U.S. Solar Market Trends 2008

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Executive Summary

Solar markets are booming in the United States due to rising energy prices, strong consumer demand, and financial incentives from the federal government, states and utilities. Over 62,000 new solar thermal and solar electric installations were completed in 2008, an increase of 16% compared with 2007. The majority of market share for each solar technology is concentrated in a few states.

Photovoltaic trends:

- The capacity of photovoltaic (PV) installations completed in 2008 grew by 63% compared with installations in 2007, and the average size of PV systems is increasing.
- Installation growth by capacity was largest in the non-residential sector, but the residential sector continues to dominate the number of installations.
- Many states reported a doubling of PV capacity installed in 2008 compared with 2007 installations.
- Installations in California, the dominant U.S. market, increased by 95% in 2008.

Solar thermal trends:

- Solar hot water installations (low-temperature thermal) have boomed since the federal investment tax credit (ITC) was extended to residential installations in 2006.
- In the continental 48 states, the annual installed capacity has more than quintupled since 2005 and residential sector installations dominate the market.
- Hawaii continues to be the largest market for solar hot water.

Solar thermal electric trends:

- No new solar thermal electric plants were connected to the grid in 2008.
- The future prospects for solar thermal electric look good and one plant may come on-line in 2009.

Over the long-term, the prospect for growth in solar installations is bright. Early indicators point to market growth in 2009, though likely at a slower rate than during the last several years. The market should return to high growth rates in 2010. The long-term extension of the federal Investment Tax Credit (ITC), new rules that allow utilities to take advantage of the ITC, and the establishment of a grant program alternative to the commercial ITC will all help solar installations. Since these policies were just recently enacted (in October 2008 and February 2009 respectively), the market will take some time to respond to these new policies. Companies have announced plans for many large solar electric projects, including solar thermal electric projects, utility-owned projects, and third-party owned projects. A few of these projects will be completed in 2009, but most will come on-line in 2010 and beyond.

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 of solar installations across the United States. Analysis of multi-year installation trends and state installation data helps these sectors learn more about the state markets and evaluate the effectiveness of marketing, financial incentives and education initiatives. In addition, these data allow better understanding of the environmental and economic impacts of solar installations.

About the Interstate Renewable Energy Council

The Interstate Renewable Energy Council (IREC) supports market-oriented services targeted a education, procurement, the adoption and implementation of uniform guidelines and standards, workforce development, and consumer protection.

"Over the long-term, the prospect for **growth** in solar installations is **bright**."

1. Introduction

Different solar energy technologies create energy for different end uses. Two technologies—photovoltaics (PV) and high-temperature concentrating solar thermal electric—produce electricity. A third technology, low-temperature solar thermal collectors, produce heat for hot water, space heating, pool heating, and 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 growth sector for PV.

High-temperature solar thermal electric systems, more commonly known as concentrating solar power (CSP), use mirrors and collecting receivers to heat a fluid to a high temperature (300°F to more than 1000°F) and then run the heat extracted from the fluid through a traditional turbine power generator or Sterling engine. CSP can also be paired with existing or new traditional power plants, providing high-temperature heat into the thermal cycle. These generating stations produce bulk power on the utility side of the meter rather than generating electricity on the customer side of the meter. CSP plants were installed in the United States in the late 1980s and early 1990s, but installation stopped due to lack of supportive government policies. Installations have now resumed and two plants in the U.S. were completed in 2006 and 2007, with a significant number of announcements for new plants between 2010-2015. In another application, concentrating solar thermal can provide high temperature solar process heat for industrial or commercial applications and a few installations are made each year using this technology.

Low-temperature solar thermal collectors can heat water, heat and cool buildings, and heat swimming pools. A variety of flat plate, evacuated tube and concentrating collector technologies produce the heat needed for these applications. Solar hot water systems were common in southern California in the early 1900s before the introduction of natural gas and many systems were sold 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, from which the industry is only now recovering.

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 of solar installations across the United States. Analysis of multi-year installation trends and state installation data helps these sectors learn more about the state markets and evaluate the effectiveness of marketing, financial incentives and education initiatives. In addition, these data allow 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 and Spain are the top markets for PV and China is the largest market for solar thermal collectors. However, 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.

"For all solar technologies, the United States is only a small part of a **robust world solar market**."

2. Photovoltaics

Overall Trends in Installations and Capacity

Annual U.S. PV installed capacity grew by 63% in 2008 compared with installations in 2007 to 335 MW_{DC} (including both grid-connected and off-grid markets—see Figure 1), bringing the cumulative installed capacity to 792 MW_{DC}. Although PV installation growth had been steady and impressive for many years, the annual growth rate doubled when the federal Investment Tax Credit (ITC) increased in 2006. By 2008, the capacity of PV installed each year was triple the annual amount installed in 2005. More than 33,500 sites installed PV in 2008, with 62% of these sites and 87% of the installed capacity connected to the grid. Most of these installations are mounted on buildings, but some are ground-mounted installations.

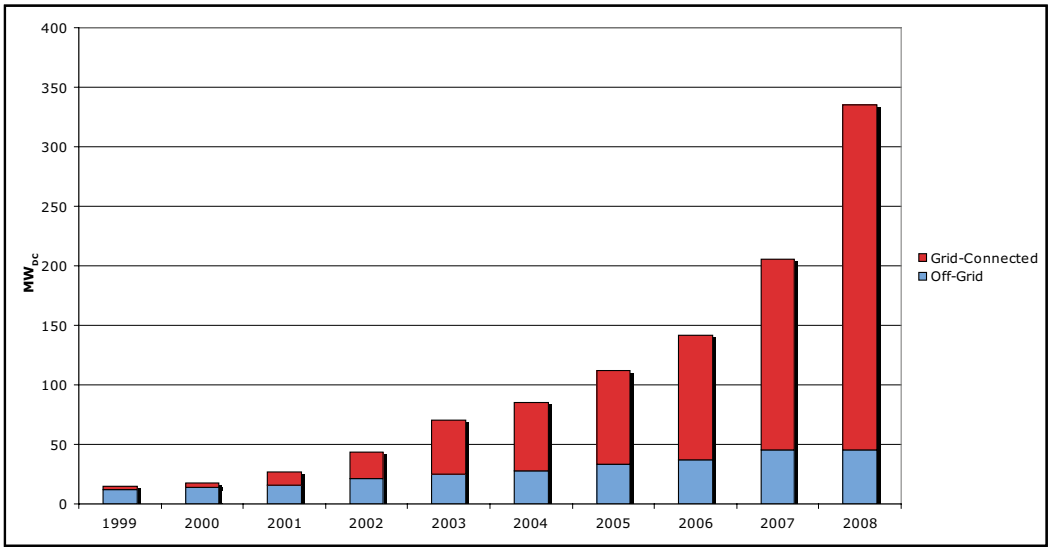


Fig. 1: Capacity of Annual U.S. Photovoltaic Installations (1999-2008)

