U.S. SOLAR MARKET TRENDS

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ABSTRACT

2010 marked the emergence of the utility sector photovoltaic market. Utility sector photovoltaic installations quadrupled over 2009 installations. The share of utility sector installations of all U.S. grid-connected PV installations grew from virtually none in 2006 to 15 percent in 2009 and 32 percent in 2010. In addition, 2010 saw installation of a 75 MW_{AC} concentrating solar power plant, the largest installed in the U.S. since 1991.

In 2010, annual distributed grid-connected PV installations in the United States grew by 62 percent, to 606 MW_{DC}. Photovoltaic arrays were installed at more than 50,000 sites in 2010, a 45 percent increase over the number of installations in 2009.

Solar water heating installations increased by 6 percent in 2010, compared with 2009. Solar water heating has shown only two years of higher growth in the last 10 years. Solar pool heating installations increased by 13 percent in 2010, the largest growth in five years.

1. INTRODUCTION

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

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

Concentrating solar power (CSP) systems use mirrors and collecting receivers to heat a fluid to a high temperature (from 300°F to more than 1,000°F), and then run the heat extracted from the fluid through a traditional turbine power generator or Stirling engine. CSP can also be paired with existing or new traditional power plants, providing high-temperature heat into the thermal cycle. These generating stations typically produce bulk power on the utility side of the meter rather than generating electricity on the customer side of the meter. CSP plants were first installed in the United States in the early 1980s.

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

This paper provides public data on U.S. solar installations by technology, state and market sector. Public data on solar installations help industry, government and non-

profit organizations improve their efforts to increase the number (and capacity) of solar installations across the United States. Analysis of multi-year installation trends and state installation data helps these stakeholders learn more about state solar markets and evaluate the effectiveness of marketing, financial incentives and education initiatives. In addition, these data allow for a better understanding of the environmental and economic impact of solar installations.

For all solar technologies, the United States is only a small part of a robust world solar market. Product availability and pricing generally reflect this status. Germany is the top market for PV; Spain is the top market for CSP; and China is the largest market for solar thermal collectors. The grid-connected PV market in Ontario, Canada, ranks as one of the largest markets in North America.

2. PHOTOVOLTAICS

2.1 Overall Trends in Installations and Capacity

Annual U.S. grid-connected PV installations doubled in 2010 compared with installations in 2009 to 890 MW_{DC}, raising the cumulative installed grid-connected capacity to 2.14 GW_{DC} (See Figure 1). The capacity of PV systems installed in 2010 was over eight times the capacity of PV installed in 2006. More than 50,000 sites installed PV in 2010, a 45% increase over the number installed the year before. While most of these installations are mounted on buildings, an increasing number are ground-mounted, and a smaller number are pole-mounted installations.

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

The following factors helped drive PV growth in 2010:

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

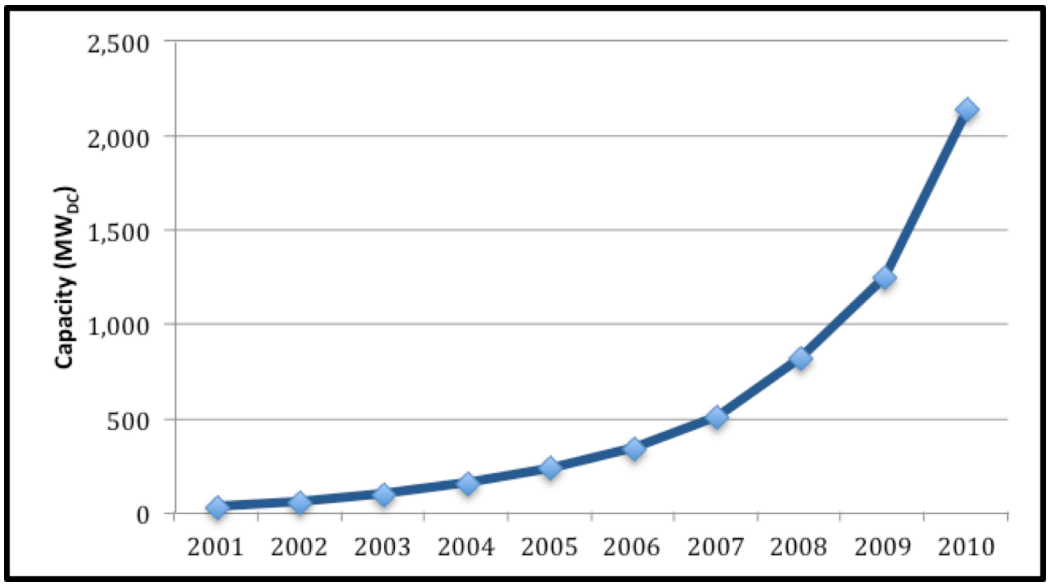

Fig. 1: Cumulative U.S. Grid-Tied Photovoltaic Installations (2001-2010)

encouraging investments in utility-scale solar plants. Utility sector investments increased by more than 4 times compared with 2009 and this sector seems poised to continue to grow quickly in the next several years. In some states, RPS requirements have led to robust solar renewable energy credit (SREC) markets, which in turn have resulted in increased demand for and installation of distributed solar installations.

