sunshine Rebate Program. In Texas, installation capacity grew, but not enough to keep Texas on the Top Ten Installation list.

State policies affect PV installations, with most installations happening in the few states with good solar policies. All states in

the Top Ten Installation list have state RPSs, which mandate that utilities generate a percentage of their power from solar or other renewable sources, and tend to encourage larger installations. Arizona and Nevada also benefit from solar installations supplying power to Pacific Gas & Electric to help meet the California RPS requirement. The RPS requirements and structure varies widely from state-to-state.

Though their impact on the total market is declining, financial rebates are important state policies, especially for smaller

Concentrating PV at Alamosa Solar Farm in Colorado

Table 3: 2012 ANNUAL TOP TEN STATES
Ranked by Grid-Connected PV Capacity Installed in 2012

2012 Rank by State	2012 (MW_{DC})	2011 (MW_{DC})	11-12 Percent Change	2012 Market Share	2011 Rank
1. California	983	547	80%	29%	1
2. Arizona	709	288	146%	21%	3
3. New Jersey	391	305	28%	12%	2
4. Nevada	226	19	1062%	7%	15
5. Massachusetts	123	42	190%	4%	10
6. North Carolina	122	45	169%	4%	9
7. Hawaii	114	40	182%	3%	11
8. Colorado	103	76	36%	3%	6
9. Maryland	80	24	227%	2%	12
10. New York	56	68	-18%	2%	7
All Other States	434	402	8%	13%	–
Total	**3,341**	**1,856**	**80%**	**--**	**--**

2011 and 2012 columns include installations completed in those years. “2012 Market Share” means share of 2012 installations. “2011 Rank” is the state ranking for installations completed in 2011.

installations. Five years ago, owners of most PV installations received a cash rebate from a state or utility incentive program and this rebate was the most important element of the financial package. In that era, no state had a significant amount of installations without also having a rebate program. For the past three years, the incentive expenditures have been declining, in part because the rebates per watt have been declining and in part because some states have stopped these programs. Despite the decreasing expenditures, installed capacity of facilities with rebate support continues to increase. When PV is less expensive, less incentive money is necessary to encourage installations.

On a cumulative per capita basis, the top five states — Arizona, Nevada, Hawaii, New Jersey and New Mexico — remained the same as the previous year, although the ranking of these five states changed (Table 5).

Table 4: CUMULATIVE TOP TEN STATES
Ranked by Grid-Connected PV Cumulative Installed Capacity through 2012

	MW_{DC}	Market Share
1. California	2,559	35%
2. Arizona	1,106	15%
3, New Jersey	956	13%
4. Nevada	350	5%
5. Colorado	300	4%
6. North Carolina	208	3%
7. Massachusetts	207	3%
8. New Mexico	203	3%
9. Hawaii	199	3%
10. New York	179	2%
All Other States	1,106	15%
Total	**7,374**	**--**

Table 5: PER CAPITA TOP TEN STATES
Ranked by Grid-Connected PV Cumulative Installed Capacity per Capita (W_{DC}/person) through 2012

	Cumulative through 2012 (W_{DC}/person)	2012 Installations (W_{DC}/person)
1. Arizona	173.1	110.9
2. Hawaii	146.6	84.0
3. Nevada	129.5	83.5
4. New Jersey	108.7	44.4
5. New Mexico	98.7	18.4
6. California	68.7	26.4
7. Colorado	59.6	20.5
8. Delaware	51.4	22.0
9. Vermont	44.7	26.0
10. Massachusetts	31.7	18.8
National Average	**23.9**	**10.8**

Information on Top State Markets

Solar electric market activity has more to do with state incentives and policies than with the amount of available sunlight or solar resource. 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 or with no RPS policy that includes a solar mandate. This section describes the market conditions in the states with the largest number of installations. As solar prices fall, increasingly electricity prices and rate policies become an important factor in state markets. States with high electricity prices will have more robust solar markets.