The following factors helped drive the large growth in 2008:

- The federal ITC was increased in 2006 for commercial taxpayers, and a credit for residential taxpayers took effect. These changes were scheduled to expire at the end of 2008. For larger systems, especially, contracts were written requiring installation by the end of 2008. Thus a large number of these large installations were completed in 2008 in anticipation of the ITC expiration. The federal ITC was renewed in October 2008 (through December 2016) and the $2,000 cap for residential installations was removed. This will influence future installations, but it was not a factor in 2008 installations.
- Many states are offering incentives, and system installation growth more than doubled in Arizona, Connecticut, Hawaii, Maryland, Massachusetts, New Mexico, North Carolina, Oregon, Pennsylvania and Wisconsin. Each of these states has one or more significant financial incentive and/or a renewable portfolio standard (RPS) program with a mandate for solar installations.
- Renewable portfolio standards with specific solar requirements had an impact in states that enacted such policies two or more years beforehand. Frequently, the market impact lags the enactment of the policy. For example, North Carolina's and Pennsylvania's RPS policies led to the first large solar installations in these states in 2008.
- The California Solar Initiative operated smoothly throughout 2008 and produced large growth in the largest market in the country. The program began in 2007 and experienced some start-up problems, which affected installations in that year. These problems have now been resolved.

Detailed data on off-grid PV installations are not available, so the remainder of the PV section of this report is limited to a discussion of the U.S. grid-connected PV market.

"**By 2008**, the capacity of PV installed each year was **triple** the annual amount installed in 2005."

Grid-Connected Installations by Sector

Residential installations were 27% of all new grid-connected PV systems installed in 2008 by capacity. Although the capacity of residential installations grew in 2008, the market share declined compared with each of the previous three years, when these installations were 35-36% of the total capacity. Figure 2 shows the annual PV installation capacity data, segmented by residential, non-residential and utility installations. Non-residential installations include such sites as government buildings, retail stores, and military installations. Their larger average size means a larger aggregated capacity. Both residential and non-residential installations are on the customer's side of the meter and produce power used on-site. In contrast, the utility installations are on the utility's side of the meter and produce bulk power for the utility grid.

Part of the drop in market share for residential installations was due to changes in the federal ITC. On October 2008, the residential ITC was renewed and the $2000 cap was removed for residential installations beginning in January 2009. This caused some homeowners in the final quarter of 2008 to delay new installations until 2009 in order to receive a larger federal tax credit. This decreased the number of residential installations in 2008.

However, a larger factor was the strong growth in non-residential installations. For most of 2008, the future of the residential and commercial ITC was uncertain; the residential ITC was scheduled to expire and the commercial ITC was scheduled to decrease from 30% to 10% on January 1, 2009. Developers signed many contracts for new installations with a delivery date before the end of 2008. This resulted in a rush of installations in the last quarter of 2008.

Another factor favoring larger installations is that the installed price per watt is significantly lower for larger systems. Based on data from the California Solar Initiative database, installations of systems larger than 500 kW cost 17% less on a per-watt basis than residential installations, most of which are smaller than 10 kW.

Virtually all of the larger installations and many of the medium-sized non-residential installations use power purchase agreements (PPAs). At least one company provides PPAs for residential customers. In these agreements, a third party finances and owns the solar installation and receives the available tax advantages and other incentives. The third party then leases the system or sells the solar-generated electricity to the building or site owner through a long-term contract.

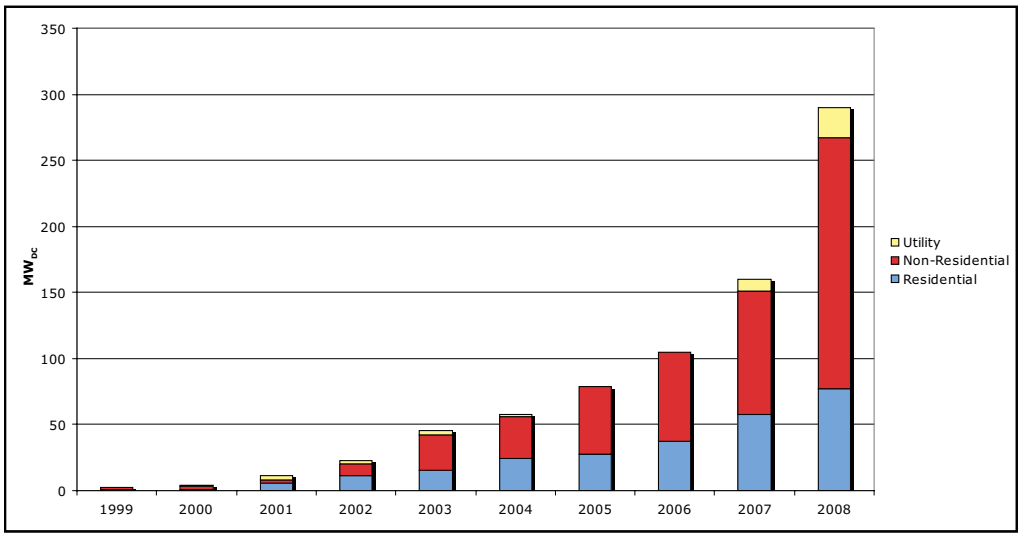


Fig. 2: Annual Installed Grid Connected PV Capacity by Sector (1999-2008)

Utility installations, defined here as installations for bulk power on the utility's side of the meter, increased to 8% of the grid-connected PV systems installed in 2008 by capacity. A 13-MW installation in Nevada and a 3-MW installation in Pennsylvania were the largest PV systems installed in 2008, and accounted for much of the new utility installed capacity. Based on announced projects, this sector should continue to grow significantly each year moving forward.

