



US Solar Industry Year in Review 2009

Thursday, April 15, 2010

Executive Summary

Despite the Great Recession of 2009, the U.S. solar energy industry grew— both in new installations and employment. Total U.S. solar electric capacity from photovoltaic (PV) and concentrating solar power (CSP) technologies climbed past 2,000 MW, enough to serve more than 350,000 homes. Total U.S. solar thermal capacity approached 24,000 MW_{th}.¹ Solar industry revenues also surged despite the economy, climbing 36 percent in 2009.

A doubling in size of the residential PV market and three new CSP plants helped lift the U.S. solar electric market 37 percent in annual installations over 2008 from 351 MW in 2008 to 481 MW in 2009. Solar water heating (SWH) installations managed 10 percent year-over-year growth, while the solar pool heating (SPH) market suffered along with the broader construction industry, dropping 10 percent.

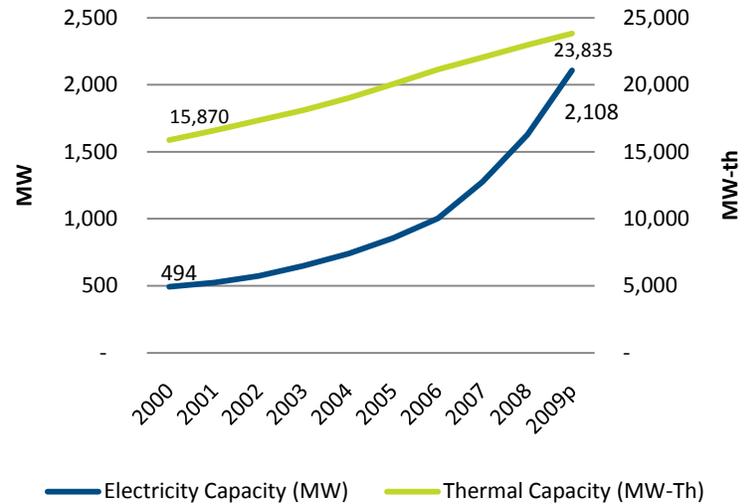
Another sign of continued optimism in solar energy: venture capitalists invested more in solar technologies than any other clean technology in 2009. In total, \$1.4 billion in venture capital flowed to solar companies in 2009.² For an industry that had a total U.S. volume of roughly \$4 billion, this signals huge optimism about near-term growth.

Solar provisions in the *American Recovery and Reinvestment Act of 2009* (ARRA) got off to a slow start but continue to ease the pressures of the credit crisis. As of early February 2010, more than 46 MW of solar capacity has been deployed with the help of the Section 1603 Treasury grants in lieu of the investment tax credit (ITC). Solar equipment manufacturers have been awarded \$600 million in manufacturing tax credits under ARRA, representing investments in new and upgraded factories of more than \$2 billion.

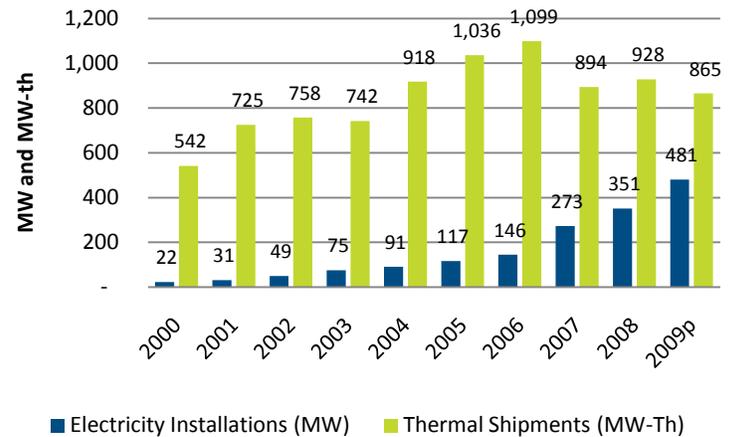
Federal Solar Policy

The significant solar policy changes in 2008 set the bar high but 2009 brought its own share of federal solar policy victories. After obtaining a long-term extension of the 30-percent investment tax credit in October of 2008, the economy put the brakes on the tax equity market.

U.S. Cumulative Solar Capacity Growth



Annual U.S. Solar Energy Capacity Growth



Iowa State and Team Alberta building their Solar Decathlon homes. (Credit: Stefano Paltera/U.S. Department of Energy Solar Decathlon)

¹ See “What’s a Watt?” box in page 12 for a description of units used in this report.

² Greentech Media <http://www.greentechmedia.com/articles/read/green-vc-total-second-best-year-ever/>

Fortunately, 2009 began with the passage of ARRA, in which Congress established the Treasury Grant Program that allows the commercial tax credit to be taken as a cash grant for a limited time and lifted the \$2,000 cap on the residential investment tax credit for solar thermal installations, for the first time allowing a full 30-percent ITC on solar water heating and other solar thermal technologies for the homeowner.

ARRA also eliminated the penalties for subsidized energy financing, encouraging state and local programs that subsidize solar installations without penalizing the customer, and it permitted Master Limited Partnerships to utilize the ITC for the first time, opening additional financing opportunities to the industry.

Among other provisions were a new tax credit for renewable energy manufacturing facilities and billions of dollars in additional funding for solar research and deployment financing.