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 to customers serviced by the state's three investor-owned electric utilities: Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric. With $327 million in CSI incentives, more than 400 MW_{DC} of PV was installed in 2012 through this program.[1] These incentives are based on actual system performance of larger systems and expected system performance of 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 by the program decreased by six percent in 2012, but the capacity installed through the program increased by 31 percent. The CSI was prudently designed as a long-term program, so the industry in California can rely on long-term policy stability. The program will exhaust available funds in 2013. As the CSI incentives end, installations continue to increase. California's steep, tiered electric rate schedule and large, peak period time-of-use rates, combined with net metering, provide enough of an incentive for consumers to continue to install solar energy systems.

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

Partially completed Agua Caliente Solar Project in Yuma County, Arizona

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 229 MW_{DC} in 2012, more than double the 2011 installations. The capacity of distributed installations by California public utilities increased by 69 percent to 84 MW_{DC} in 2012. 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.

The result of these programs is that 40 percent of all distributed PV installations in the U.S. have been in California. California has long had strong incentives and good net metering policies. Now, as the incentives are ending, dropping PV prices and high electricity rates are propelling continued growth in distributed installations.

California also has large markets for utility installations due to an RPS requirement of 20 percent renewable energy generation by 2013 and 33 percent by 2020. This includes all renewable technologies and inspired many PV installations in 2012. This requirement led to 488 MW_{DC} of utility sector solar installations in California in 2012, plus an additional 520 MW_{DC} of utility installations in Arizona and Nevada where the electricity produced flows to California. Fully 48 percent of all utility sector installations either are in California or supply electricity for the California market.

Arizona ranks second for 2012 capacity installed, and it more than doubled the capacity installed in 2011. However, the numbers are skewed by the fact that 58 percent of the 2012 capacity installed was at two utility plants supplying electricity to PG&E in California. These two plants, Agua Caliente and Mesquite Solar 1, were the two largest U.S. solar installations at the end of 2012. If we look just at installations in Arizona that supply electricity for Arizona, the state would fall to third place, and the growth rate would be a much more modest 23 percent.

Arizona solar policy has evolved over the past several years. The current requirement is that 15 percent of electricity be generated from renewable sources by 2025. Distributed generation must provide 30 percent of this energy, divided equally between residential and non-utility, non-residential installations. Solar water heaters may also provide RECs for RPS compliance in Arizona. Although residential installations increased by 83 percent, distributed non-residential installations decreased by 41 percent compared with 2011 installations. The market for net metered systems in 2013 and beyond is uncertain, with the state's largest utility (Arizona Public Service) relying on a study it commissioned that concludes that residential net-metered customers are currently being subsidized by other customers. Solar energy advocates have countered with a study showing that no subsidy exists, and the Arizona Corporation Commission is reviewing the evidence.

In **New Jersey**, an RPS with a solar requirement built a strong PV market. The solar requirement was 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 2012, rebate expenditures were $2.4 million for 17 MW_{DC} of installations. This means the capacity of installations increased 24 percent with 82 percent less financial incentives than in 2011. Now, for most 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 SRECs, which New Jersey utilities use to comply with the RPS. In 2012, new installations with a combined capacity of 373 MW_{DC} were selling SRECs, representing 96 percent of new installations in New Jersey. Although New Jersey SREC prices crashed in 2012, the state made policy changes to stabilize its long-term SREC market.

Nevada has an RPS with a solar carve-out that requires one percent solar generation in 2013, 1.3 percent in 2020 and 1.5 percent in 2025. Although the state has a rebate program called RenewableGenerations, distributed installations are less than five percent of the capacity installed in 2012. Almost half of the 2012 capacity is due to one utility installation, Copper Mountain Solar Complex, which supplies electricity to PG&E in California.

Massachusetts has a long history of providing rebates for PV installations. In 2010, Massachusetts awarded $37 million in rebates for 14 MW_{DC} of PV installations. These installations represented 63 percent of the PV capacity installed in Massachusetts that year. In 2012, the state awarded $8 million in rebates for 14 MW_{DC} of PV installations. Thus, 80 percent fewer rebate dollars funded the same amount of installed PV capacity. During the same period, the amount of installed capacity not receiving rebates increased from 9 MW_{DC} to 108 MW_{DC}. This is due to the Massachusetts RPS, which has a solar carve-out of 0.163 percent in 2012 and 0.2744 percent in 2013. Massachusetts uses an SREC market for compliance with the RPS requirements.