Grid-Connected Installations by Capacity

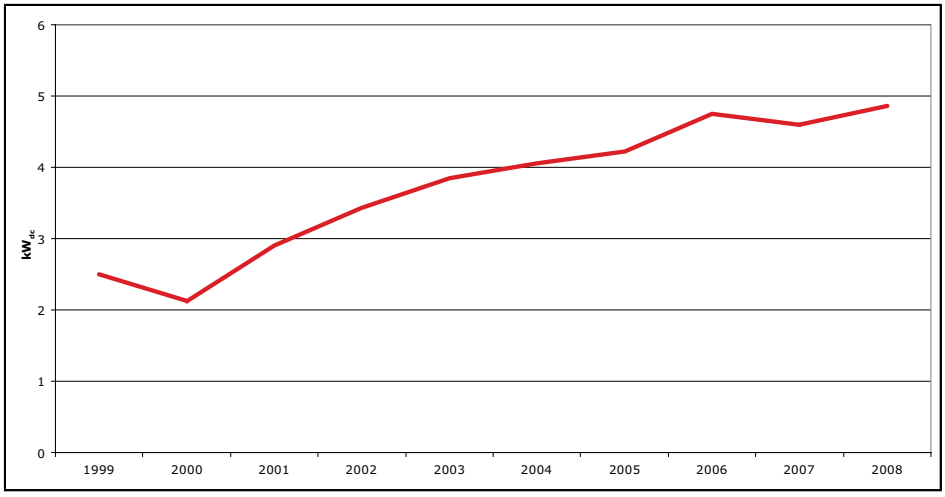


Fig. 3: Average Capacity of Grid-Connected Residential PV Installations (1999-2008)

The average size of a grid-connected PV residential installation has grown steadily from 2.5 kW in 1999 to nearly 4.9 kW in 2008 (see Figure 3). The average size of a non-residential system has also been growing in recent years, topping 110 kW_{DC} in 2008 (see Figure 4). 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.

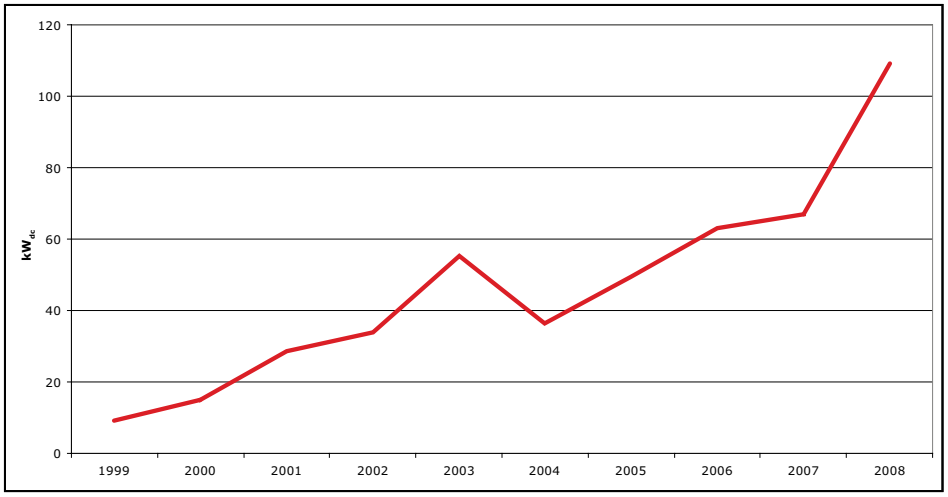


Fig. 4: Average Size of Grid-Connected Non-Residential PV Installations (1999-2008)

Installation of large systems—those greater than 500 kW—grew faster than any other sector. Within the non-residential sector, large systems accounted for 43% of the annual installations on a capacity basis in 2008 compared with only 19% in 2005 (see Figure 5). A total of 84 systems larger than 500 kW accounted for 30% of the total PV capacity installed in 2008.

"**Installation** of large systems... **grew faster** than any other sector."

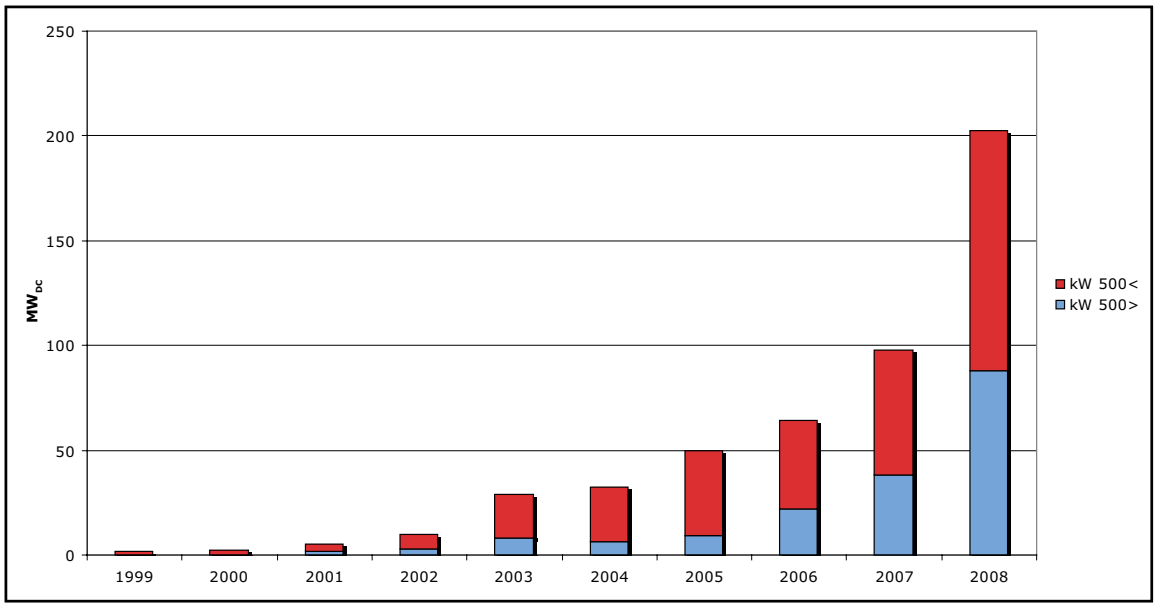


Fig. 5: Non-Residential Grid-Connected PV Installations by Capacity (1999-2008)

In several states, regulators are considering defining third-party owners of solar equipment as utilities (i.e. the PPA model discussed previously). Such rulings are generally unfavorable to the solar PPA model. If such rulings are made, third-party owners in these states may still be able to lease solar facilities (as opposed to owning and operating solar facilities) without being classified as utilities, but their ability to use the federal ITC will need to be clarified. If the federal ITC cannot be used as readily under the leasing model, PPAs will become less viable in these states, and the growth of solar installations in these states will be constrained.