Treasury Grant

The grant created by ARRA reduces the need for tax equity partners and significantly lowers the transaction costs for a solar project. As of early February 2010, 182 solar projects had received Treasury grants totaling \$81 million—representing more than \$271 million in solar energy investment. The 13 solar thermal and 169 solar electric projects receiving the grant are spread over 30 states and the electric systems total 46.5 MW. Unless Congress extends the program, it will end December 31, 2010.³

Manufacturing Investment Tax Credit

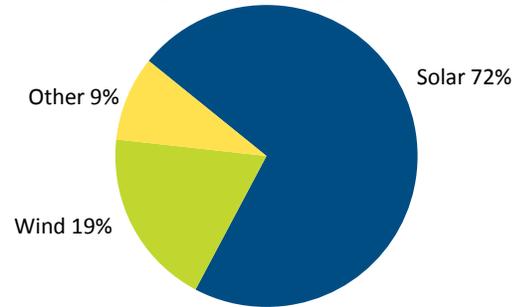
With the economy suffering record job losses, spurring domestic manufacturing was a primary concern for Congress and the Administration. The ARRA created a 30-percent manufacturing investment tax credit (MITC) for equipment that makes renewable energy components. The Department of Energy (DOE) announced the recipients of the \$2.3 billion in credits in January 2010. Of the 183 winning projects, 60 were factories supplying the solar energy industry, accounting for nearly a third of the selected projects and 46 percent of the awarded funds. These tax credits will create thousands of new domestic solar manufacturing jobs.

Department of Energy Funding

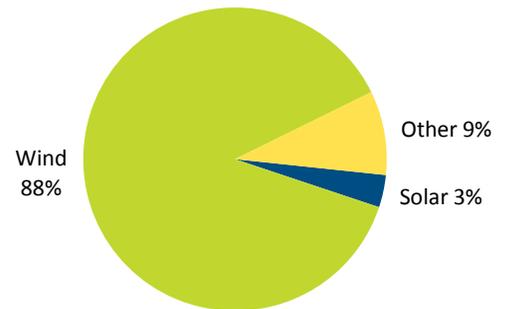
Of the \$16.8 billion in ARRA funds directed to DOE's Office of Energy Efficiency and Renewable Energy, \$115 million went to the Solar Energy Technologies Program, \$1.6 billion for Clean Renewable Energy Bonds (CREBs), \$2.7 billion went to fund Energy Efficiency and Conservation Block Grants and \$3.1 billion was provided for State Energy Program (SEP) grants.

The SEP grants in particular are helping support the deployment of solar

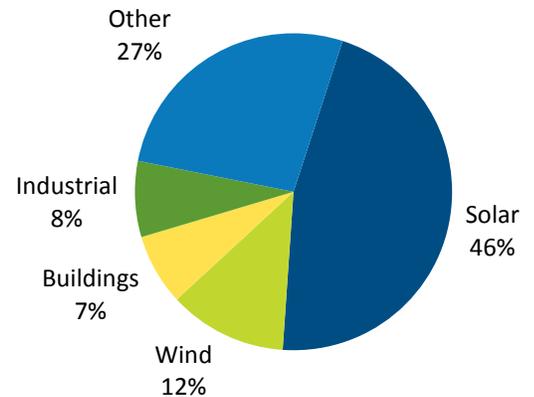
**Treasury Grant Awards
(by Number of Projects)**



**Treasury Grant Awards
(by Value)**



Manufacturing ITC Awards (by Value)



Worker inspects CSP receiver tubes at SCHOTT Solar in Albuquerque, NM. (SCHOTT Solar)

³ See SEIA's "Guide to Federal Tax Incentives for Solar Energy" for more details.

energy equipment around the country. Virginia, Maryland, Delaware, Massachusetts, New York, Pennsylvania, Vermont and Wyoming are using their SEP allotments to fund existing rebate programs and create new programs where none existed before. Other states are using the funds for competitive grants, large installations, manufacturing incentives, research centers, low-interest financing and worker training.

Solar Industry Driving Employment

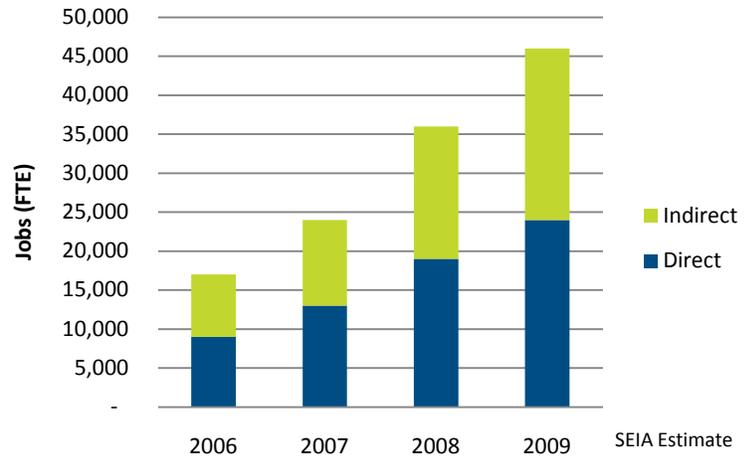
Answering ARRA's call, the solar energy industry is putting Americans back to work. While the recession has taken its toll on the solar industry, the many provisions of ARRA, the Emergency Economic Stabilization Act of 2008 (EESA) and the hard work of tens of thousands of solar workers have helped the industry maintain modest growth.

