



EcoMotion – Sustainability Solutions

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The State of Solar on Campus: 2014 Edition

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1. The Global Solar Revolution

The rise of solar power – specifically photovoltaics – is nothing short of remarkable. It is a bonanza, a revolution in the best sense of the word. What a decade of progress.

The Emergence of a Technology and Industry

Solar energy has been around for a long time. Every hour, enough sunshine falls on Earth to power our society for an entire year. But sunlight is gentle, it is spread across the planet, and hard to capture. It has been used for heating buildings and water for a long time.

Developed in the Bell Laboratories in Murray Hill, New Jersey in 1954, photovoltaics or PVs are just turning 60 years old. For some time a nascent technology, PVs are reaching maturity, growing at a fabulous clip.

More and more homes are going solar, so are businesses and government facilities. Elementary schools are going solar, so are middle and high schools. Thanks to advances in technology, policy, and financing, the growth of solar is robust and gaining momentum.

This report focuses on higher education. Campuses are hot-beds of solar action, evidenced by the AASHE Solar Database.¹ This report documents 541 solar systems on university and college campuses, and there are no doubt more. The university/college market sector is one of the fastest growing for solar, with deals driven not only by economics, but long-term values. These institutions embody sustainable practices. Universities and colleges know that they are leaders in their communities and have a major responsibility to their students and society.

The Global Solar Marketplace

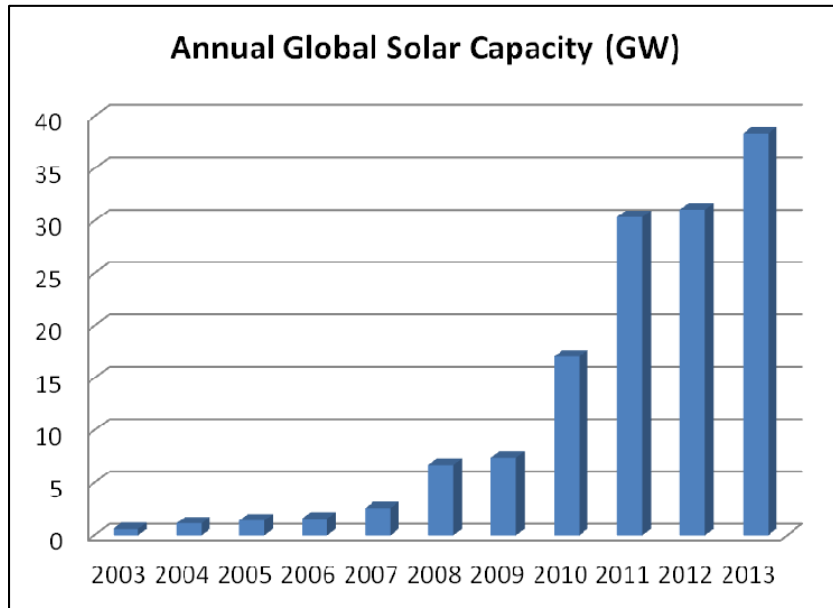
The growth of photovoltaics has been steep. In 2000, there were only 1.5 gigawatts (GW) of PV capacity worldwide. Thirteen years later and by the end of 2013, the global capacity of solar electric systems was 139 GW.² That's the peak output of 139 nuclear reactors.

In 2013, global solar capacity increased by 38.9 GW, eclipsing the record-setting levels in 2012 and 2012. For the first time, Asia topped Europe and became the predominant region for solar

¹ AASHE, the Association for the Advancement of Sustainability in Higher Education, has developed a database of solar installations in member institutions. Sponsored by EcoMotion, the database provides rich information on solar systems across the country and in Canada.

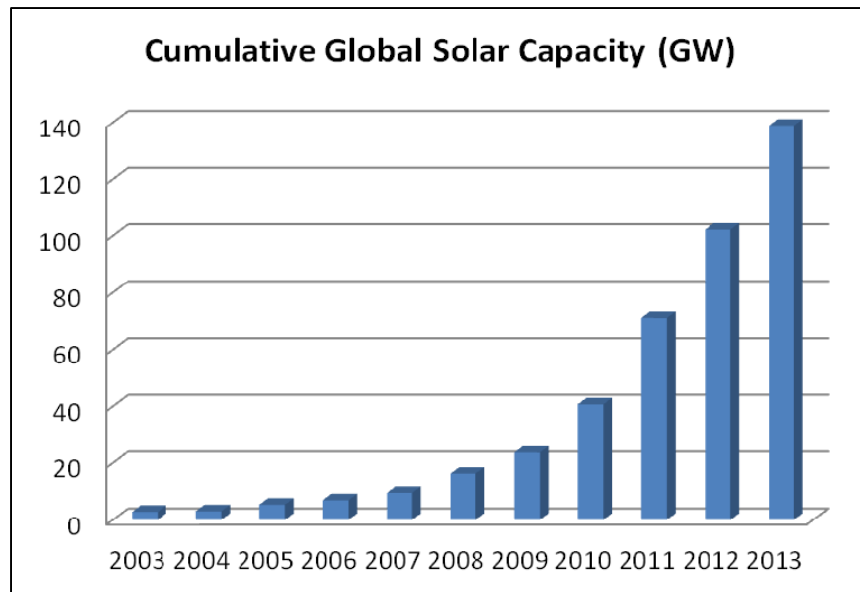
² The European Photovoltaics Industry Association Global Market Outlook for PV 2013 – 2017. Brussels, Belgium.

installations with 55% of capacity additions. That said, in 2013 and for the first time, five forms of renewables were the top new forms of generating capacity in Europe!



And the future is bright. While there have been terrific advances, solar power represents less than 1% of generating capacity.³ There’s lots of “headroom” for continued growth, huge opportunities to be tapped in the coming decades, and perhaps all century. While discussed later on a national scale in detail the main drivers for global uptake of solar are the reduced cost of solar equipment, government policies, incentives and tax credits/benefits, and environmental/climate concerns.

³ Germany, naturally, has a higher percentage contribution than the global average with solar providing 2.6% of all electricity generated, and 5.2% of peak demand.



The bar charts above shows the dramatic annual and cumulative uptake of solar installations in the last 10 years, particularly the past five years. Even during the recent economic recession coupled with a slowdown in construction worldwide, solar installations still maintained a positive increase albeit reduced.⁴

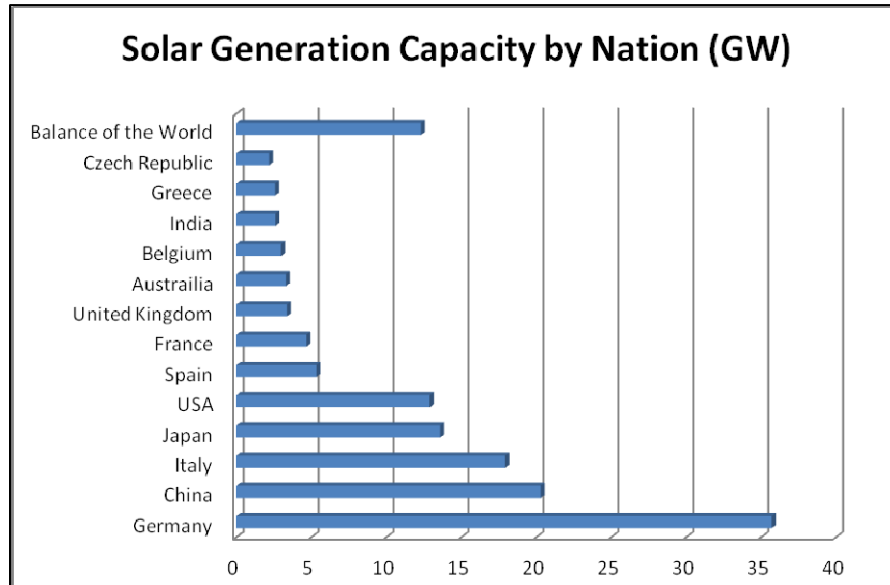
Solar Capacity by Nation

In terms of capacity by country, Germany appears to have lost its stronghold on annual capacity additions. In 2013, China was the leading installer of solar capacity (11.8 GW), followed by Japan (6.9 GW), and the United States (4.8 GW).