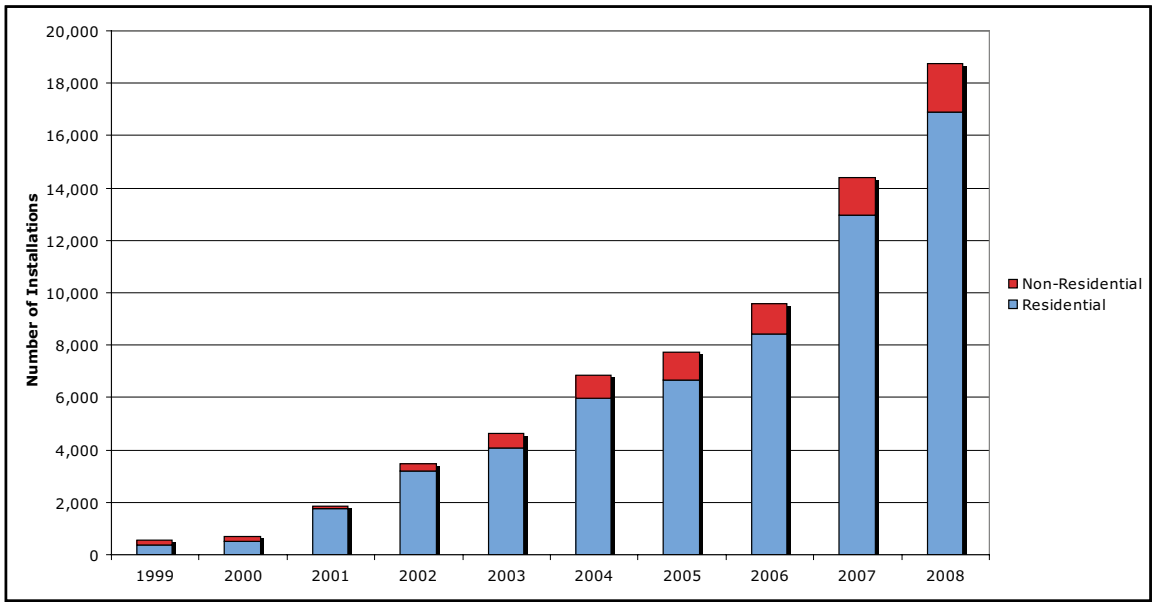


Fig. 6: Number of Annual Grid-Connected PV Installations (1999-2008)

Almost 19,000 grid-connected PV installations were completed in 2008, with 90% of these at residential locations (see Figure 6). At the end of 2008, 69,000 PV installations were operating on the grid, including 61,000 residential installations. Since the average size of non-residential systems is more than ten times the average size of residential systems, the number of residential installations is much larger than non-residential installations, even though the installed capacity of non-residential installations is greater.

Grid-Connected Installations by State

In 2008, installations of grid-connected PV systems were concentrated in California, New Jersey, Colorado, and Nevada, as shown in Table 1. These same four states were the leading states for installations in 2007. Table 2 shows that 62% of all PV capacity installed in 2008 was in California. As noted earlier, no comprehensive data exists for off-grid PV installations by state. A more complete listing of the installed capacity by state is included in Appendix C.

New California PV installed capacity in 2008 nearly doubled to 179 MW_{DC} compared with installations completed in 2007. The market more than doubled in Hawaii, Arizona, Connecticut, Oregon, North Carolina, Pennsylvania, Massachusetts, Maryland, Wisconsin, and New Mexico. Of the top ten states, only Nevada saw a decline in the capacity of systems installed in 2008 compared with those installed in 2007. Nevada was home to the largest single installation in both 2007 and 2008, but that one large installation was somewhat smaller in 2008 than in 2007.

Although new state markets emerged in 2008, the U.S. PV market remains very concentrated in a few states. Eighty-two percent of grid-connected installed capacity was in California, New Jersey, Colorado, and Nevada and 95% was in the top ten states.

Table 2 shows the cumulative per capita grid-connected PV capacity through 2008. Even with the largest population in the country, California has the highest total capacity of installations per capita—a capacity that is more than five times the national average. Both Hawaii and Nevada installed more on a per-capita basis than California in 2008. The large number of installations in a few states raises the national average, but 44 states have a per-capita PV installation rate that is less than the national average. As a point of reference, the city of Freiburg, Germany, with less solar resource than any of these states, has 41 watts installed per capita, considerably more than the average 3 watts installed per capita in the U.S.

Table 1: TOP TEN STATES BY 2008 CAPACITY
Ranked by Grid-Connected PV Capacity Installed in 2008 (MW_{DC}/yr)

2008 Rank by State	2008 (MW_{DC})	2007 (MW_{DC})	07-08 % change	2008 Market Share	2007 Rank
1. California	178.7	91.8	95%	62%	1
2. New Jersey	22.5	20.4	10%	8%	2
3. Colorado	21.7	11.5	88%	7%	4
4. Nevada	14.9	15.9	-6%	5%	3
5. Hawaii	8.6	2.9	200%	3%	6
6. New York	7.0	3.8	85%	2%	5
7. Arizona	6.4	2.8	129%	2%	7
8. Connecticut	5.3	2.5	109%	2%	8
9. Oregon	4.8	1.1	330%	2%	11
10. North Carolina	4.0	0.4	899%	1%	16
All Other States	15.9	7.2	122%	5%	
Total	289.8	160.3	81%		

Table 2: TOP TEN STATES BY CUMULATIVE CAPACITY
Ranked by Grid-Connected PV Cumulative Installed Capacity through 2008

	MW_{DC}	Market Share
1. California	528	67%
2. New Jersey	70	9%
3. Colorado	36	5%
4. Nevada	34	4%
5. Arizona	25	3%
6. New York	22	3%
7. Hawaii	14	2%
8. Connecticut	9	1%
9. Oregon	8	1%
10. Massachusetts	8	1%
All Other States	39	5%
Total	792	

Table 3: TOP TEN STATES BY PER CAPITA CAPACITY
Ranked by Cumulative Installed PV Capacity per Capita (WDC/person) through 2008

	Cumulative through 2008 (W_{DC}/person)	2008 Installations (W_{DC}/person)
1. California	14.6	4.9
2. Nevada	14.2	6.7
3. Hawaii	10.6	6.2
4. New Jersey	8.1	2.6
5. Colorado	7.7	4.6
6. Arizona	4.3	1.1
7. Connecticut	2.5	1.5
8. Delaware	2.2	0.7
9. Oregon	2.1	1.3
10. Vermont	1.8	0.6
National Average	2.7	1.0

Incentives by State

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

In 2007, **California** began the 10-year $3 billion Go Solar California campaign. The largest part of this campaign is the California Solar Initiative overseen by the California Public Utilities Commission (CPUC). This includes a rebate and performance incentive program for customers serviced by Pacific Gas & Electric, Southern California Edison, or San Diego Gas and Electric. Over 125 MW of PV was installed in 2008 through this program. 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. The CPUC program replaced the CPUC's Self Generation Incentive Program for large systems and the California Energy Commission's (CEC) Emerging Renewables Program for smaller systems.

In addition, the CEC administers the New Solar Home Partnership program for solar installation on new homes. Beginning in 2008, California municipal utilities were required to offer solar incentives. As a result, installations in municipal utility service territories almost tripled to 11 MW compared with 2007. 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.