Some sectors were flat and others declined slightly, but overall employment in the solar industry increased by 10,000 people from 2008 to 2009. In addition, the growth in economic activity from the industry and its employees supported an additional 7,000 induced jobs for a total economic impact of 17,000 new jobs in 2009. In total, the solar industry and its supply chain now support roughly 46,000 jobs in the U.S. With growth expected to continue, that number is likely to surpass 60,000 by the end of 2010.⁴

Manufacturing on the Rise

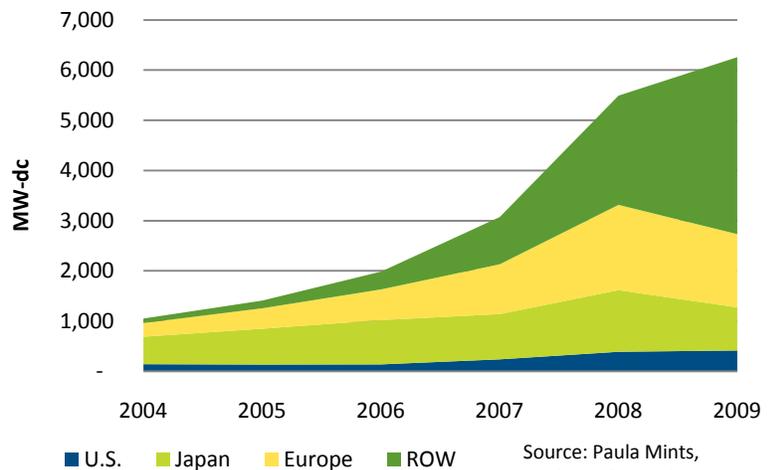
Though the U.S. has lost the lead in PV manufacturing that it held in the 1980's, both domestic capacity and production continue to grow steadily, keeping pace with domestic demand. The U.S. already has enough manufacturing capacity to meet all domestic demand for solar equipment and, with the MITC driving capacity expansion, will likely maintain self-sufficiency and robust two-way trade going forward. Many of the leading solar companies in the world are headquartered in the U.S., many have major existing manufacturing operations and many more have plans to set up new facilities in the states to meet growing demand. These companies supply all types of solar energy equipment for PV, CSP, SWH and SPH.

Estimated U.S. Solar Industry Employment



Worker installs solar shingles. (Dow Solar Solutions)

Global PV Module Supply



⁴ In addition to employing 46,000 directly and indirectly, the economic activity in the U.S. solar industry supports the employment of an additional 33,000 people (induced jobs) for a total economic impact of up to 79,000 jobs.

State Solar Policy

State policies continue to be some of the primary drivers for solar energy markets in the U.S. State net metering and interconnection rules define the market access for on-site distributed generation solar electric systems and even small incentive programs can draw attention to the solar industry.

In 2009, new incentives emerged in Pennsylvania, Virginia, Vermont and elsewhere, while some states used ARRA funds to bolster existing programs. The year also brought expansion of PACE financing and continued evolution of state renewable energy standard (RES) policies.

PACE Financing on the Rise

Property-assessed clean energy (PACE) financing began spreading across the country in 2009. Since the City of Berkeley became the first to adopt this financing mechanism, 16 states have enacted PACE-enabling legislation: California, Colorado, Illinois, Louisiana, Maryland, Nevada, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Texas, Vermont, Virginia and Wisconsin. These provisions will allow homeowners and business-owners to finance solar energy systems through municipal or other government-backed bonds via an assessment on their property taxes. This ensures the availability of credit, reduces the upfront cost and facilitates transfer of the system to new property owners in the event of a sale.

State RES Updates

Eleven states modified their RES solar requirements in 2009. Of the 30 states and District of Columbia that have an RES, 18 now have a solar or distributed generation (DG) carve-out and 5 provide extra credits for solar or DG. Nevada increased its carve-out from 5 to 6 percent. Missouri upped its overall standard to 15 percent with a 2-percent solar carve-out (0.3 percent of retail sales). Illinois added a 6-percent carve-out (1.5 percent of retail sales). Washington, D.C. doubled its overall goal to 20 percent and increased its solar carve-out to 0.4 percent of retail sales.

At least four states now include solar water heating as a qualifying RES energy source. While there has been little activity from this in the past few years, Arizona's law is starting to drive a more meaningful SWH industry, in part, by purchasing associated renewable energy credits (RECs) upfront, reducing the initial investment costs of SWH systems in that state.

Additional Information

For up-to-date information on state solar policies, see the [Database of State Incentives for Renewables & Efficiency Solar Portal](#).



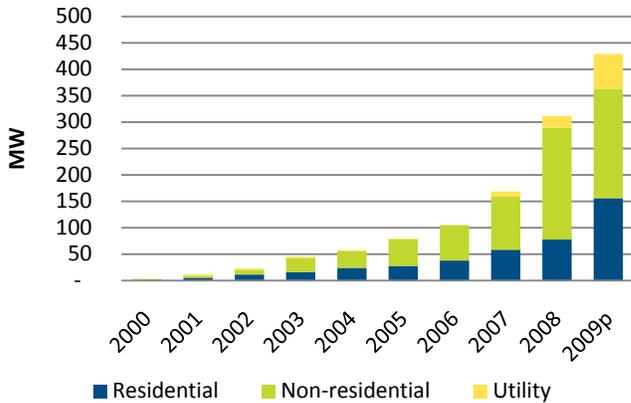
A 555-kW PV system on landfill in Canton, North Carolina. (Joanna Malcolm, FLS Energy; Suniva)