In terms of cumulative capacity, however, Germany leads the pack. Its cumulative capacity is double that of the next country, Italy. There are now over a million solar systems in Germany.⁵ Spain had a boon during its Feed-in Tariff program 2008 – 2009, then a bust when incentives were cut.

⁴ European Photovoltaic Industry Association publication, "Global Market Outlook 2013-2017."

⁵ Stephen Lacey, for GRIST, part of the Guardian Environmental Network, September 12, 2011.

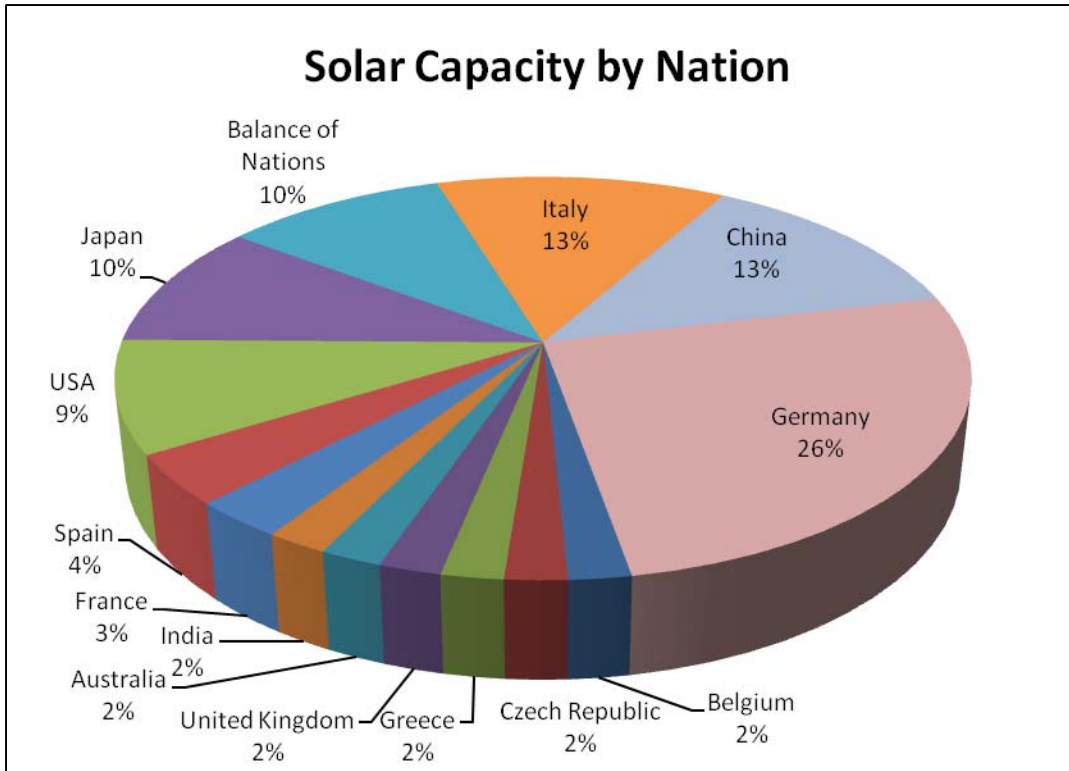


Drivers in Solar Development

Policy developments, notably attractive incentives, have dictated the global flow of poly- and mono-crystalline solar panels. Drawn by incentives, the solar market has shifted from country to country. The rise and fall of Feed in Tariffs (FiTs) in the European Union and Asia have driven the growth in the installations and the manufacturing capacity of the market, shifting from Germany to Spain to South Korea and Italy.

Now Japan is poised to be the largest solar market – by revenues – in 2013, soaring past #2 China (which will likely still retain the #1 installed capacity distinction), and #3 Germany despite 1 Euro/kW solar pricing. Thanks to its incentives, Japan’s solar capacity surged 270% in the first quarter of 2013 while European installations dropped by 34% in this same time period.

Fukushima has a lot to do with it. Following the earthquake and tsunami that resulted in nuclear disaster in March of 2011, Japan took steps to introduce incentives that reward renewables. The June 2012, FiT incentives were introduced with solar awarded at 53 cents/kWh. The pie chart below shows the national percentages of solar installed capacity at the end of 2012.



The global market for solar remains strong. There is ample availability of quality panels at record-low prices. There are sufficient incentives and third-party financing. Shortages in past years were caused by robust incentive programs in one country taking away and over the supply chain for other countries and driving cost up through shortages. This was exacerbated by shortages of poly-silicon, a production issue now resolved thanks to increased capacity.

Campus Solar Case Study # 1

Oberlin College: "On the Cutting Edge"

Location: Oberlin, Ohio

Enrollment: 2,900

Solar Capacity: 2.43 MW

Oberlin is known for its firsts: It was the first college in America to accept women and blacks.

Oberlin has a 2.27 megawatt solar array, the largest photovoltaic array on any college or university campus in Ohio. Through a power purchase agreement, the college entered into an

agreement with Spearpoint Energy to purchase electricity from the array which began producing in September 2012.

The array provides research opportunities for students and faculty. Additional PV currently in operation on campus include a 59 kW system on the roof of the Adam Joseph Lewis Center for Environmental Studies and the 101 kW array in the adjacent parking pavilion.

2. Solar in America

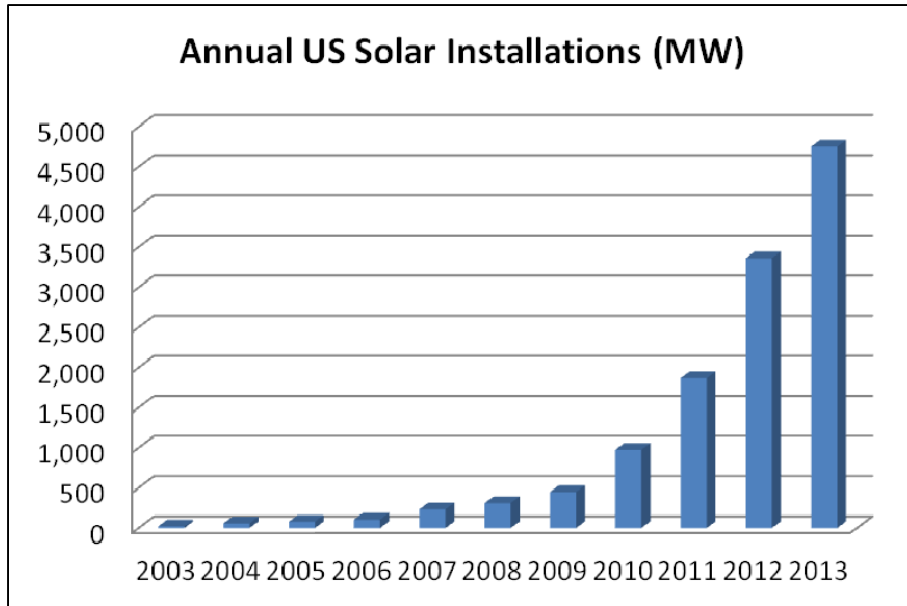
The U.S. solar market is robust. It continues to grow taking advantage of greater solar awareness and demand, increased renewable portfolio standards promoted by state legislatures and their regulators, and lower installed prices.