- State financial incentives continue to be an important factor, especially for residential and commercial distributed installations. Of the top ten states for PV installations, six have rebate programs that are the most significant driver in those markets. The federal incentives are important, but they are generally insufficient to create a market by themselves.
- Federal stimulus funding through ARRA helped solar installations in a number of different ways. First the cash grant program provided a stronger incentive for installations than the federal tax credit. Second, ARRA funded many government solar installations at both the federal and state levels. Third, some states used their ARRA funding to create or enhance state financial incentive programs. Although the impact of ARRA programs will continue to be felt in 2011, this impact will begin to decrease as the funding is completed.
- Prices for PV modules continue to decline. In 2010, the installed price for residential systems decreased 13% compared with 2009 and non-residential systems decreased 20%

2.2 Grid-Connected Installations by Sector

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

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

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

Table 1: SAMPLE INSTALLATIONS BY SECTOR

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

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

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

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

2.3 Size of Grid-Connected Installations

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

Although the number of utility PV installations remains small, the average system size is large (over 1,450 kW_{DC}), so these installations represent 32% of all installations on a capacity basis**.** Just 34 utility installations greater than 1 MW_{DC} totaled 239 MW_{DC}, or 27% of the capacity total of U.S. systems installed in 2010. In 2009, just 6 such installations totaled 60 MW_{DC}. Large utility installations attract significant attention, but small installations also occur in the utility sector. In New Jersey, Public Service Electric and Gas Company began installing 200-W PV systems mounted on power poles. These installations totaled more than 13 MW_{DC} in 2010.

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

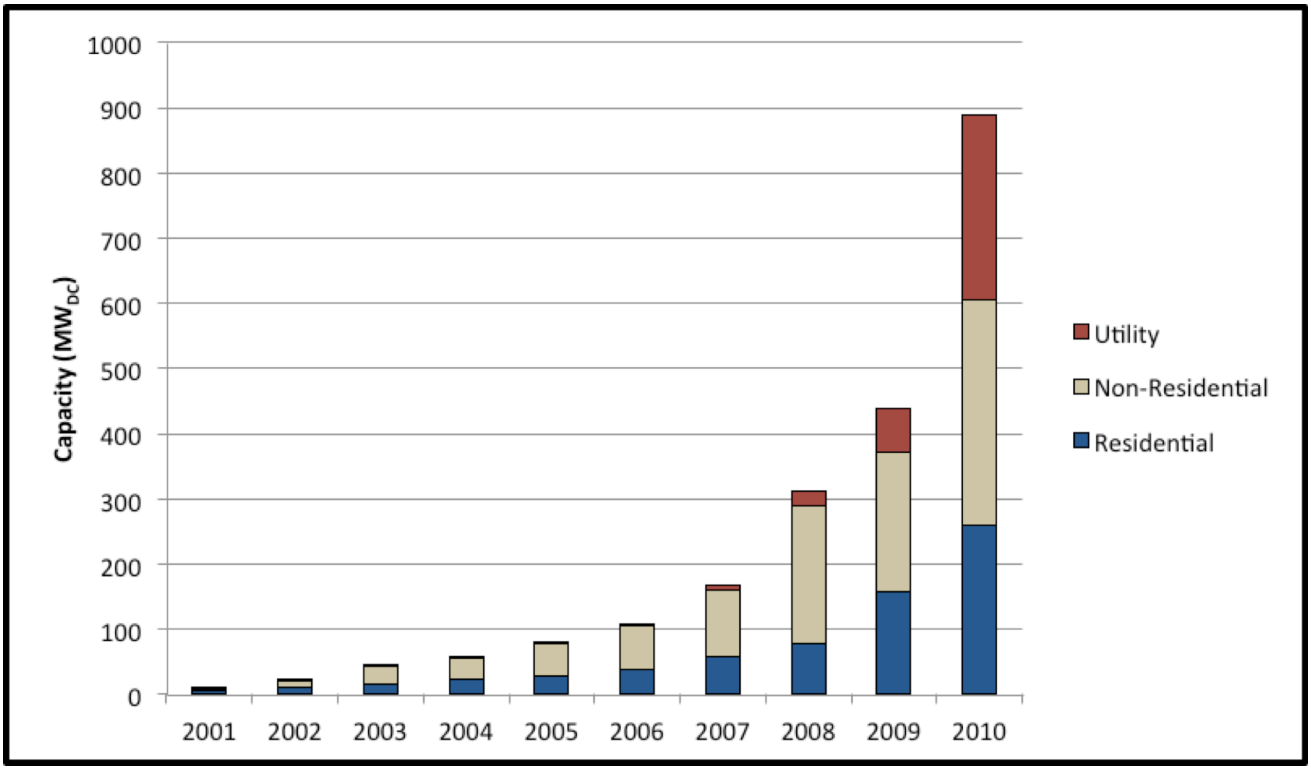

Fig. 2: Annual Installed Grid-Connected PV Capacity by Sector (2001-2010)