Top 10 States for New Grid-Tied Solar Electric Installations in 2009*

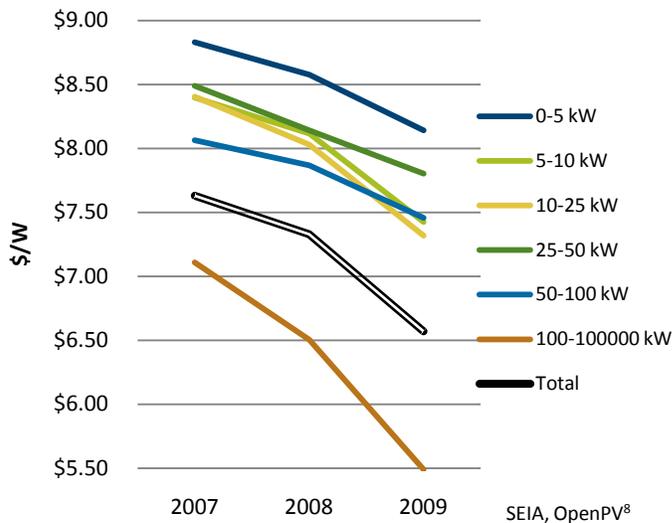
Capacity Installed in 2009			Cumulative Capacity in 2009		
1	Calif.	220	1	Calif.	1,102
2	N.J.	57	2	N.J.	128
3	Fla.	36	3	Nev.	100
4	Ariz.	23	4	Colo.	59
5	Colo.	23	5	Ariz.	50
6	Hawaii	14	6	Fla.	39
7	N.Y.	12	7	N.Y.	34
8	Mass.	10	8	Hawaii	27
9	Conn.	9	9	Conn.	20
10	N.C.	8	10	Mass.	18
	Others	29		Others	78
Total		441 MW	Total		1,653 MW

* Includes all grid-tied PV and CSP.

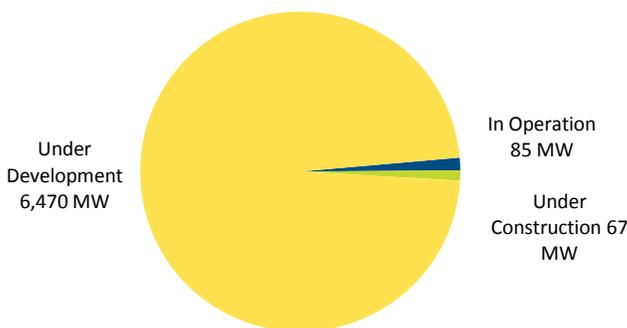
Grid-Tied PV Capacity Additions



Average PV Installed Cost



PV Project Pipeline



Photovoltaics

The PV industry managed to maintain growth in 2009 despite difficulties in the housing and construction sectors and cumulative grid-tied capacity sailed past the 1 gigawatt (1,000 MW) mark by installing 429 MW. An estimated 40 MW of off-grid capacity was also added. However, year-over-year growth in annual grid-tied capacity additions of 38 percent fell short of the 84 percent growth in 2008. Notable growth came in the utility sector⁵ which nearly tripled from 22 MW in 2008 to 66 MW in 2009. Residential installations were buoyed by the removal of the \$2,000 cap on the ITC, lifting volume 101 percent from 78 MW in 2008 to 156 MW in 2009.

Two utility-scale solar power projects became the largest and second largest installations in the U.S. The 25-MW_{ac} DeSoto Next Generation Solar Energy Center and the 21-MW_{ac} FSE Blythe bumped the 14-MW_{ac} Nellis Air Force Base installation into third place.

Price Declines

2009 marked a second year of major price declines for PV modules.⁶ Prices have fallen to \$1.85-\$2.25 per watt from \$3.50-\$4.00 per watt in mid-2008, a drop of over 40 percent.⁷ With module prices accounting for up to half of the installed cost of a PV system, these prices are beginning to put downward pressure on system prices. Average installed cost fell roughly 10 percent from 2008 to 2009.⁸ This is despite the large shift to the more labor-intensive (and expensive) residential installations. With new innovations in the installation process, increasing economies of scale and innovative equipment increasing energy yields, the cost reductions are expected to continue. PV is becoming an increasingly attractive and secure investment.

What to Expect in 2010

PV is getting ready to go big. Residential and commercial rooftop installations are expected to remain strong and the utility-scale PV is expected to grow significantly, with more than 6,000 MW in announced projects in the pipeline. With the Treasury Grant Program set to expire at the end of the year, many in the solar industry wish to meet the start-construction deadline of December 31, 2010. Most industry analysts expect another year of growth in the PV industry.

⁵ "Utility sector" refers to all capacity that feeds electricity directly into the distribution grid or the transmission grid, rather than primarily serving on-site use. It includes utility-scale solar power plants, utility-owned distributed systems, and non-utility owned distributed systems located on customer property that connect to the grid on the utility side of the meter.

⁶ "Modules" or "panels" are collections of PV cells. Modules are connected to form an array that makes up a PV system.

⁷ Paula Mints, Navigant Consulting, Inc.

⁸ Capacity-weighted average based on data from SEIA and OpenPV.nrel.gov downloaded 3/30/2010. For a more detailed analysis of PV system prices, see "[Tracking the Sun II: The Installed Cost of Photovoltaics](#)" in the U.S. from 1998-2008 from Lawrence Berkeley National Laboratory.

Concentrating Solar Power

New U.S. concentrating solar power (CSP) facilities have been added in three of the last four years following 15 years of inactivity. Three new CSP facilities came online in 2009, the 5-MW_{ac} Sierra SunTower from eSolar, the 2-MW_{ac} Holaniku trough from Sopogy, and the 5-MW_{ac} Kimberlina linear Fresnel system from AREVA Solar (formerly Austra). The Sierra SunTower is the first power tower operating in the U.S. in a decade and Holaniku is the first CSP facility to come online in Hawaii.