Chinese panel prices coupled with tax incentives and renewable standards are supporting a booming industry. Household purchased systems – more dependent on local utility incentives -- are down. Leasing is the only viable option for many homeowners, especially in California where residential solar incentives are now minimal.

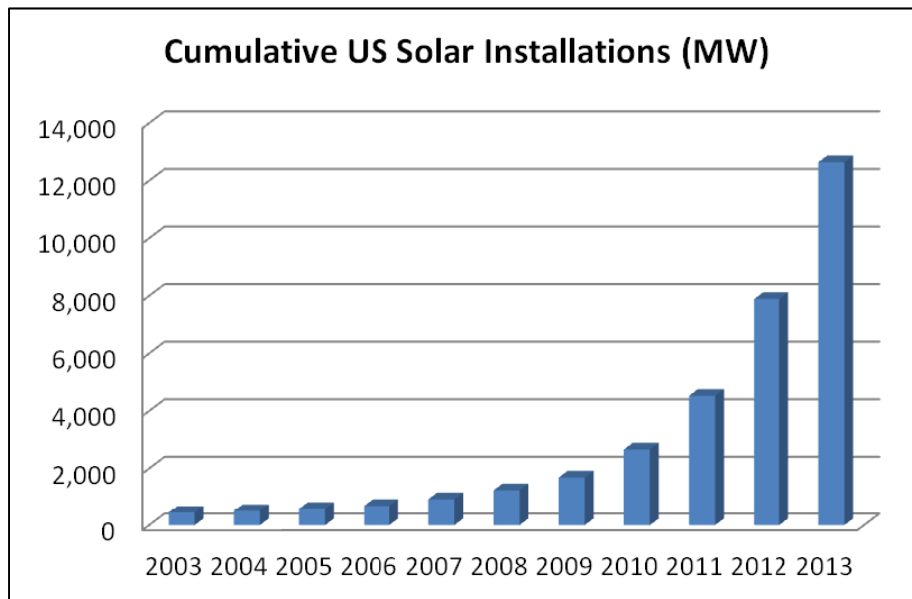
Solar Capacity on the Rise

According to "U.S. Solar Market Insight: 2nd Quarter 2012" prepared by the Solar Energy Industries Association (SEIA), U.S. solar achieved its second-best quarter in history, having installed 742 megawatts of solar power. The total 2012 capacity addition was the nation's largest, with 3.3 GW installed. Solar has become an \$11.5 billion industry at the national level.⁶

⁶ Solar Energy Industries Association: [Q2 2013 SMI Fact Sheet](http://www.seia.org/research-resources/solar-industry-data), <http://www.seia.org/research-resources/solar-industry-data>



In total, the U.S. now has 12.9 MW of cumulative installed solar capacity.⁷ The solar-power business is expanding quickly in the United States. The U.S. is on pace to install as much solar power this year as it did in this century's entire first decade. And it's happening on homes, businesses, chain stores, and of course in higher education.



The breadth of the industry is pronounced, from local ordinances for solar, to corporate actions. In Lancaster, California an ordinance will require that all new homes built after January

⁷ Solar Energy Industries Association, "Solar Market Insight Report 2013 Year in Review"
<http://www.seia.org/research-resources/solar-market-insight-report-2013-year-review>

2014 are fitted with solar systems. “The global warming crisis will be solved by neighborhoods, not nations,” said Mayor R. Rex Parris. Lancaster’s ordinance is flexible. Builders can aggregate solar systems on car ports or other open areas. They can also buy credits from other solar systems as long as they are within the city limits.

Concurrently, big corporate names and investors are going solar. Household names like Google and Warren Buffet are investing in solar.⁸ Solar energy is being deployed on a massive scale by the most iconic brands and best-managed companies in the U.S. in order to help lower operating costs and increase profits. The Top 10 in terms of on-site solar capacity are Walmart, Costco, Kohl’s Department Stores, IKEA, Macy’s, McGraw-Hill, Johnson & Johnson, Staples, Campbell’s Soup, and Walgreens.

Wal-Mart reports about 200 energy projects in operation, with more than 100 solar installations in California. Its goal is to become completely powered by renewable energy. Wal-Mart expects to have as much as 90 megawatts of capacity by the end of this year.

Market Forces

Declining Panel Prices: The global and national markets are being propelled by lower panel prices. Remarkably, PV prices have dropped 95% since 1980, from \$33.69/watt to about a dollar a watt today!⁹ Wholesale prices of solar modules are 25% or less than they were 4 years ago.¹⁰

The solar industry’s pain has been the solar consumer’s gain. Unlike electronic gadgets like cell phones and flat-screen TVs which have prices drop with mass production, the decline in solar module prices have been driven by “brutal” competition, notably the influence of China’s policies, the current top producer of solar modules. German and Japanese producers were forced to lower prices and in many cases join forces with Chinese firms in order to compete. Many well-known brand names have closed shop or moved to China to remain viable.¹¹

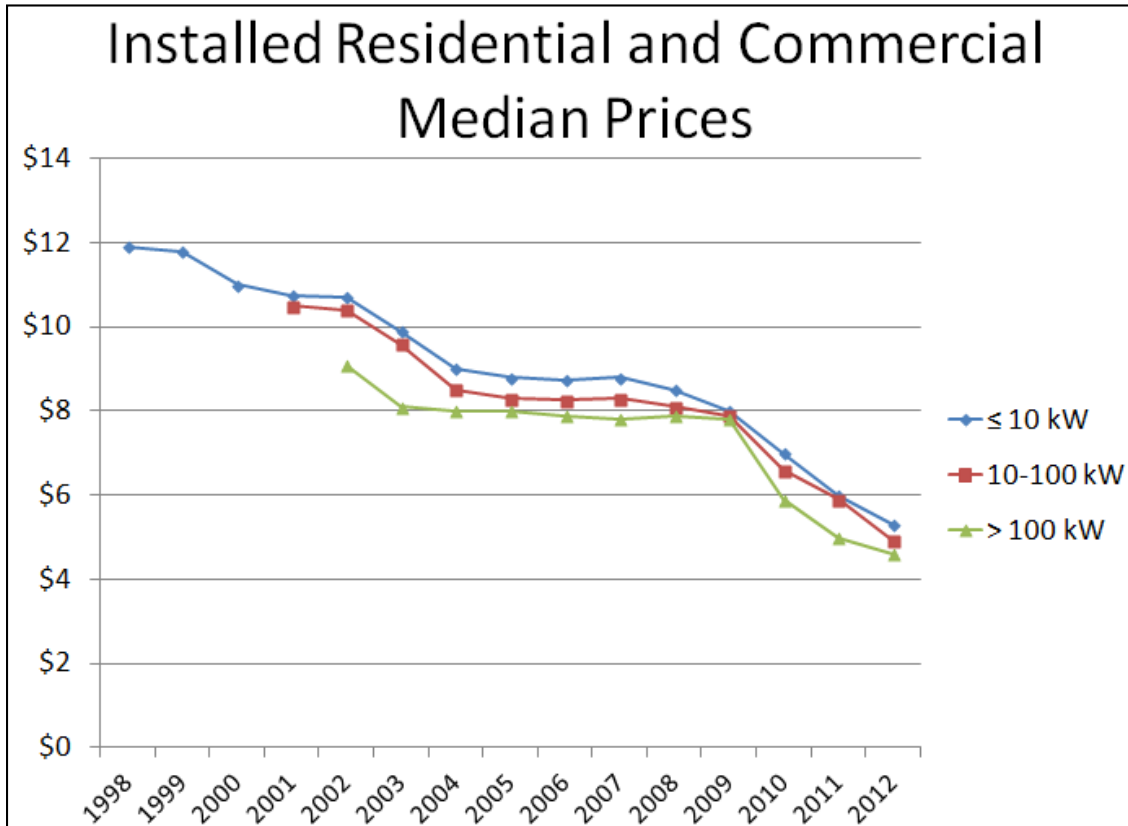
⁸ MidAmerican Energy Holdings Company has announced the purchase of two adjacent solar farms in the Antelope Valley developed by SunPower with a combined capacity of 579 MW. MidAmerican is controlled by Warren Buffet’s Berkshire Hathaway. MidAmerican already owns the 550 MW Topaz Solar Farm built by First Solar in San Luis County, California, and has a 49% share of a 290 MW solar plant in Yuma, Arizona.