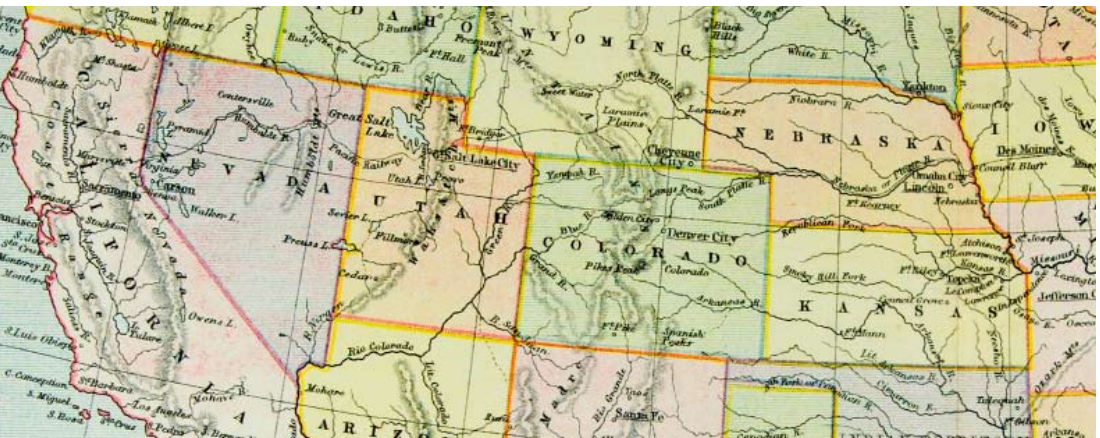
As California programs began to convert to the CSI programs, some program design problems developed. This slowed the number of 2007 installations over what might have been otherwise expected. By 2008, the program was operating more smoothly, resulting in the large installation growth in 2008. CSI has the advantage of being a 10-year program, so the industry in California can now rely on long-term policy stability.

In **New Jersey**, a generous (albeit inconsistent) state rebate program and an RPS with a solar requirement of 2.12% by 2021 have helped build a strong PV market. Now, for larger installations, the capacity-based rebate program is being converted into a performance-based incentive that involves payments based on the actual energy production of a PV system. This program created a market for solar renewable energy credits (SRECs). At the end of 2008, installations with a combined capacity of 59 MW were selling SRECs. The average SREC price was $417 per MWH during the last half of 2008. Small PV installations will continue to receive rebate payments. The New Jersey market continues to grow, though at a slower rate than many other states. Uncertainty about the state budget, waiting lists for incentives, and future solar incentives may have contributed to this slowing.

In 2005, **Colorado** voters passed Amendment 37, an action that created an RPS with a solar requirement equal to 0.4% of retail electricity sales. Later, the legislature doubled the overall RPS requirements. Xcel Energy is by far the largest utility in the state and over 90% of 2008 Colorado installations were part of Xcel programs. Xcel offers capacity-based rebates for smaller, customer-sited PV systems. For these systems, part of the capacity credit is 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 smaller Colorado utilities were active as well and installed nearly 2 MW in 2008—an amount equal to 9 times the amount installed in 2007.

Nevada has an RPS with a solar carve-out equal to 5% of the overall standard. In 2009 the Nevada Legislature increased the state's renewable portfolio standard from 20% by 2015 to 25% by 2025, increasing the solar carve-out from 1% to 1.5% (6% of the required 25%), in recognition that the solar portion was fully subscribed. The solar carve-out has brought online a number of large solar installations. Nevada boasts two of the largest U.S. PV installations, the 14-MW plant at Nellis Air Force Base and the 12.6 MW Sempra-First Solar installation. The Nevada RPS also led to the installation of the 64-MW Solar One solar thermal electric plant during 2007.



"Solar electric market activity has more to do with **state incentives** and policies than with the amount of available solar resources."

In addition, Nevada utilities offer a rebate program for schools, public buildings, residential, and small-scale commercial customer-sited PV installations. However, the "SolarGenerations" program is small, capping capacity by category of applicant (1 MW for schools, 760 kW for public buildings, and 1 MW for residential and small commercial under 30 kW). In addition, there is no rebate available for commercial projects over 30kW, and to date the entire program is underperforming. The rebate-funded installations accounted for only 5% of the total 2008 installations on a capacity basis. Recent legislation (SB 358) should lead to improvements in the program. SB 358 will establish a more efficient 30-day application approval process. In addition, the capacity limits will now increase at 9% per year, leading to roughly 97 megawatts by 2020 if the program is efficiently run and fully subscribed.

Hawaii has the nation's highest electricity prices, a significant state solar tax credit, and an established solar industry, which has been active for decades and has a track record of professionalism and credibility. This meant companies and individuals were ready to install photovoltaics when the price was right. The increase in the federal ITC improved the economics of solar electricity and, along with Hawaii's net energy metering program, led to a dramatic increase in commercial as well as residential installations.

In **New York**, both the New York State Energy Research and Development Authority (NYSERDA) and the Long Island Power Authority (LIPA) provide PV rebates, and most systems in the state have been installed through these two programs. The installed PV capacity in New York has been growing steadily every year. On a capacity basis, only 24% of the 2008 New York installations were non-residential, compared with 73% in the rest of the United States. Interconnection and net metering restrictions in New York make large installations difficult, though legislation passed in 2008 will improve this situation. LIPA announced plans for several large installations totaling 50 MW for installation in 2009 through 2011.

Arizona is another state where the solar policy is evolving. For a number of years, Arizona has had an RPS (known there as the Environmental Portfolio Standard), which mandated renewable-energy installations. Although no utility ever met the standard, Arizona ranked second for capacity of PV installed each year from 1997 through 2004. Arizona has more PV capacity installed on the utility side of the meter than any other state. However, by 2007 Arizona's rank had fallen to sixth among states for capacity of annual PV installations. Recent changes added a requirement that 30% of the RPS be met through customer-site installations and that half must come from the residential sector. Arizona (along with California, Nevada and Colorado) is a likely site for future solar thermal electric plants.

Connecticut, Massachusetts, and Oregon all provide rebates administered by non-profit organizations funded with system benefit charges paid by electricity consumers. Each state's PV market has grown in the last few years, and continued growth is likely. With enhanced tax benefits in Oregon, many more large installations are expected. The new Commonwealth Solar initiative in Massachusetts has the goal of installing 27 MW of PV during the four-year duration of the program.

3. Solar Thermal Electric

No new solar thermal electric plants were connected to the grid in 2008. At least one research and development facility was constructed this past year, but it does not have a generator to produce electricity. Sixty-five megawatts of solar thermal electric capacity were added in 2006 and 2007 and nine solar thermal electric plants with a capacity of 354 MW were constructed in California from 1985 to 1991. These plants continue to operate today.

The future prospects for solar thermal electric plants look bright, although developers are not expected to complete any new plants until at least 2010. According to the Solar Energy Industries Association (1), several different companies have announced plans totaling over 7,000 MW of generating capacity, and some have begun to receive required approvals from government agencies for these projects.