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

2010 Rank by State	2010 (MW_{DC})	2009 (MW_{DC})	09-10 % change	2010 Market Share	2009 Rank
1. California	252.0	213.7	18%	28%	1
2. New Jersey	132.4	57.3	131%	15%	2
3. Nevada	68.3	2.5	2598%	8%	15
4. Colorado	62.0	23.4	165%	7%	4
5. Arizona	61.1	21.1	189%	7%	5
6. Pennsylvania	46.5	4.4	947%	5%	13
7. New Mexico	40.9	1.4	2815%	5%	20
8. Florida	34.8	35.7	-2%	4%	3
9. North Carolina	28.7	6.6	332%	3%	10
10. Texas	25.9	4.2	517%	3%	14
All Other States	137.7	67.6	104%	15%	--
Total	890.2	438.0	103%	--	--

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

The average size of grid-connected PV installations varies from state-to-state, depending on available incentives, interconnection standards, net metering regulations, solar resources, retail electricity rates, and other factors. The Database for State Incentives for Renewables & Efficiency provides summary tables of state and utility financial incentives (DSIRE 2010)

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

2.4 Grid-Connected Installations by State

In 2010, installations of grid-connected PV systems were concentrated in California, New Jersey, Nevada, Colorado and Arizona, as shown in Table 2. The market more than doubled in all of the top ten states, except for California and Florida. Nevada, New Mexico and Texas are new states on the top ten list this year due to one very large installation in each state. Pennsylvania made it onto the list because of installations driven by their new strong renewable portfolio and rebate program. With the exception of Nevada, all states on the top ten list have strong state renewable portfolio or financial incentive programs. Although Nevada has a renewable portfolio standard and a solar rebate program, it makes the top ten list because of the single large 58 MW_{DC} installation that sells electricity to Pacific Gas and Electric in California to meet the California renewable portfolio standards.

3. CONCENTRATING SOLAR POWER

Developers have touted plans for concentrating solar power plants for a number of years and in 2010 the largest plant since the 1980s was completed. Florida Power and Light installed a 75 MW_{AC} concentrating solar power plant near Indiantown, Florida in 2010.

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

4. SOLAR HEATING AND COOLING

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

Solar water heating installations increased by 6 percent in 2010, compared with 2009 (GreenTech Media and Solar Energy Industries Association, 2011). Solar water heating has shown only two years of strong growth in the last 10 years. In 2006, solar water heating installations more than doubled compared with 2005. That year, the residential federal ITC was established and the commercial ITC increased. Then in 2008, installations grew by 56 percent compared with 2007. In 2008 the cap on the amount of the federal ITC a residential customer can receive was removed. The solar water heating markets respond when federal incentives are increased, but, unlike photovoltaic installations, market demand does not sustain high growth rates. (See Figure 3.)

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

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

A positive development for solar thermal is the emergence of a market for solar thermal process heating systems, which use solar thermal energy to provide energy for industrial process uses. This market in 2009 was about one-quarter of the solar hot water market. These are installations on industrial or commercial establishments and include some third party PPA systems. Since the PPA ownership model has been key to the growth of the non-residential PV market, it will be interesting to see how it effects the solar thermal market's growth.

5. SOLAR POOL HEATING

The installation of solar thermal systems to heat pools increased by 13 percent, the largest improvement in five years (see Figure 4). The solar pool heating market has been soft for years, due to weak real estate markets. The economic decline in the real estate markets in Florida and California likely led to the decrease in pool installations and thus the decline in the installed capacity of solar pool systems in recent years.