⁹ Presentation by California Energy Commission Commissioner David Hochschild, Palm Springs, October 2013.

¹⁰ Scientific American, “Smaller, cheaper, faster: Does Moore’s law apply to solar cells?,” <http://blogs.scientificamerican.com/guest-blog/2011/03/16/smaller-cheaper-faster-does-moores-law-apply-to-solar-cells/>

¹¹ Solar development in China has been supported by the Chinese Development Bank with zero-interest loans.

The resulting advantage to solar developers (and solar integrators that install systems) was the plummeting cost of equipment. With panels -- the largest cost component of a PV system -- falling so sharply in price, the total installed cost fell too and for installations of all sizes. Research at the Lawrence Berkeley National Laboratory -- presented in the graph below -- shows how the decline in prices accelerated in 2009. This resulted in a new low cost in 2012 at almost a third of the cost 14 years earlier in 1998. People who think solar costs too much are using outdated information.

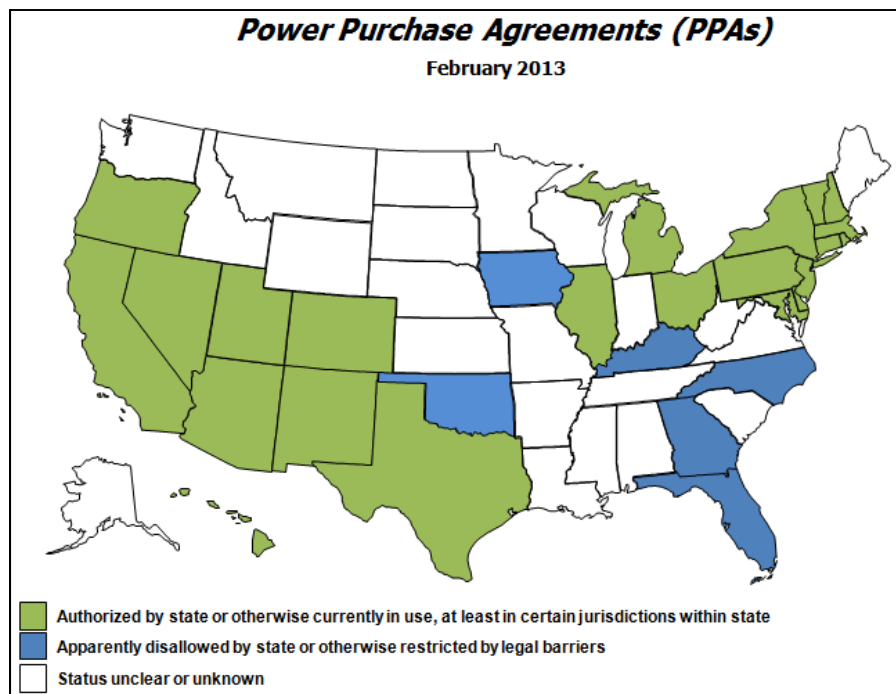


Private-Sector Collaborations: Many solar deals in America are driven by the private sector, eager to finance systems. For customers like non-profits and academic institutions without a “tax appetite,” or who cannot claim tax credits, third-party financiers that can monetize credits and benefits are essential to making solar deals viable.

Traditional solar deals are done with two parties, a host site and a utility partner. The host invests, nets out utility incentives, and then net energy meters the system’s output with the utility. In solar, a “third party” finances the system (taking all tax credits and depreciation benefits), continues to own and operate the system, selling its output to the host through a Power Purchase Agreement (PPA), or equipment lease.

Third party arrangements dominate the commercial, non-profit, municipal, institutional, campus, and even residential markets. The combination of the federal tax credit, federal and state depreciation benefits, and various utility incentives allow the net cost of systems to be as low as 10 to 20% of gross cost. This balance is then net metered or recouped using a FIT incentive mechanism.

For many solar customers, having a third party put up the capital, take all the risk, and maintain the system is a compelling solution. Government entities, institutions, campuses, and non-profits with no tax appetite often find the third party option is the only one that allows them to move forward with solar power. And they absolve all responsibility for maintenance, secured with a performance guarantee from the owner. But as the map below makes clear, PPAs are not allowed in every state.¹²



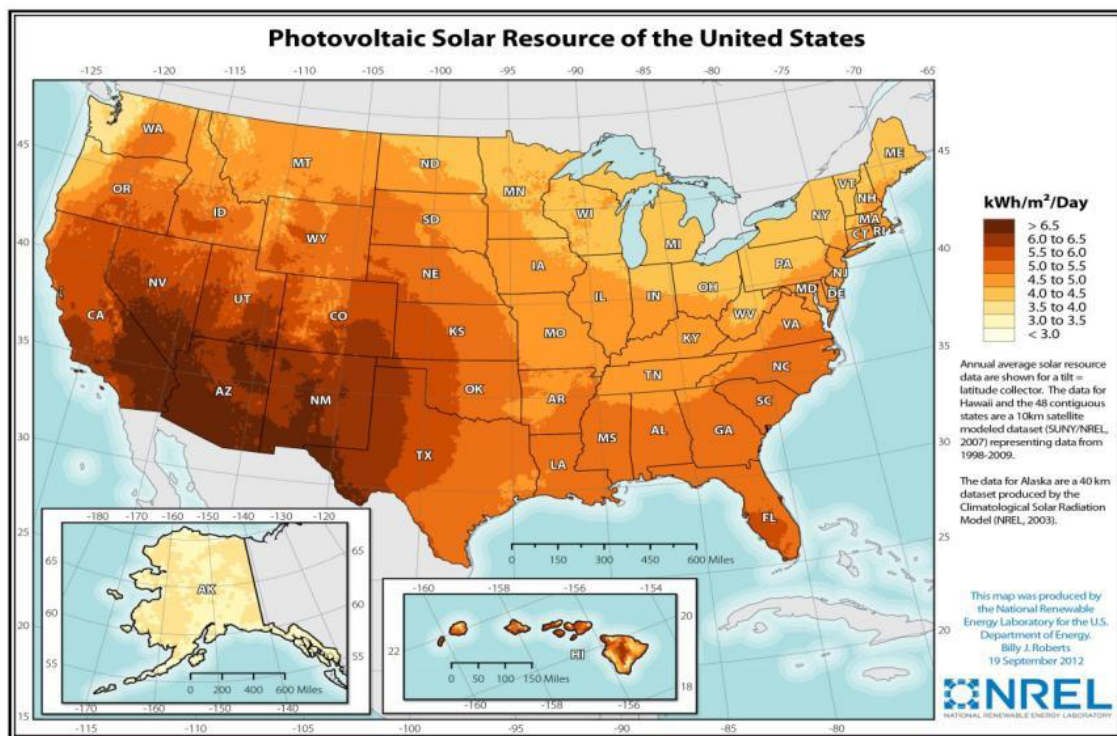
¹² DSIRE, the Database of State Incentives for Renewables and Efficiency, operated by the North Carolina Solar Center and supported by the U.S. Department of Energy and the Interstate Renewable Energy Council. http://www.dsireusa.org/documents/summarymaps/3rd_Party_PPA_map.pdf

Financing and the Solar Equation

Solar deals in America are a function of gross installed costs, and then benefits in the form of: a) tax credits, b) depreciation benefits, c) utility incentives, and d) net energy metering or feed-in tariffs. These buy down and pay off the system to result in a pay-back and return on investment over the life of the system.