4. Solar Hot Water and Space Heating

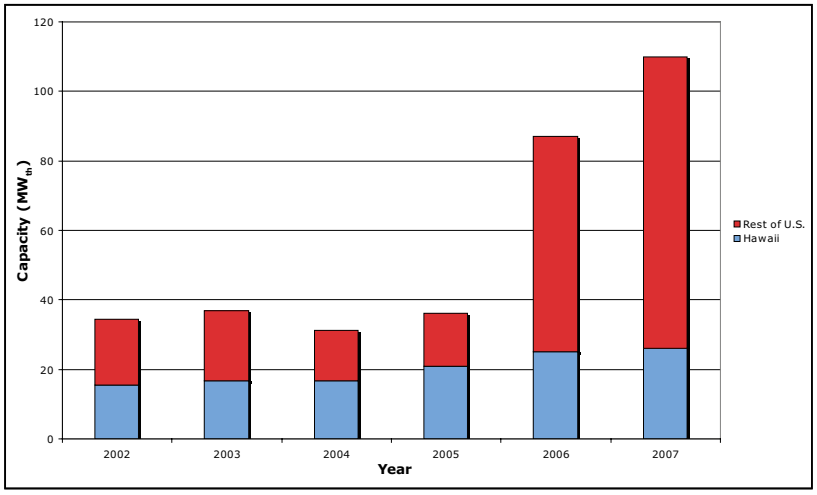


Fig. 7: Annual Installed Capacity for Solar Hot Water and Space Heating (2002-2007). Based on analysis of collector shipment data from EIA.

Solar thermal collectors can heat hot water for domestic or commercial use or heat spaces such as houses or offices. More rarely, solar-thermal collectors can provide heat for industrial processes or air conditioning.

In 2006, the new residential federal ITC and the increased commercial ITC, together with rising conventional energy prices, contributed to a dramatic increase in the U.S. solar hot water market. The credits were further increased in February 2009 with the removal of the $2,000 cap. Prior to 2006, about half of the solar water heaters sold each year in the United States were in Hawaii due to a combination of utility rebates, state tax credits, and high energy prices. By 2008, the national capacity of systems installed each year was triple the number in 2005, and installations outside Hawaii increased by 5-1/2 times (see Figure 7). After Hawaii, Florida and California lead the states in solar hot water installations. Data for solar thermal installations comes from the U.S. Energy Information Administration and lag the data from other sources by a year. Therefore these data are only available through 2007.

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Figure 8 shows that, like PV installations, solar water heating and space heating installations are concentrated in a few states (and Puerto Rico). However, the states with the most installed capacity for solar hot water are different than the states with the most installed PV. Hawaii represents almost half of the solar hot water market. High energy prices and strong government policies have built the solar hot water market in Hawaii. In addition, installation costs are lower in Hawaii than in most other locations in the United States because freezing is not a concern.

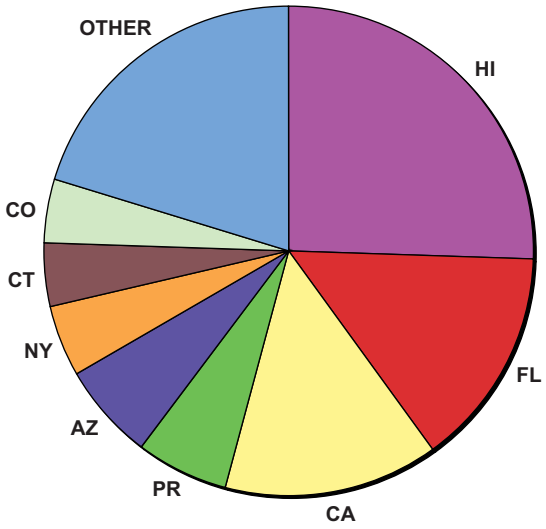

Fig. 8: Installed Solar Hot Water and Space Heating Capacity by State for 2006-2007. Based on analysis of EIA data for 2006-2007.

4.3 Solar Pool Heating

Figure 9 shows the annual installed capacity for solar pool heating systems during 1999 to 2008. Installed capacity declined 3% in 2008 following a dramatic decline of 24% in solar pool heating capacity in 2007 compared with 2006. To a certain extent, the sales of solar pool heating systems follow the sales of pools. The economic decline in the real estate markets in Florida and California likely led to the decrease in pool installations and thus the dramatic decline in capacity installed of solar pool systems in 2007 and 2008 compared with earlier years.

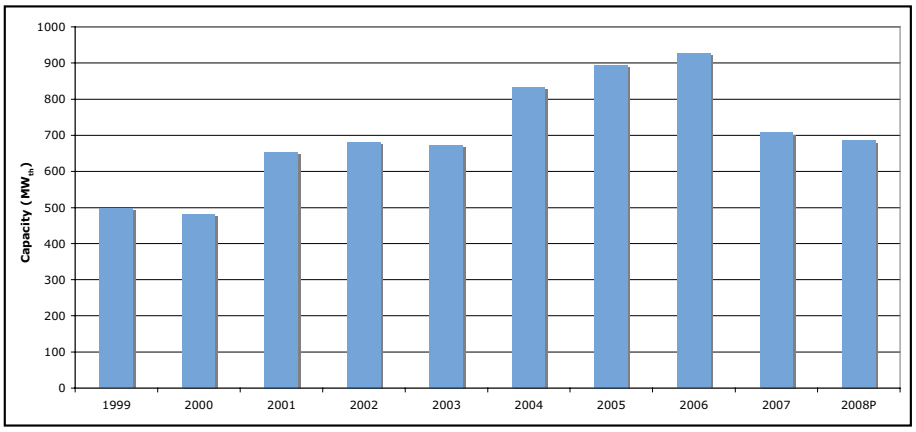

Fig. 9: Annual Installed Capacity for Solar Pool Heating (1999-2008) Based on collector shipment data from EIA and SEREF.

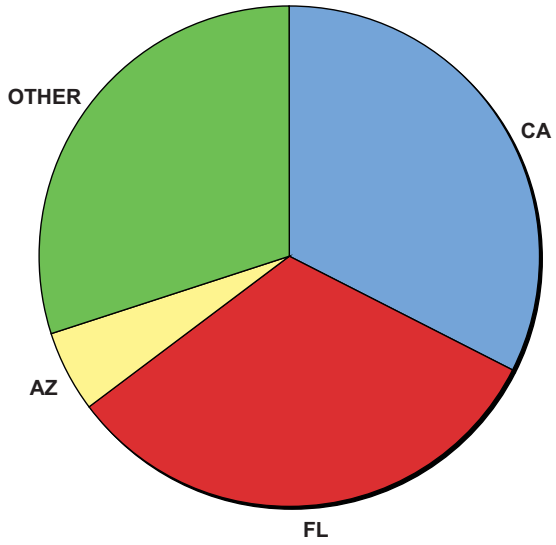

Fig. 10: Installed Solar Pool Heating Capacity by State. Based on EIA Data for 2006-2007.