North Carolina has an RPS requiring 0.2 percent from solar by 2018. Most North Carolina installations sell the generated solar electricity to utility companies. North Carolina set up the Renewable Energy Tracking System to track RECs and record compliance with the standard.

Hawaii has the highest electricity rates in the country by far. The 2012 average price of nearly $0.34/kWh is more than twice the rate in any other state and three and a half times the national average electricity price. Hawaii also has a personal state solar income tax credit. Some 94 percent of Hawaii installations were distributed in 2012. The financial benefits of PV are usually more favorable in Hawaii than in any other U.S. state and on a per capita basis, Hawaii had, by far, the most installed capacity of distributed PV in 2012.

Ground-mount array at Maui Arts Cultural Center in Maui, Hawaii

The combination of state and/or local incentives and the federal ITC created strong markets for most of the installations around the country.

In 2005, **Colorado** voters passed Amendment 37, which created an RPS with a solar mandate equal to 0.4 percent of retail electricity sales. Later, the legislature doubled the overall RPS requirements and the solar mandate. The current requirement is that utilities must have three percent distributed generation by 2020 with half of that total serving retail customers. Xcel Energy is by far the largest utility in the state, and 95 percent of Colorado's PV installations in 2012 were part of Xcel's programs. Though it offers capacity-based rebates for smaller, customer-sited PV systems, Xcel has ended incentives for larger distributed installations. As a result, 2012 distributed non-residential installations fell by 50 percent compared with installations in 2011.

Maryland has an RPS with a solar carve-out requiring 0.1 percent from solar in 2012 and increasing to two percent in 2020. Installations in Maryland have grown quickly and, of the Top 10 States for Annual Capacity, Maryland had the highest growth rate of all states except for Nevada.

New York has had long-term significant rebate programs operated by the New York State Energy Research and Development Authority and the Long Island Power Authority. Because of these programs, distributed installations increased by 81 percent in 2012 compared with 2011. Overall, the total annual

capacity installed in New York decreased in 2012 compared with 2011. This is due to the fact that BP Solar built two large utility installations with a combined capacity of 37.6 MW_{DC} in 2011. There were no utility sector installations in New York n 2012.

Although this report covers U.S. installations, the market across the border in the province of **Ontario**, Canada, is also noteworthy. In 2012, Ontario added installations with a capacity of about 226 MW_{DC}, which is 16 percent less than the capacity installed in 2011. If Ontario were a U.S. state, it would have ranked fourth on IREC's list of states. A feed-in tariff program begun in 2008 jump-started the Ontario solar market.

Ground mount installation in Worton, Maryland

3. CONCENTRATING SOLAR POWER

No new concentrating solar plants were completed in 2012 (Figure 10). To date, slightly more than 500 MW CSP plants are in the U.S., much of them built in the late 1980s and early 1990s. In 2013, CSP plants generating nearly 800 MW are likely to be completed at sites in California, Nevada and Arizona. This includes three power towers at the Ivanpah Solar Project in Barstow, California, which was 92 percent complete as of May 2013. Additional plants are under construction for completion in 2014 and 2015.