Before we get too deep, let's begin with where the sun shines!

Solar Insolation: It's no accident that sun-rich states like California and Arizona are the nation's leaders in solar development. As the map below prepared by the National Renewable Energy Laboratory (NREL) demonstrates, the total "sun hours" can be twice as much in the southern states as in the northern states.¹³ Thus there is considerable construction of utility-scale solar generation being developed in the southwest.



Tax credits and tax benefits: One of the biggest boons to solar in the U.S. is the federal tax credit. For most installations, and for those with a "tax appetite," 30% of the net system cost (after utility incentives) is returned in the form of a tax credit. For both residential and

¹³ National Renewable Energy Laboratory, U.S. Department of Energy, Golden, Colorado.

commercial installations, the ITC (Investment Tax Credit) is in place through 2016, after which it is scheduled to drop to 10%. There is no upward limit on the tax credit, so it applies to 2 kW residential roof-top systems as well as 100 megawatt solar farms.

Solar systems also benefit from accelerated depreciation schedules. Systems can be depreciated in five years, providing another value equivalent to about 35% of total system cost. For those that can monetize the tax credits and depreciation benefits, more than 60% of the total cost is recovered.

Utility Incentives: Utility incentives vary dramatically in price, from 5 – 10% of the total cost, to 50% and higher. There are a variety of means for utilities to promote solar. While many argue about the relative merits of feed-in tariffs versus rebates and SRECs, all agree that any model works as long as the incentive is sufficient.

California's Solar Initiative took the place of the Million Solar Roofs campaign. The CSI's goal is to provide 3 GW of solar, or "distributed generation," throughout California. Thus far, the state's investor-owned utilities have installed 1.6 GW with another 0.3 GW in the queue. Solar installations are still on the rise despite near-exhausted incentives.

Like German feed-in tariffs, the CSI has had a "degressive" or declining incentive structure. Ten blocks of capacity were identified, each with incentives for that amount of capacity. Over time, the incentives fell, both for residential and non-residential systems. The CSI, and similar incentive-based programs, provides different incentives, some estimated payments per unit of capacity and some performance-based payments for actual solar production for larger systems. Fortunately panel prices have dropped as fast as the declining incentives.

Campus Solar Case Study # 2

Butte College: "Grid Positive and Green Mapping"

Location: Oroville, California

Enrollment: 14,234

Solar Capacity: 4.55 MW

Butte College is in rural northern California, essentially a self-contained city with its own water system, sewage treatment, etc. It recycles 76% of its wastes. The college is "grid-positive," generating more energy than it consumes thanks to the 25,000 solar panels that adorn campus rooftops, parking lots, and a hillside.

There's a Sustainability Resource Center on campus. Solar integration in the curriculum has come through the Butte College "Green Map" developed by students with support from the Student Success Department, available to the public via the college website. It is a free, online, interactive resource designed to highlight sustainable businesses, social services, art and cultural opportunities, and all environmental resources available to the college community.

SRECs as Incentives: How did New Jersey catapult itself into the ranks of the top solar states? Incentives. New Jersey was the first state to roll out an enticing SREC program. Initially, state utilities were paying over \$0.60 per kWh to purchase SCRECs from homeowners, businesses, and developers who installed solar power. Even though that market has leveled at a much lower rate now, the success of the program was phenomenal. In terms of installed capacity, New Jersey rivaled California, which has had significant utility solar incentives in place since 2007.

Solar Renewable Energy Credits (SRECs) form the basis for incentives in states like New Jersey. The concept is for the regulated utilities to create a carbon market through the sale and purchase of SRECs. Instead of getting paid an incentive (\$/watt or cents/kWh), homeowners, businesses, and campuses are paid for their solar RECs by their utilities. For every megawatt-hour of production, an SREC value is paid. Massachusetts, Maryland, Washington DC, Ohio, Delaware and Pennsylvania also have SREC programs. Connecticut has a similar program called ZRECs.

The Garden State – New Jersey – became the third state to break the threshold of 1,000 megawatts) of solar capacity, joining California and Arizona in the "Gigawatt Club." Despite relatively low insolation levels, and due to policy and the use of SRECs, there are over 20,000 separate solar projects in New Jersey, including over 15,000 residential, 3,000 commercial, 300 school, and 200 government installations spanning across rooftops, carports, landfills, and brownfields.¹⁴

Net Energy Metering: Another key ingredient for successful solar deals is net metering. Net metering assures full retail value for the solar energy generated whether is it immediately used on site, or sent back to the grid for a credit.

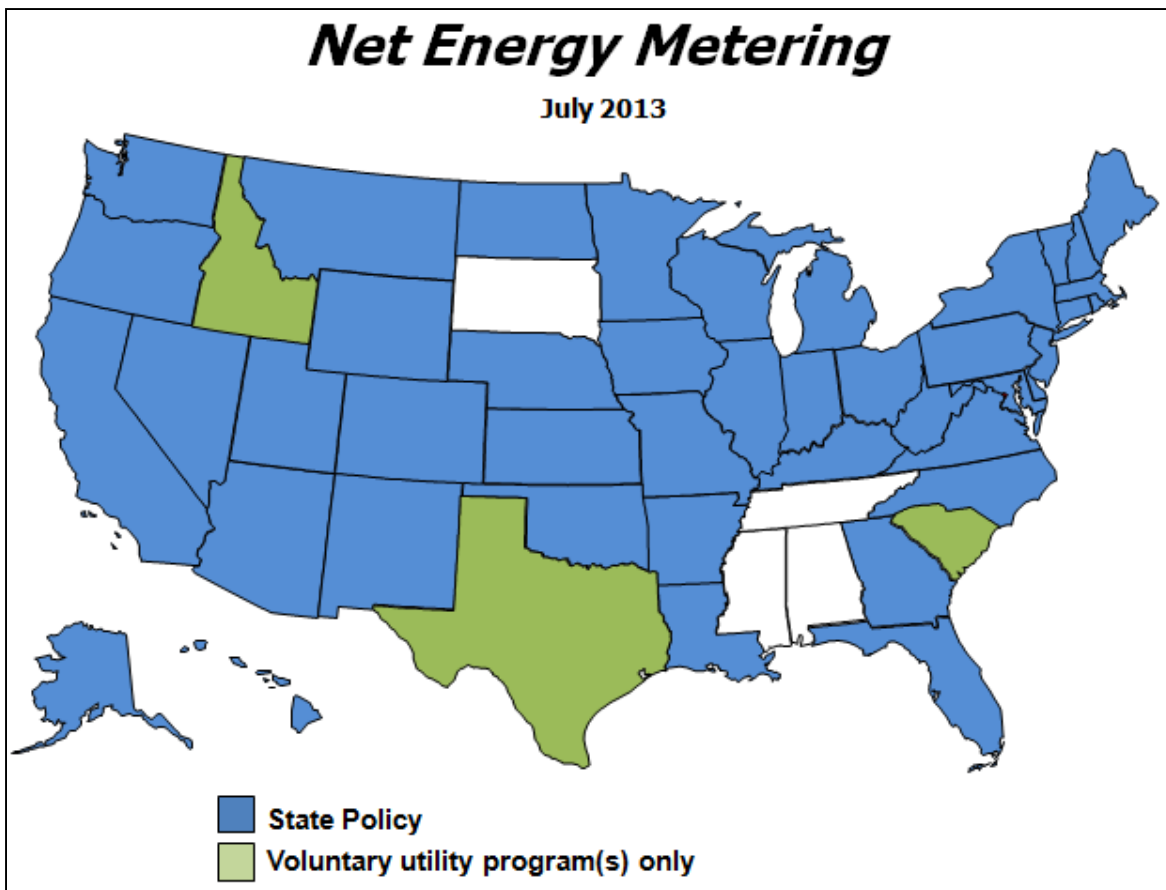
Note that utilities across the country are now mounting a challenge to NEM, asking for distribution charges and other fees to compensate the grid for its back-up and diurnal

¹⁴ Kristopher Settle, Energy Biz newsletter, June 11, 2013

relationship, where every day there is a cycle of credit and debit for many solar systems. (Customers with steady demand for power during PV generating periods are exempt from concerns of such rule changes.)