Siting Developments

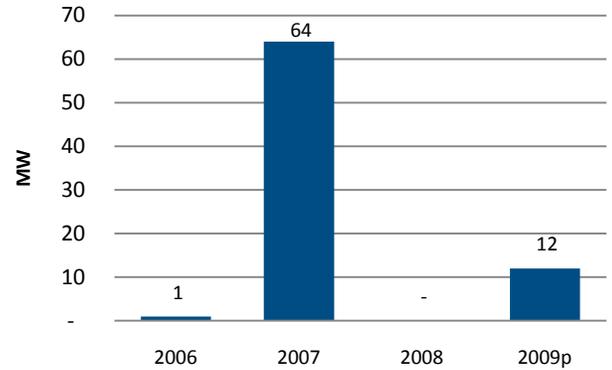
In 2009, Secretary of the Interior Ken Salazar announced two initiatives to speed the development of solar energy on public lands. First, four Renewable Energy Coordination Offices were established across the west (in California, Nevada, Wyoming and Arizona), along with renewable energy teams in five other offices. Second, the Bureau of Land Management (BLM) identified 14 solar energy projects that were in position to qualify for ARRA-related funding, if permitted, during 2010. BLM and the U.S. Fish & Wildlife Service have focused their resources on getting these “fast-track” projects through the permitting process so they can commence construction by December 31, 2010.

Pipeline

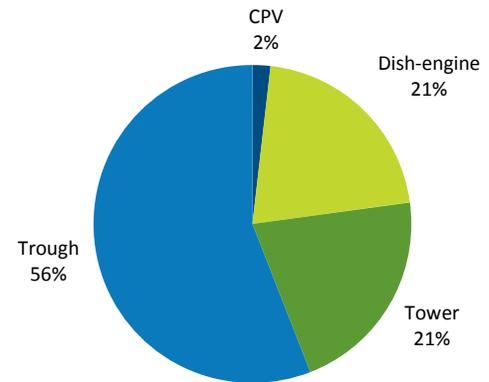
The U.S. now has 432 MW of operational CSP plants in commercial production (as of March 2010), making it the world leader in installed CSP, and more plants are on the way. Several projects are expected to come online before the end of the year, and many additional projects will begin construction before the end of December and meet the deadline to qualify for the 30-percent Treasury grant.

At least three additional CSP facilities are likely to come online in 2010: a 2-MW_{ac} Stirling dish installation in Phoenix, Ariz., a 4-MW_{th} trough plant displacing coal-fired generation in Grand Junction, Colo., and the 75-MW Martin Next Generation Solar Energy Center hybrid trough in Martin County, Fla.. With the completion of these three projects by the end of the year, the U.S. will maintain its healthy lead over Spain in CSP capacity, with more than 500 MW installed.

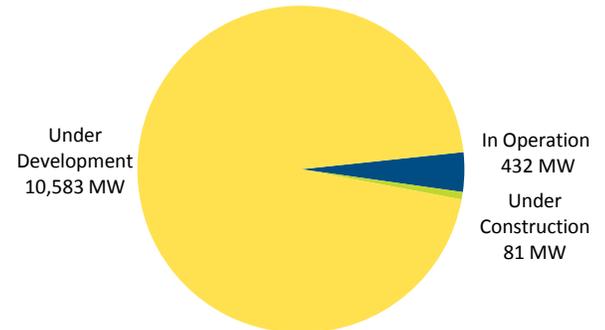
CSP Capacity Additions



CSP Project Pipeline by Technology



CSP Project Pipeline



Trough (Acciona North America)



Dish (Tessera Solar)



Tower (eSolar)

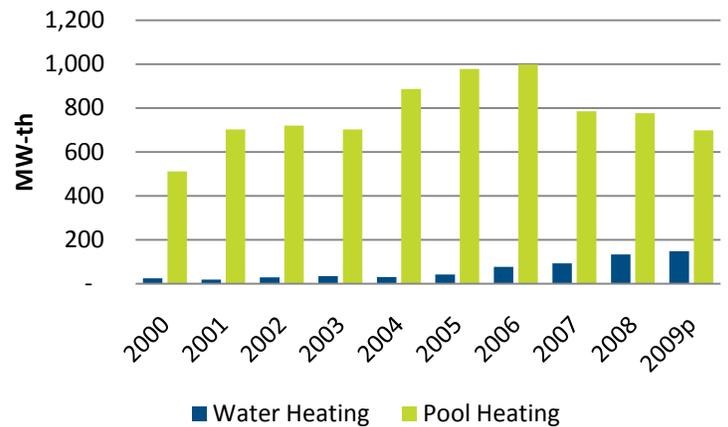
Solar Thermal

Solar heating and cooling technologies saw a mixed year in 2009. Solar water heater (SWH) shipments managed modest growth for the fifth consecutive year with the help of the expanded federal investment tax credit. Solar pool heating (SPH) experienced a third year of decline, mirroring struggles in the housing market. SEIA estimates SWH collector shipments grew 10 percent to 147 MW_{th} and SPH shipments sunk 10 percent to 699 MW_{th} for the year.⁹

SEIA expects continued growth in SWH in 2010. This year, California will launch the most ambitious state SWH incentive program with the goal of installing 200,000 SWH systems. In addition, increased use of SWH to generate renewable energy certificates (RECs) to meet state renewable energy standards could drive additional deployment in some states as we began to see in Arizona last year. This optimism is mirrored by the many new products seeking certification from the Solar Rating and Certification Corporation, the testing body charged with certifying equipment for eligibility to take the federal ITC.

While the real estate market continues to impact the solar pool heating sector, SEIA is working to help commercial pools take advantage of solar energy. Nearly 300,000 non-residential pools at hotels, schools, gyms and physical therapy centers in the U.S. need year-round heating. Heating these pools results in as much as 1 million metric tons of carbon-dioxide pollution each year. Current law prohibits these facilities from taking advantage of the federal ITC.