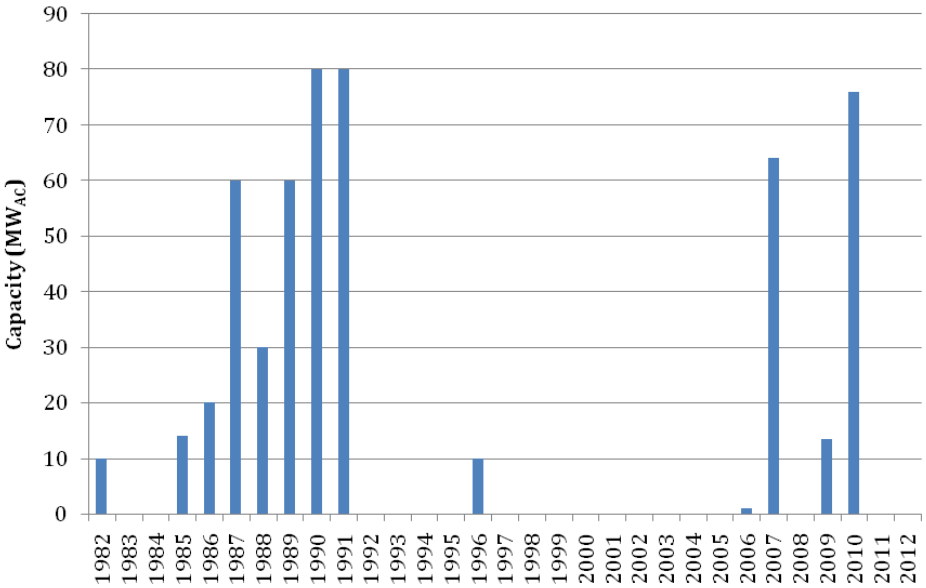


Figure 10: Annual Installed U.S. CSP Capacity (1982-2012)

4. PROSPECTS FOR 2013

What can we expect in U.S. solar markets in 2013? As of June 2013, indicators pointed to continued growth in grid-connected PV. Reductions in PV module prices, continuation of the federal ITC, strong state RPSs, net metering policies and available capital for third-party ownership will help drive market growth.

Many large solar projects began construction in 2012 in order to take advantage of the 1603 Treasury Grant Program. These installations, both distributed and utility-sector projects, will be completed in 2013 through 2016. Since projects that begin construction in 2013 will no longer have the cash grant option, developers will need to find entities, such as banks and insurance companies with tax bills large enough to take advantage of remaining tax credits. Solar developers have announced several large funding packages in 2013, indicating that financing continues to be available for more installations.

5. CONCLUSION

PV markets continue to grow in the United States. More than 3.3 GW_{DC} of PV installations were completed in 2012 at 95,000 sites. The capacity installed was 80 percent greater than the amount installed in 2011. The markets for each solar technology are concentrated in a few states.

PV installations are getting larger. Almost half of the capacity installed in 2012 was at just 61 sites with a capacity of 5 MW_{DC} or larger. The largest 2012 installation was nearly 290 MW_{DC} and there were four installations larger than 100 MW_{DC}.

These markets depend on a combination of federal and state policies and financial incentives, the most significant of which include:

- Federal ITC
- U.S. 1603 Treasury Grant Program
- Federal loan guarantees
- State RPSs, especially those with solar requirements
- Net metering
- State, utility or local rebates or other financial payments.

In addition to government policies, the following factors are important contributors to the growth of solar markets:

- Lower installed costs for PV installations
- Availability of capital for third-party ownership of systems.

U.S. PV market growth will continue in 2013, with larger utility-sector projects leading the way.

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APPENDIX A
DATA SOURCES

Grid-Connected PV

State data were obtained for grid-connected PV installations from the following sources:

- State agencies or organizations administrating state incentive programs
- Utility companies
- Energy Information Agency data on New Electricity Generation Plants and Net Metered Systems (EIA 2013 and EIA 2012)

GreenTech Media, in cooperation with the Solar Energy Industries Association, collects solar installations data on a quarterly basis (GTM/SEIA 2012). The Solar Electric Power Association publishes an annual report on installation by utility that is based on an annual utility survey (Krishanmoorthy, Taylor & Campbell 2013). Since 2010, IREC has collaborated on both of these other installations reports and exchanged data. This collaboration results in better and more extensive installation data. 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 have historically been the most reliable data. As rebates fund a smaller share of PV installations each year, incentive databases become less important data sources.

Off-Grid PV

IREC does not collect data for these installations, and they are not included in this report's charts.

Solar Heating and Cooling

Previous editions of this report included data for solar heating and cooling installations. However, this year's report does not include this data.

Concentrating PV at Alamosa Solar Farm in Colorado

APPENDIX B
ASSUMPTIONS

Residential PV Installation in Arizona

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 watt (W), kiowatts (kW), or megawatts (MW). 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.

This study reports PV capacity in direct current (DC) watts under Standard Test Conditions ($W_{DC\text{-}STC}$) of 1000 W/m^2 solar irradiance and 25° C PV module temperature. 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 percent 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 2010, AC watts were 86.2 percent of DC watts. In 2012 the ratio increased to 86.9 percent. In cases where the capacity was reported in AC watts, IREC used 86.5 percent to convert the data to DC watts.