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

7. PROSPECTS FOR 2011

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

Companies have announced plans for many large solar

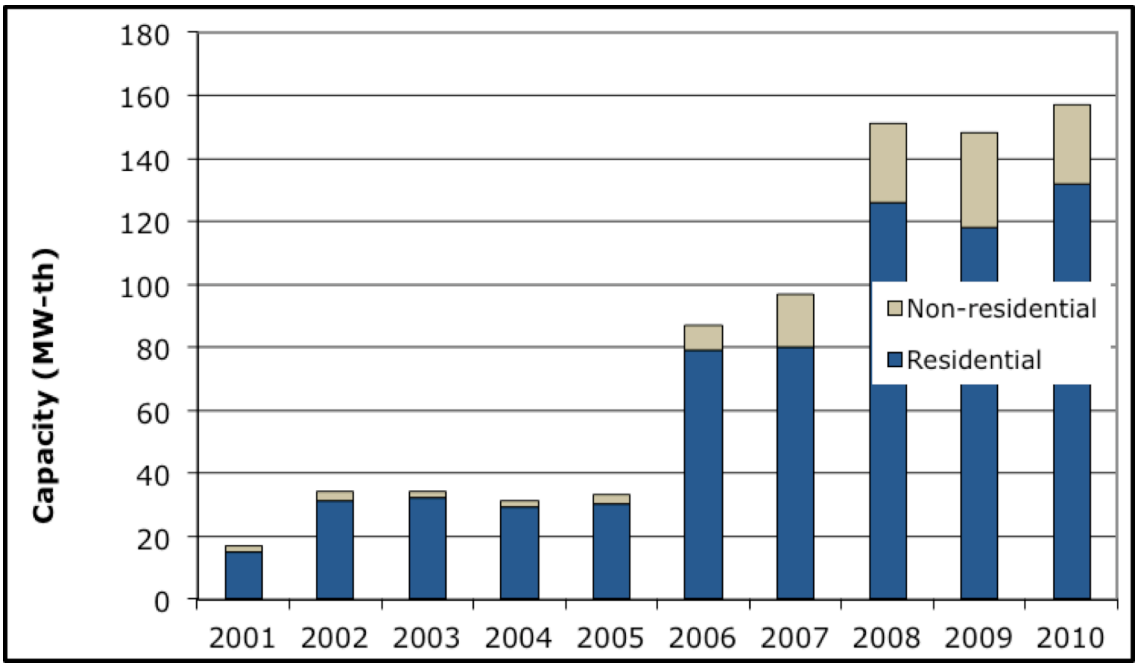

Fig. 3: Annual Installed U.S. Capacity for Solar Heating and Cooling (2001-2010)
Based on analysis of collector shipment data from EIA and GTM/ SEIA.

projects, including solar thermal electric projects, utility-owned projects and third party-owned projects. Some of these projects will be completed in 2011, and many more will start construction in 2011 to take advantage of the federal cash grant program. Completion of these later projects will likely occur in 2012 and 2013.

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

8. ACKNOWLEDGEMENTS

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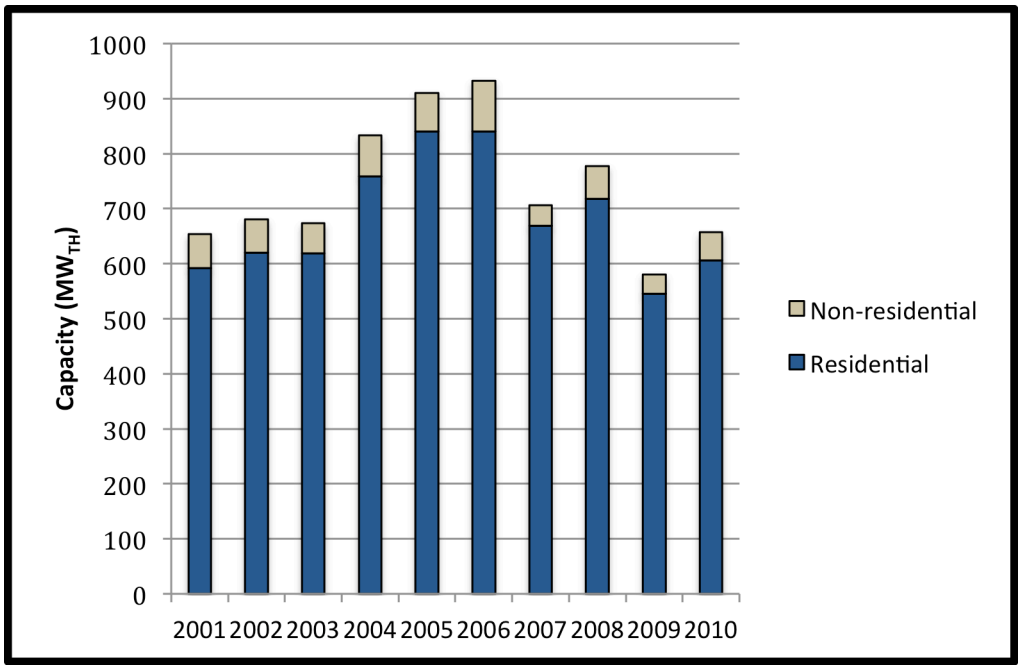

Fig. 4: Annual Installed Capacity for Solar Pool Heating (2001-2010)
Based on collector shipment data from EIA and GTM/ SEIA.