Solar Thermal Collector Shipments



Solar water heating system on home. (Caleffi Solar)

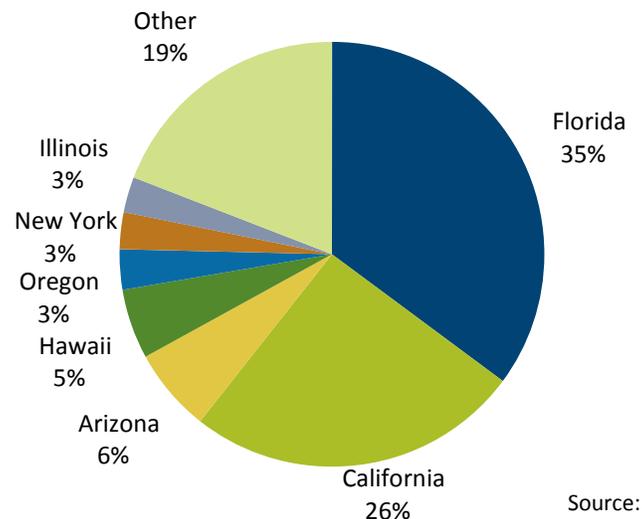
ENERGY STAR

Solar water heating equipment got a boost this year by becoming eligible to sport the ENERGY STAR label. As of publication of this report, there are already 279 ENERGY STAR-certified solar water heaters. Many solar water heaters will now benefit from the brand recognition and trust that many consumers associate with the program.

Solar Cooling

While solar cooling technologies have yet to take off in the U.S., the potential is enormous. More than 60 percent of energy consumed residential and commercial buildings is for thermal services. Of that, water heating accounts for about one quarter. The rest is used for space heating and cooling, a huge growth opportunity for solar energy over the next few years.

Destination of Solar Thermal Collector Shipments in 2008



Source: EIA

⁹ SEIA Estimates

Solar Policy in 2010

The American Recovery and Reinvestment Act aimed to stimulate the economy through creation of green jobs and, with the help of several key policies, the solar industry has delivered. The Treasury Grant Program, the Loan Guarantee Program and the Manufacturing Investment Tax Credit in particular have driven a sizable increase in solar employment. However, funds and timeframes for these programs were limited.

The TGP, which provides a grant in lieu of the investment tax credit (ITC) for projects that begin construction before the end of 2010 and come online before the end of 2016, was intended to help the solar industry finance projects at a time of limited tax equity. However, the program did not launch until July of 2009, shortening the effective length of the program by nearly half a year. What's more, the tax equity markets do not yet show the signs of recovery necessary for a smooth return to tax credit incentives. To help ensure a liquid solar market, SEIA is supporting the effort to extend the "commence construction" deadline for this program through 2012.

ARRA provided \$6 billion for the LGP, enabling capital investment of up to \$90 billion. However, \$2 billion of these funds were used by Congress to pay for an extension of the "Cash for Clunkers" new car rebate. SEIA is seeking restoration of these funds to support an additional \$30 billion in renewable energy deployment.

The MITC created by ARRA provided for only \$2.3 billion in credits. While solar energy equipment manufacturing received roughly a third of these credits, global demand for solar equipment will continue to rise and extending this credit will help ensure that U.S. manufacturing stays competitive with other countries offering generous incentives to attract new facilities. SEIA is pursuing the extension of this credit for solar manufacturing through 2016.



Workers install a solar cooling system on the Steinway & Sons piano factory in New York. (Steinway & Sons)

SEIA Webinars

SEIA now offers webinars on new topics on a regular basis. Previous topics have included:

- Equity Analysts' Perspective on the Solar Market
- Treasury Grant Program
- Loan Guarantee Program
- Manufacturing Tax Credit
- Tax Equity in the Current Market
- Calculating your Tax Basis
- Utility Scale Interconnection
- Update on the Treasury Grant and MITC Programs
- Section 1603 Grants and State Taxability
- Project Finance Series

These webinars are free to SEIA members and aim to keep solar companies up-to-date on the issues that affect their businesses.

View upcoming webinars at www.seia.org/cs/webinars

Solar Bill of Rights

In October 2009, SEIA launched its "Solar Bill of Rights" campaign. The Solar Bill of Rights is SEIA's grassroots advocacy effort to engage with all Americans, politicians, activists and celebrities to build support for eight rights designed to create a policy environment that allows solar to compete on a level playing field with fossil fuels. Nearly 2,000 people signed the Solar Bill of Rights during the first four months of the campaign.

Show your support at www.SolarBillOfRights.org, Facebook, Twitter or LinkedIn.

Solar at Copenhagen

SEIA, along with the European Photovoltaic Industry Association, lead the effort at United Nations Framework Convention on Climate Change (UNFCCC) to show all participants and observers that solar energy is ready to meet the climate challenge. SEIA brought together solar associations from around the globe to produce "[Seizing the Solar Solution: Combating Climate Change Through Accelerated Deployment](#)," a report that outlines solar energy's potential to reduce pollution that causes climate change in developed and developing nations alike.

Copenhagen marked the solar industry's first major presence in the 15-year history of these climate negotiations. As the world moves closer to a carbon-constrained economy, SEIA will continue make sure governments and business are prepared for the solar solution.