The trend continues for solar pool heating systems, with installations concentrated in a few states, notably Florida and California (see Figure 10). Unlike other solar technologies, only a few states offer incentives for solar pool heating systems and those incentives are modest.

5. Number Of Installations

The number of solar installations from all technologies grew from 18,000 installed during 1999 to 60,000 installed during 2008, as shown in Figure 10. This includes grid-connected and off-grid PV, solar hot water, solar pool heating and solar thermal-electric. Through 2005, over half of these installations were for solar pool heating. Because of the expanded federal ITC and the slump in the new pool market, the market shares of the different solar technologies changed significantly since 2006. Grid-connected PV and solar hot water installations saw the largest growth during this period.

These charts 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.

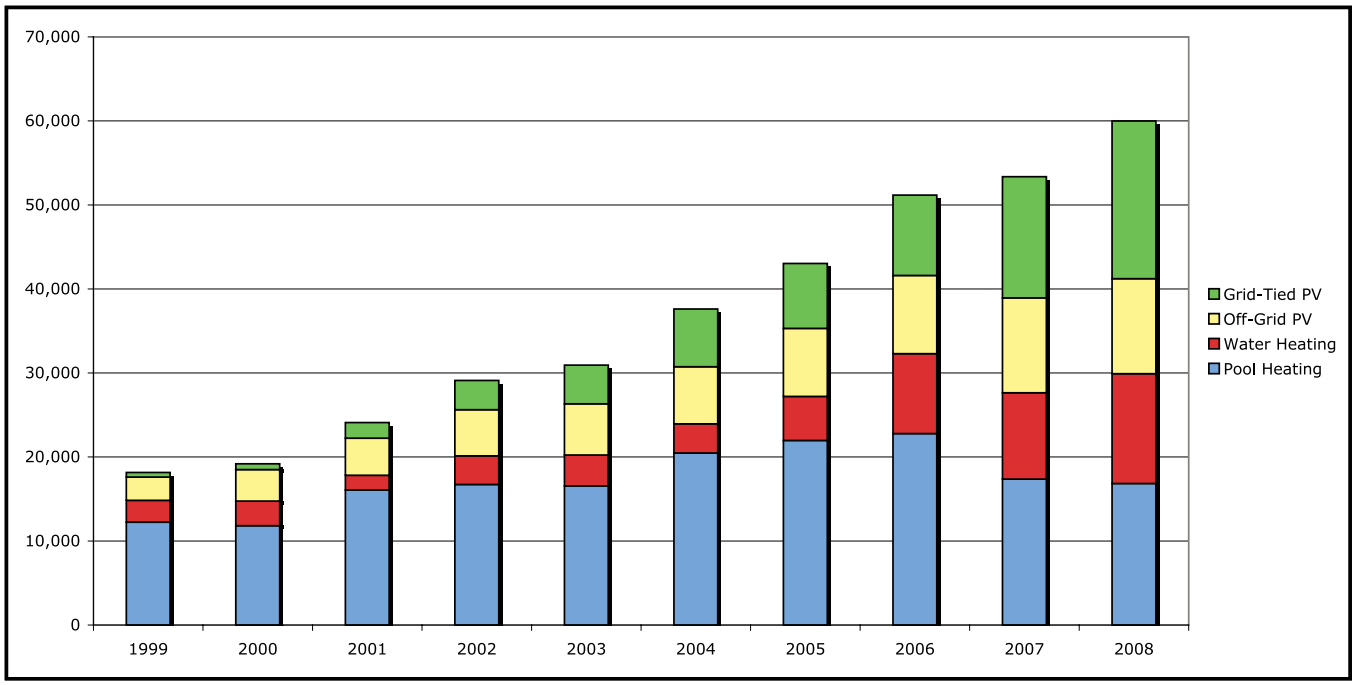

Fig. 11: Number of Annual Solar Installations by Technology (1999-2008)

TABLE 4: CUMMULATIVE SOLAR INSTALLATIONS BY TECHNOLOGY, 1993-2008

Solar Pool Heating	235,000
Solar Hot Water (and Space Heating)	87,000
Off-grid Photovoltaics	70,000
Grid-Connected Photovoltaics	69,000
Total	461,000

Table 4 shows that the cumulative solar installations by technology for 1993-2008. totals 461,000.

"Grid-connected PV and solar hot water installations saw the **largest growth**."

6. Prospects For 2009 and 2010

Early indicators point to market growth in 2009, though likely at a slower rate than during the last several years. The market growth rate will likely accelerate in 2010. The long-term extension of the federal ITC, new rules that allow electric utilities to use the ITC, and the establishment of a grant alternative to the commercial ITC will all help drive market growth. Since these policies were only recently enacted (in October 2008 and February 2009), the market will take some time to respond to these new policies. However, due to the poor housing market and restricted capital availability, the solar market will respond slower to these initiatives than it might have in a stronger economic environment. Companies have announced plans for many large solar projects, including solar thermal electric projects, utility-owned projects, and third-party owned projects. A few of these projects will be completed in 2009, but most will come on-line in 2010 and beyond.

Prices for grid-connected PV installations are beginning to fall, and many analysts expect prices to continue to fall indefinitely. Lower PV prices offer the potential of installations in states without state or local incentives. However, in 2009, installations will continue to be concentrated in states with strong financial incentives and other strong solar policies, and these incentives and other policies will remain critical to market growth.

Electric utility announcements point to growth in installations on the utility-side of the meter. Many of these installations will be large arrays owned by the utility or a third-party. Others involve siting PV on residential or commercial buildings. These systems are configured on the utility-side of the meter and have no effect on the consumer's bill; instead the building owner receives a roof lease payment or similar type of compensation.

7. Conclusion

Solar markets are booming in the United States due to consumer interest in green technologies, concern about energy prices, and financial incentives from the federal government, states, local governments and utilities. Over 62,000 installations were completed in 2008. The markets for each solar technology are concentrated in a few states.

The number of new PV installations grew by 63% in 2008 compared with those installed in 2007 and the average size of PV systems is growing. A 12.6-MW installation in Nevada and a 3-MW installation in Pennsylvania were the largest PV systems installed in 2008, and together accounted for 5% of the annual installed capacity. The PV market is expanding to more states, and installations doubled in more than eleven states. However, California remains the dominant market.

Solar hot water installations have boomed since the enhanced federal ITC took effect in 2006. In the continental 48 states, annual installed capacity has quintupled since 2005. Hawaii remains the largest market for solar hot water.