While the cost of solar installation may be relatively similar in different regions of the country, utility rates vary wildly and have a lot to do with the value of the solar energy produced. Utility rates that have high rates are going to have solar investment pay back sooner than regions with low utility rates. Generally, the highest rates in America are on the coasts.

Not every state allows net energy metering (NEM). The DSIRE tool provided by North Carolina State University tracks NEM states as well as a catalogue of most federal, state, and local solar incentives.¹⁵



Feed-in Tariffs: Feed-in Tariffs are perhaps the most elegant mechanism for incentivizing solar. Fixed prices are established for solar fed into the grid by independent producers. This separate

¹⁵ <http://www.dsireusa.org>

transaction approach has provided significant income for homeowners and business owners, popular among farmers who in instances can make more harvesting photons than crops.

Feed-in tariff recipients get a fixed price, for instance 45 cents per kilowatt-hour for 20 years. This makes it easy for investors to see their returns without assumed escalation rates and their like. This simplicity, coupled with attractive prices, has propelled the marketplace. But note that not all feed-in tariffs are good. Those with insufficient incentives, are as ineffectual as insufficient rebate levels.

4. Campus Solar Leadership

Spurred by the environmental movement and the energy crisis of the seventies and now underscored by the threat of global climate change... renewables and particularly solar electric systems have found their way to college campuses, big time! This past year, Princeton University energized its 27-acre, 5.3 MW system.¹⁶

Campuses across America are utilizing rooftops, fields, and parking lots to generate electricity from the sun. University presidents, facilities staff, professors, students, and alumni are praising the benefits of solar energy. Campuses have become “living labs” for clean technologies.

While this report focuses on colleges and universities, Elementary, middle, and high schools are also benefitting from photovoltaics on campus. Hundreds of schools across the country are benefactors of utility-sponsored solar programs. Under contract with the City of Santa Monica, EcoMotion worked to get solar installed on every elementary school there.

Thanks to the maturation of the solar industry, including; technology, financing mechanisms, and project management, solar on college campuses has grown in leaps and bounds.

¹⁶ Princeton’s system is made up of 16,500 Sunpower panels, 80% of which are on trackers. The system will supply 5% of the University’s needs, and after 8 years when Princeton takes ownership and retains the SRECs, it will account for 6% of the carbon footprint reduction required to meet the commitment to reach 1990 levels by 2020. Sunpower also offered Princeton employees \$2,000 rebates for household installations.

Campus Solar Case Study # 3

University of Arizona: “Getting in the Solar Zone”

Location: Tucson, Arizona

Enrollment: 40,223

Solar capacity: 4.4 MW

The University of Arizona (UA) has not only invested in a 4.4 MW of solar capacity on campus, but also created the Solar Zone @ the UA Tech Park. The Zone’s project vision is “to create an integrated business location with world class companies and organizations working to increase Southern Arizona’s renewable energy capacity, develop world-class solar products, create imaginative, next generation technology, and establish a model solar demonstration campus for metro Tucson.”

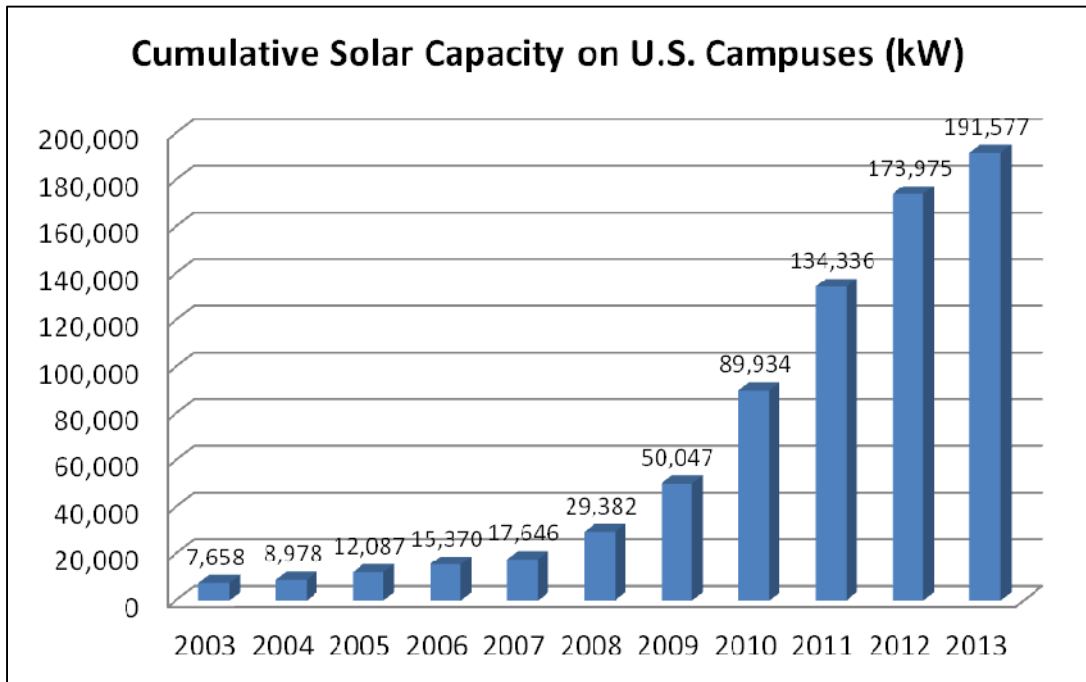
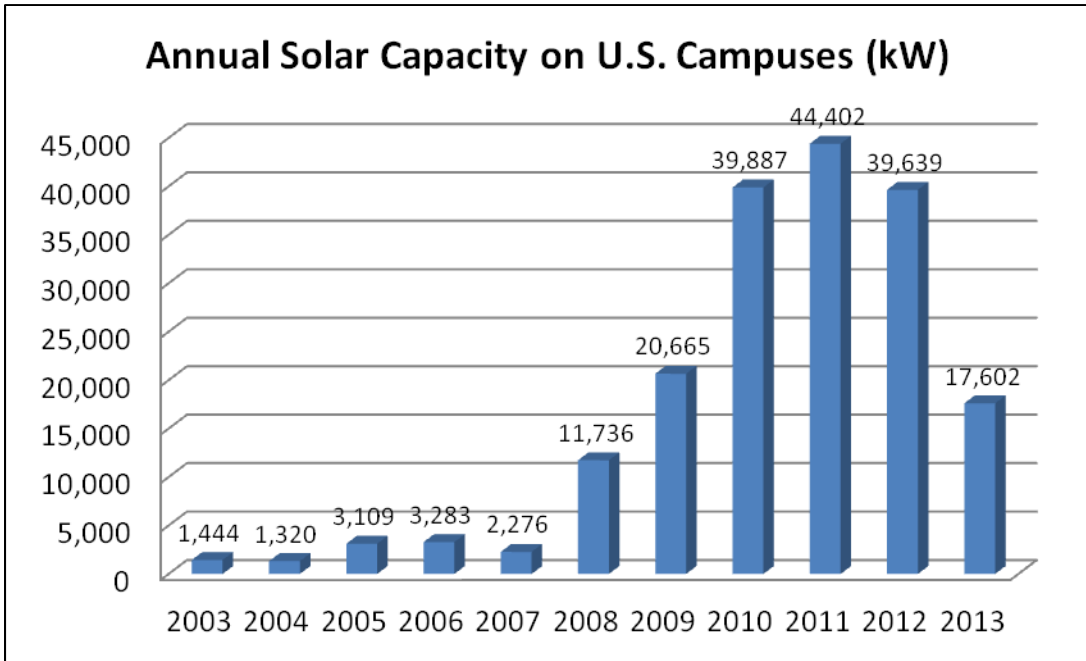
UA also hosts the University of Arizona Photovoltaic Research Lab. It analyzes historical and real-time performance data of different PV systems from multiple manufacturers at several test facilities across southern Arizona. It also conducts third-party PV performance analysis for local and corporate partners. UAPV has worked with their educational partners to develop PV curriculum for high schools, as well as technology and community colleges.