Find more information at www.solarcop15.org

International Solar Round-Up 2009

Germany

Germany continued its steady growth yet again, regaining its title as the largest PV market by installing 3,800 MW of new capacity in 2009. This represents a doubling of the 1,500 MW installed in 2008 and is attributable, in part, to the improved project economics resulting from the decline in module prices. This growth has caused the German government to pursue an additional mid-year cut in incentives in 2010 above and beyond what was already scheduled but the country is expected to remain the single largest market for PV in 2010. Germany continues to be one of the largest market for solar thermal installations.

Spain

After rocketing past Germany to become the largest PV market in 2008, a drastic reduction in incentives pushed Spain down to 180 MW in new PV and CSP capacity for 2009, compared to 2,710 MW in 2008. Not all news was bad; Spain added more new CSP capacity than any other country in 2009, leading both the U.S. and China by a wide margin with 120 MW added. Spain ranks second after the U.S. in total CSP capacity with 181 MW installed.

Italy

Installations in Italy more than doubled from 2008's 338 MW to roughly 700 MW in 2009, putting it in second place for new capacity for the year. The country's strong incentives and good solar resources should help the market stay strong in 2010.

Japan

After two stagnant years, Japan recovered to have its best year ever, installing 484 MW, edging out the U.S. for the third place for annual capacity additions. This resurgence was driven in part by the falling equipment costs and in part by new incentives (roughly US\$0.80 per watt) that went into effect in January 2009.

Czech Republic

The Czech Republic emerged as one of the top markets for PV last year with annual installations jumping to 411 MW. Though the country ranked fifth in installations, it installed more new PV per capita (roughly 40 watts per person) than any country except Germany in 2009. The massive growth—from just over 50 MW in 2008—was due do the country's generous US\$0.63 per kWh solar incentives. However, this rapid ramp-up in solar capacity has prompted a reduction in its feed-in tariff payments.

China and India

Both China and India made headlines in 2009 when they independently announced plans to expand their solar power capacities to 20,000 MW each by 2020. If these plans move forward, Asia will become a major demand center for solar energy equipment after several years of expanding manufacturing capacity.

Top Countries for New Solar Electric Installations in 2009

	Capacity Installed in 2009	Cumulative Capacity at End of 2009
Germany	3,800 MW	9,677 MW
Italy	700 MW	1,158 MW
Japan	484 MW	2,628 MW
United States	481 MW	2,108 MW
Czech Republic	411 MW	465 MW
Belgium	292 MW	362 MW
France	285 MW	465 MW
Spain	180 MW	3,595 MW
Total	~6,900 MW	~21,500 MW

Solar's Growing Role in the US Energy Mix

Though solar energy continues to account for less than 1 percent of the U.S. energy supply, its contribution is expected to rise dramatically in the coming years as costs continue to decline making it more competitive in more states. This natural evolution will help drive demand in places that have yet to see the development of significant markets. Other states will see even more growth as RES carve-out provisions begin to require more and more capacity. Lawrence Berkeley National Laboratory estimates that compliance with existing solar and distributed generation carve-outs will require roughly 9,000 MW of solar capacity by 2025. In the short term, these carve-outs will help provide a base level of installations and grow the industry to a size that supports strong economies of scale.

In addition to satisfying carve-out requirements, solar is showing increasing competitiveness against fossil fuels. When compared to the high cost of generation in places like Hawaii, where most electricity is generated with oil, or when compared to peaking generators, solar energy looks increasingly attractive.



A 650-kW system on eBay headquarters in San Jose, California. (SolarCity)

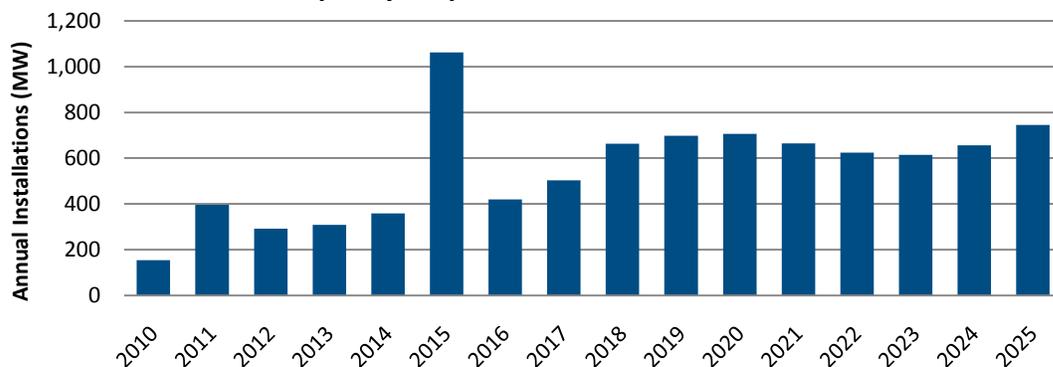
The rising cost of fossil fuels due to dwindling supplies and increased international demand ensure that the trend toward solar competitiveness continues. Any major movement at a regional, national or international level to regulate greenhouse gas emissions or to put a price on emissions will only accelerate this trend. This means that those looking to hedge against volatile and increasing energy prices will do well to turn to solar energy.

A Vision for the Future

Later this year, the U.S. Department of Energy is expected to release a report that explores the potential for solar energy to provide a significant share of the nation's electricity by 2030. The report will explore the costs and benefits of realizing this solar-powered future and paint a picture of how it would work.

This vision would require hundreds of thousands of new solar megawatts, many times more than the current global solar capacity. However, this industry has shown extraordinary ability to grow quickly to meet any demand.

New Solar Capacity Required to Meet State RPS Carve-Outs



Source: LBNL

About SEIA

Established in 1974, the Solar Energy Industries Association is the national trade association of solar energy industry. As the voice of the industry, SEIA works with its 1,000 members to make solar a mainstream and significant energy source by expanding markets, removing market barriers, strengthening the industry and educating the public on the benefits of solar energy.