No new solar thermal electric plants were connected to the grid in 2008. The future prospects for solar thermal electric look bright, although no new plants are expected to be completed until 2010.

Federal tax incentives expanded or renewed in October 2008 and February 2009 will lead to market growth in 2009 and accelerating market growth in 2010.

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PHOTO CREDITS:

Photovoltaic Installations in Massachusetts (Pg. 1-2)
Photograph courtesy of Massachusetts Renewable Energy Trust

3-MW Conergy-Exelon Installation in Pennsylvania (Pg. 3)
Photograph courtesy of Conergy

2-MW Southern California Edison Photovoltaic Installation in Fontana, CA (Pg. 9)
Photograph courtesy of First Solar

Solar Hot Water Installations in San Diego (Pg. 10)
Photograph courtesy of California Center for Sustainable Energy

Photovoltaic Installations (Pg. 12, 13)
Photographs courtesy of SunEdison

Appendix A
Data Sources

1.1 Grid-Connected Photovoltaics

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

- State agencies or organizations administrating state incentive programs (data most commonly available from states with incentives);
- Utility companies (data most commonly available from utilities that manage incentive programs or from interconnection agreements); and
- Non-profit organizations (data most commonly collected through surveys or from installations facilitated by local programs).

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.

1.1 Off-Grid Photovoltaics

National data for off-grid PV capacity were obtained from the Prometheus Institute. Other sources provide much less data on off-grid PV installations than grid-connected installations. The best grid-connected data come from incentive programs, which usually do not fund off-grid applications. Therefore, state data are not reported for off-grid PV installations.

1.2 Solar Thermal

Some sources report data on state solar thermal 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 shipments by market sector and end use (i.e. shipments to California and total shipments for pool heating use)(2). 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 than 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.

Luckily, most pool heating collector manufacturers only ship collectors for that market. EIA provided the author with data titled, Solar Thermal Collector Shipments by State of Destination for Companies that Shipped only Collectors to be used for Pool Heating. These shipments account for 95% of the total pool shipments reported elsewhere by EIA.

This study then calculated the difference between the "Total Solar Thermal Collector Shipments by State" and the "Shipments from Companies that Shipped Collectors to be used for Pool Heating." This difference is assumed to be the shipments for hot water and space heating.

This analysis provides a general picture of the state distribution of solar thermal installations, especially for states with the largest number of installations. However, there are problems with these data. Hot water and space heating installations are small compared with the number of pool heating installations, and solar thermal exports are rising. Both these factors make analysis of EIA data difficult. In addition, manufacturers report to EIA where they shipped the collectors. Most shipments go to wholesale and retail distributors. The final destination and installation of the collectors may be in a different state and is not reported to the EIA.

The resulting state analysis was compared with state installation data obtained from other sources. While not a perfect match, the general trends are confirmed (i.e., the top states and the general proportion of collectors sold there). In general, this analysis shows a higher use of thermal collectors for solar hot water than other state sources show.

EIA data for 2008 will not be available until the fall of 2009. Preliminary pool data from the Solar Energy Industries Association was used for 2008 (3).

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.

The notable exception to reporting DC watts are the California Energy Commission (CEC) Emerging Renewables Program and the California Public Utilities Commission (CPUC) Self-Generation Incentive Program, which report alternating current (AC) watts. CEC 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 reports installation capacity in both DC and AC watts. Therefore the average ratio between AC and DC watts can be determined for each year. In 2007, DC watts was 84% of AC watts and in 2008 the ratio was 85.5%. These ratios are used to convert other data reported in AC 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}) (Recommendation: Converting solar thermal collector area into installed capacity, 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 Hot Water Residential: 50 ft^2 (4.6 m^2)
Solar Hot Water 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 Los Angeles Department of Water and Power (LADWP), which do include both residential and commercial data, indicates that the 10 kW_{DC} assumption is reasonable.

For the first time this year, an estimate was made of residential and non-residential installations for the solar thermal sectors based on EIA data. Making this estimate reduced the total number of estimated solar thermal installations.

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. In many cases, the agency that administers and 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.

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, as this is a better proxy than the incentive paid date. This method of setting the installation date was used for the first time in this edition of the report. Data for the pervious year have been updated where this information is available.

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

Appendix B continued

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 2007 and earlier do not always agree with the numbers published in the 2007 edition of this report.

References

(1) Solar Energy Industries Association, Major Solar Projects: Operational and Under Development, June 11, 2009. Retrieved June 24, 2009 from http://www.seia.org/galleries/pdf/Major%20Solar%20Projects.pdf

(2) Energy Information Administration, Renewable Energy Annual, 1997-2007 editions

(3) Solar Energy Industries Association (SEIA), US Solar Industry Year in Review, 2008.

Appendix C
Grid-Connected PV Installatons by State

State	Capacity Installed in 2007 (MW_{DC})	Capacity Installed in 2008 (MW_{DC})	Cumulative Installed Capacity (MW_{DC})
Alabama	*	*	*
Alaska	*	*	*
Arizona	2.8	6.4	25.3
Arkansas	*	*	*
California	91.8	178.7	528.3
Colorado	11.5	21.7	35.7
Connecticut	2.5	5.3	8.8
Delaware	0.4	0.6	1.8
District of Columbia	*	0.2	0.7
Florida	1.0	0.9	3.0
Georgia	*	*	*
Hawaii	2.9	8.6	13.5
Idaho	*	*	*
Illinois	0.2	0.4	2.8
Indiana	*	*	*
Iowa	*	*	*
Kansas	*	*	*
Kentucky	*	*	*
Louisiana	*	*	*
Maine	*	*	0.3
Maryland	0.3	2.2	3.1
Massachusetts	1.4	2.9	7.5
Michigan	*	*	0.4
Minnesota	0.3	0.3	1.0
Mississippi	*	*	*
Missouri	*	*	*
Montana	0.2	0.1	0.7
Nebraska	*	*	*
Nevada	15.9	14.9	34.2
New Hampshire	*	*	0.1
New Jersey	20.4	22.5	70.2
New Mexico	0.2	0.6	1.0
New York	3.8	7.0	21.9
North Carolina	0.4	4.0	4.7
North Dakota	*	*	*
Ohio	0.1	0.4	1.4
Oklahoma	*	*	*
Oregon	1.1	4.8	7.7
Pennsylvania	0.1	3.0	3.9
Rhode Island	*	*	0.6
South Carolina	*	*	*
South Dakota	*	*	*
Tennessee	*	*	0.4
Texas	0.6	1.2	4.4
Utah	*	*	0.2
Vermont	0.2	0.4	1.1
Virginia	*	*	0.2
Washington	1.2	0.8	3.7
West Virginia	*	*	*
Wisconsin	0.6	1.7	3.1
Wyoming	*	*	*

* less than 100 kW_{dc} or data not available