The AASHE Solar Database

The AASHE solar database is a repository for campus solar systems.¹⁷ Working with its member institutions, the database has detailed information on 552 solar installations on 326 campuses at colleges and universities in 46 states. In each case, universities and colleges self-report solar system details for the benefit of the AASHE membership.

What information can we glean information from the database? The total capacity of the 552 installations is 191,577 kilowatts, nearly 192 MW. The average system capacity is 352 kilowatts. Thus far, 155 developers and 169 installation companies have been hired for this work. For colleges and universities, 2011 was a banner year with 44,402 kW installed.

¹⁷ <http://www.aashe.org/resources/campus-solar-photovoltaic-installations/>



The next table illustrates the sheer size of solar system, and the corresponding commitment made by each campus. Arizona State University has 22.3 MW installed. Mount St. Mary's College in Maryland has 17.4 MW installed. And while not yet listed in the database, the first Ivy League school has now developed a large system: Princeton has energized its 16,500-panel, 5.3 MW array.

Even more recently, Texas A&M announced its plan to develop a 50 MW solar field, integrated with its Center for Solar. The university's aspiration is to be "the premier destination for the study and advance of solar energy." The \$600 million field will be privately financed to generate 100% of campus use, while providing power for an additional 20,000 homes. This campus's goal to be the world's largest research center for the evaluation, development, and testing of solar technologies.

Top Ten Campuses by Total Installed Capacity (2013)

	Institution Name	Total Capacity (kW)
1	Arizona State University (AZ)	23,567
2	Rutgers, the State University of New Jersey (NJ)	17,417
3	Mount St. Mary's University (MD)	17,400
4	West Hills Community College District (CA)	6,000
5	United States Air Force Academy (CO)	6,000
6	Princeton University (NJ)	5,735
7	Colorado State University (CO)	5,559
8	California State University, Fullerton (CA)	5,400
9	Arizona Western College (AZ)	5,105
10	Butte College (CA)	4,616

The table below highlights the states with the most campus solar capacity. California and Arizona with their abundant solar insolation, lead the country. New Jersey, thanks to its incentive structure, is third. Maryland and Colorado are fourth and fifth.

States with the Most Campus Solar Capacity (2013)

#	State or Province	Total Capacity (kW)	# of Installations
1	California	59,364	82
2	Arizona	50,532	118
3	New Jersey	47,746	17
4	Maryland	22,423	14
5	Colorado	13,222	20
6	Massachusetts	4,567	38
7	Texas	4,261	29
8	Ohio	4,231	18
9	Florida	2,484	11
10	Iowa	2020	8

Then there's sheer size of individual arrays. Mount St. Mary's University in Maryland has the biggest single system at 17.4 MW. Less than half that size, and with 8.0 MW of capacity, is the system at Rutgers in New Jersey, followed by the West Hills Community College District in California, and the United States Air Force Academy in Colorado Springs.

Top Ten Largest Solar Systems (2012)

	Institution Name	Total Capacity (kW)
1	Mount St. Mary's University (MD)	17,400
2	Rutgers, the State University of New Jersey (NJ)	8,000
3	West Hills Community College District (CA)	6,000
4	United States Air Force Academy (CO)	6,000
5	Arizona Western College (AZ)	5,000
6	Los Angeles Southwest College (CA)	4,000
7	William Paterson University of New Jersey (NJ)	3,500
8	Colorado State University (CO)	3,300
9	Contra Costa College (CA)	3,200
10	Butte College (CA)	2,700

Curriculum and Student Engagement

Thus far, this report has focused on solar systems, manifestations of the greening of the physical plant. But solar on campus can generate more than kilowatt-hours. It has huge educational value. This section focuses on curriculum and student engagement.

Colleges and universities are not only installing solar systems to cut costs and reduce their footprints, but they are also integrating solar and renewable themes into their curricula. AASHE lists 411 Bachelors of Arts and 441 Masters sustainability-focused degree programs through its membership database.

Engaging students through the interdisciplinary integration of renewables and sustainability into all aspects of curriculum is possible and happening now on many campuses as school administrators ask themselves questions such as...

- Can students demonstrate and apply social, engineering, political, technical, and business skills that influence implementation of solar energy?
- Can math students track and accurately present solar production and trends?

- Can business majors analyze the cost effectiveness of a solar project over the lifecycle of the system?
- Can science students track the greenhouse gas emissions reductions offered by a solar project and attach it to the broader carbon footprint on campus?
- Can English and film majors create educational materials and documentaries to describe and publicize a solar project?
- Can Graphic Art students provide quality graphics and renderings for displays, web pages, signage, and written descriptions of the project?

Green Mountain College in Vermont was the second college in the nation to achieve climate neutrality through campus-wide efficiency, adoption of clean energy (biomass from farming operations), and the purchase of local carbon offsets. It did so in the spring of spring of 2011.

While solar is certainly not the preferred renewable resource there, notable is the student-led effort to present the energy and carbon footprint of the campus via the “Green Mountain College Energy Dashboard.” It is part of a comprehensive energy management system on campus which streams energy data in real time.

Campus Solar Case Study # 4

Arizona State University: “PV and Campus Metabolism”

Location: Phoenix, Arizona

Enrollment: 272,254

Solar Capacity: 22.3 MW

Arizona State University is largest in the nation for solar capacity, and is also a leader in the integration of solar into its sustainability goals. ASU has made clear its strategy of attracting students who care about the environment and global future.

ASU Sustainability has online videos about its solar and sustainability goals for the university community and prospective students. <http://vimeo.com/sustainability>

Groups on campus collaborated to create the “Campus Metabolism” that shows energy data in real time per building. Its virtual classroom and residence room allows students to measure their own carbon footprints. <http://cm.asu.edu>

With the generous support of Sam Walton and Julie Ann Wrigley, ASU created the Global Institute of Sustainability to spur action campus-wide on all sustainability issues. This action includes work to drive the campus toward sustainability through multiple initiatives but also through academic courses, degree programs, and hands on training.

Leveraging Solar Integrators: Solar integrators are developing educational components of their services to bring more value to their proposals and project. For instance, these offerings include the addition of displays, signage, trainings, and other curricular components. At a minimum, solar integrators provide web-based monitoring for installations, typically including some kind of custom “dashboard” displayed on line and at a central location on campus with a flat screen display. However, the possibilities are many.