Acknowledgements

Special thanks go to **Larry Sherwood** of the [Interstate Renewable Energy Council](#) for his hard work in gathering and assembling the PV data provided in this report.

SEIA would also like to thank the following people and organizations for their generous support in reviewing and providing data for this report.

- [European Photovoltaic Industry Association](#)
- [Bundesverband Solarwirtschaft](#)
- [European Solar Thermal Electricity Association](#)
- [European Solar Thermal Industry Federation](#)
- [Japanese Photovoltaic Energy Association](#)
- Paula Mints, [Navigant Consulting, Inc.](#)
- [The Solar Alliance](#)
- [The Vote Solar Initiative](#)
- Galen Barbose, [Lawrence Berkeley National Lab](#)

Contact Us

For more information or questions about this report, email research@seia.org.

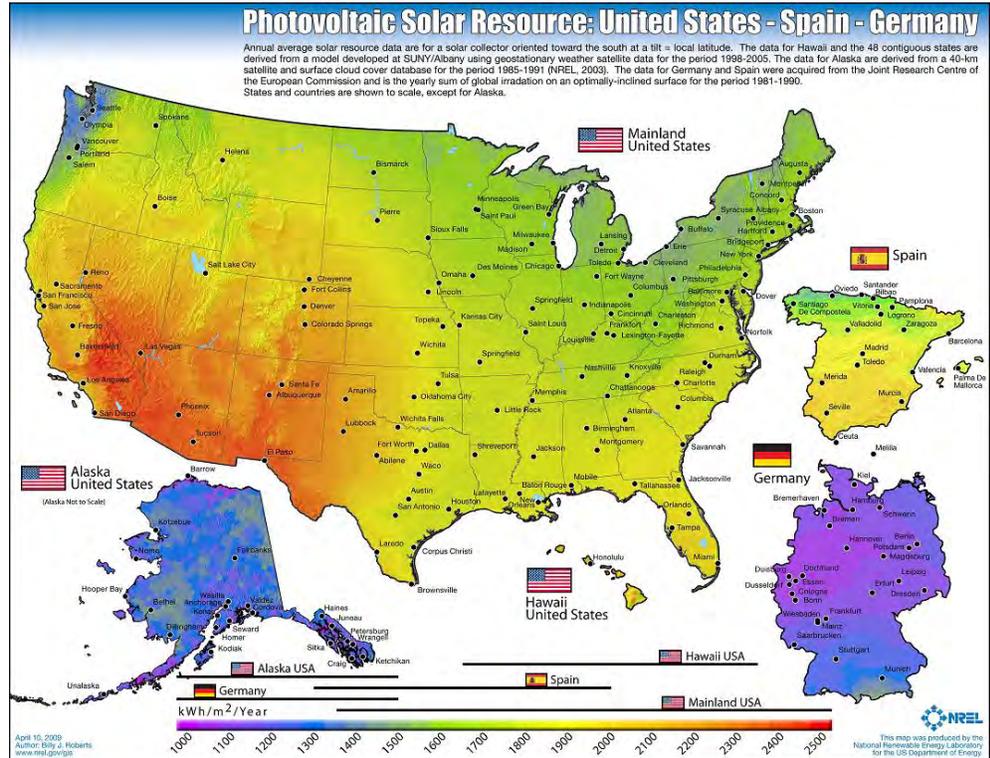
For press inquiries, contact SEIA's communications team, Monique Hanis and Jared Blanton.

For a PDF of this report with clickable hyperlinks and additional charts, please visit SEIA's web site at www.seia.org.

Note on data: Unless otherwise noted, PV data in this report is from Larry Sherwood and SEIA. Thermal shipments for 2008 and earlier are from the [Energy Information Administration](#) and the [International Energy Agency](#). Thermal shipments for 2009 are SEIA estimates. CSP data are from SEIA. Data is best available and may differ from earlier reports.

Photovoltaic Solar Resource: United States - Spain - Germany

Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2003). The data for Germany and Spain were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1990. States and countries are shown to scale, except for Alaska.



What's a Watt?

Watt (W): A watt is a unit of *power* (like horsepower used to measure engines) that measures the rate of flow of energy. Solar equipment is often measured in peak watts or maximum power output rating. 1 W = 1 joule/second. (A joule is a unit of energy equal to 0.24 calories.)

Kilowatt (kW): 1 kW = 1,000 W or 1.34 horsepower.

Megawatt (MW): 1 MW = 1,000 kW = 1,000,000 W.

Depending on location and configuration, 1 MW of solar power capacity can provide 1,300 to 2,500 MWh (1.3 to 2.5 million kWh) of electricity per year, enough to supply 120 to 220 average American homes.

Gigawatt (GW): 1 GW = 1,000 MW = 1 million kW = 1 billion W

Kilowatt-hour (kWh): A kilowatt-hour is a unit of *energy* necessary to provide 1 kW of *power* for 1 hour. 1 kWh can light a 100-W light bulb for 10 hours. The average American household uses 936 kWh of electricity per month.

(EIA, <http://www.eia.doe.gov/cneaf/electricity/esr/table5.html>)

Watt-thermal (W_{th}): Solar thermal systems (water heating, pool heating, etc.) do not provide *power* but instead provide thermal *energy* or heat. However, to roughly compare solar thermal capacity to solar electric capacity, thermal capacity is reported in watts-thermal by treating one square meter of collector area as equivalent to 700 watts of solar electric capacity.