Number of Installations

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.

The results for cumulative installations include all new installations in previous 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, this is based on the date when the installation was connected and producing power. Calendar Year (CY) is used as the year basis for all data.

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. If these are the only data available, this is the installation date used in this report.

Net Metering

In states where net-metering data was unavailable, IREC assumed that systems meeting the local rules for net-metered systems were net-metered.

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, installed capacity and number of installations shown in this report for 2011 and earlier are not always identical to what was reported in the 2011 or earlier editions of this report.

APPENDIX C

GRID CONNECTED PV INSTALLATIONS BY STATE

State	Capacity Installed in 2012 (MW_{DC})				Cumulative Installed Capacity (MW_{DC})
	Residential	Non-Residential	Utility	Total	
Alabama	*	0.1	0.5	0.6	1.1
Alaska	*	*	*	*	*
Arizona	66.2	69.0	573.7	708.8	1,106.4
Arkansas	0.5	*	*	0.6	1.5
California	200.1	295.2	487.8	983.2	2,559.3
Colorado	20.1	15.5	67.4	102.9	299.6
Connecticut	3.8	3.7	*	7.5	39.6
Delaware	2.0	2.7	15.0	19.7	46.1
District of Columbia	1.3	1.0	*	2.3	13.9
Florida	5.3	10.4	6.2	21.9	116.9
Georgia	0.6	6.6	1.0	8.2	21.4
Hawaii	70.3	37.0	6.9	114.3	199.5
Idaho	0.4	0.3	*	0.7	1.0
Illinois	1.0	2.7	23.1	26.7	42.9
Indiana	0.4	0.6	*	0.9	4.4
Iowa	0.4	0.7	*	1.1	1.2
Kansas	0.1	0.2	*	0.3	0.5
Kentucky	0.1	*	1.3	1.5	4.8
Louisiana	11.0	0.9	*	11.9	18.2
Maine	1.4	0.3	*	1.7	2.8
Maryland	6.5	42.8	30.4	79.7	116.8
Massachusetts	14.6	104.1	4.5	123.2	207.3
Michigan	3.4	7.7	*	11.1	19.9
Minnesota	1.3	3.2	27.9	6.5	11.3
Mississippi	*	*	0.1	0.1	0.7
Missouri	6.9	9.7	*	16.6	18.5
Montana	1.0	0.4	*	1.4	2.2
Nebraska	*	*	*	0.1	0.4
Nevada	2.1	8.5	215.0	225.6	349.7
New Hampshire	1.0	1.3	*	2.3	5.4
New Jersey	42.9	262.9	84.9	390.7	955.7
New Mexico	5.2	4.8	27.9	37.9	203.4
New York	15.8	39.8	*	55.6	179.4
North Carolina	0.5	20.0	101.9	122.4	207.9
North Dakota	*	*	*	*	0.1
Ohio	2.0	40.4	5.9	48.3	79.9
Oklahoma	0.1	*	*	0.2	0.3
Oregon	5.8	4.9	10.0	20.6	56.4
Pennsylvania	10.0	21.3	*	31.3	164.3

GRID CONNECTED PHOTOVOLTAIC INSTALLATIONS BY STATE continued

State	Capacity Installed in 2012 (MW_{DC})				Cumulative Installed Capacity (MW_{DC})
Rhode Island	0.1	0.6	*	0.7	1.9
South Carolina	0.3	0.2	*	0.5	4.6
South Dakota	*	*	*	*	*
Tennessee	*	0.2	22.8	23.0	45.0
Texas	9.3	9.6	35.7	54.7	140.3
Utah	1.3	3.7	0.6	5.6	10.0
Vermont	5.3	2.3	8.8	16.3	28.0
Virginia	1.0	4.3	*	5.2	10.5
Washington	5.2	2.0	*	7.2	19.5
West Virginia	0.9	0.2	*	1.1	1.7
Wisconsin	0.9	7.3	*	8.2	21.1
Wyoming	0.3	*	*	0.4	0.6
Territories	*	3.6	25.8	29.4	29.8
TOTAL	**528.9**	**1,053.1**	**1759.2**	**3,341.1**	**7,373.8**

* = less than 100 kW_{DC} or data not available

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