Real Goods Solar (RGS) has brought solar technologies and systems to over 40 schools and universities. Within a recent PPA proposal for a large system RGS included reference to multiple educational examples of value-added to a standard solar system project that are great examples of what’s possible “within a deal:”

- Provided two 2-hour solar education workshops for the entire faculty regarding solar energy and their new system. Topics included the fundamentals of solar technology, key components of the system, and suggestions for lesson plans for classes such as economics, law, and science.
- For NYSERDA’s School Power...Naturally program, RGS installed solar energy systems on 50 schools throughout New York, and provided 60 different lesson plans for kindergarten through high school to be incorporated into New York State curricula.
- At the New England Institute of Technology, RGS installed a 24 kW solar PV system and a 100 kW wind turbine. The systems were specifically designed to be utilized by the school for hands-on training for its students
- At the Hudson Valley Community College RGS was selected to design and construct a 66 kW combination ground- and roof-mounted solar PV system at the new TEC-SMART (Training and Education Center for Semiconductor Manufacturing and Alternative and Renewable Technologies) facility to provide hands-on training for students

Every educational institution is unique, making its own way in the emerging solar field. All efforts and levels of participation are helping to engage students, faculty, and the broader community.

This ranges range from a simple big screen visual in a building lobby to large signage at a system on a hillside; from an interactive website showing production to a site showing campus-wide energy use and savings levels in real time; from small solar clubs to a campus-wide sustainability ethos; from short continuing education lectures to full scale Master's degree programs; from offsetting energy consumption and a net zero energy campus, from "feel good" to significant dollar savings investments.

One thing stands out: Solar systems provide value at levels above and beyond their power generation.

Campus Solar Case Study # 5

East Los Angeles College: "Solar in the Heart of Los Angeles"

Location: Monterey Park, California

Enrollment: 34,697

Solar Capacity: 1.2 MW

Los Angeles Community College District is the largest community college district in the nation. Its goal is to put at least 1 MW of photovoltaics on each of its nine campuses. So far, it has done so on five campuses. Most notable is the East Los Angeles College (ELAC) campus and its "Green Campus" model.

At ELAC, Chevron Energy Solutions was retained through a power purchase agreement for the 1.2 MW photovoltaic (PV) system. It is comprised of 5,952 solar panels mounted on top of seven large-scale carports. These provide shaded parking for 530 vehicles. The electricity generated by the solar panels satisfies approximately 45% of the College's energy needs.

ELAC's solar system works in conjunction with the campus's new Central Utility Plant. It cuts costs by drawing power from the grid at night when demand is lower and prices cheaper.

5. Taking Action on Your Campus

Finding Allies and Building Support

Let's face it, unless you are the university president, you can unlikely do this alone. You need allies and to build a base of support from students, faculty, administrators, as well as the Board of Directors/Trustees. This is a communications exercise.

Who else wants solar? You know your campus best... but scour all possibilities. Who is motivated to support this?

- Students
- Student organizations
- Environmental clubs
- Outdoor clubs
- Parents of students
- Science teachers
- Facilities personnel
- Admissions
- Alumni
- Trustees
- Members of the community

Finding motivations is key: The president may well have signed the American Colleges and Universities Presidents' Climate Commitment (ACUPCC) for carbon neutrality. A facilities manager may have a solar system at home, or know just the spot for it! Admissions departments are looking for ways to lure new students, and every university is always on watch retaining students. The CFO may have heard of generous utility incentives... and/or PPAs. Identify the benefits for each stakeholder and build your base of support.

First Steps in Planning and Design

The following preliminary check-list is intended to spur your organization and direction. Start a file and build it. This dossier will lead to conceptual design, then competitive bid, selection and interconnection.

- Do you already have solar?

- If so, find out how it happened!
- Check DSIREusa.org to determine current utility incentives.
- Does your utility offer Net Energy Metering or a Feed in Tariff incentive?
- Consider sites for solar on your campus in light of development plans.
- Determine how many meters are on campus, and their rate and location.
- Get 12 months of electric bills for each meter, or a select meter or meters.
- Determine trenching opportunities from solar system to meter.
- Call EcoMotion for a cursory financial analysis of the system

PV 201: Six Warnings from the Solar Advisor

Warning #1: Don't rely on blended rates to predict your solar system's savings

The number one misleading sales technique that EcoMotion has seen is the use of “blended rates.” A blended rate is derived by dividing a total electric bill by the number of kWh used in that billing cycle. It's a value that can't be used for solar. Blended rates shorten payback periods and falsely bump up returns on investment, and could even make some deals upside down!

Most institutional electric bills are comprised of two main parts. Charges for units of energy known as kilowatt hours (kWh) and charges for the amount of capacity demanded known as demand charges or facilities demand charges (kW). While solar energy generation will all or a portion of kWh charges, the impact on demand charges may be little or none.

Let's say a campus building has a large solar array connected to its meter. If that solar array generates 30% of the annual kWh use, the kWh portion bill will fall by 30%. Demand charges are typically determined by the highest energy demand during the billing cycle. If that happens at 7:30 AM, before solar generation hours, or at 8:0 PM, after solar generation hours, then there is little or no savings on the kW charges. Libraries, dormitories, sports facilities, academic buildings, and cafeterias are all examples of buildings that are likely to have heavy electricity demand outside of daylight hours.

Watch out for this one: It is not wise to assume that the entire bill is impacted by percentage of solar energy offset.

Warning #2: Beware of aggressive claims of utility cost escalation

Most solar companies and PPA providers will base their financial assumptions and proposition on an anticipated level of utility price increases. This is called escalation. In California, solar promoters point to a study that showed an average annual 6.7% rate increase. If one assumes

the rates of the local electric utility will increase at an annual rate of 6%, the potential savings for the campus looks a lot more impressive than if a 2% annual increase was assumed.

These days, with natural gas prices stable and quite low, one can argue that modest utility rate increases are likely, less than 6% annually. That said, preparation for a low-carbon power system by adding renewables to the grid may be expensive, increasing pressure on rates. So it's hard to predict the utility escalation rate.

Two tips: First, watch out for high escalation rates in solar proposals. Less than 3% seems conservative; over 6% is aggressive. Depending on the host/client, EcoMotion has used escalation rates from 3 – 5%. Second, the most important thing is to compare various proposals using the same set of utility escalation assumptions.

Warning #3: Don't rely on one bid or proposal to find the right solar provider

It probably goes without saying, but getting more than one bid is smart business in almost all cases. The solar industry is very competitive and there is a diverse set of quality suppliers, quality equipment, and best practices. Solar providers have different strengths in terms of the type of installation (ground, roof, car port, or parking structure) and in terms of the financing or PPA terms they can provide. We received eight bids for a campus installation in New York.

Educational institutions seeking to go solar do so as a long-term partnership with their solar provider. (This is true for leased systems, and owned systems that must be monitored and maintained.) Institutions are likely to receive a number of attractive bids and favorable initial terms from large solar developers, but that does not guarantee a successful project. Instead, it is about finding the right partner to work with that can deliver; the kind of partner that spends months of due diligence and capital ensuring that the educational institution receives the value they require from a solar project.

It is equally important that the institution conduct due diligence. Just because the solar developer is well-known or its initial bid is attractive, the deal may get buried amidst multiple layers of approvals that can significantly change the initial terms. Even worse, some solar developers have used "bait and switch" tactics, promising more than they can actually deliver, only to change the terms once they know they have exclusive access to the project.

We advise colleges and universities to do the following: Select a solar developer that will be a healthy long-term partner, preemptively work with the developer on the issues that will arise, and to be persistent in seeing the project reaches completion, all while adhering to the spirit of the terms that allowed for such a successful engagement.

Warning #4: Watch for PPA rate escalators and terms

To monetize America's tax credits and depreciation benefits, many colleges and universities have chosen a solar solution that includes a third party financier/owner through a PPA. The goal for both the third party and the campus will be to set an initial rate for each kWh of solar generated that is lower than is being paid to the utility. Deals that start at a higher rate (solar > grid prices) are considered "upside-down."

Being at parity (solar = grid), or lower is a great start, but there is a second factor: If the annual escalation rate of the PPA price exceeds that of the utility, the deal could also be "upside-down" in the later years. Overall, a solar system could be a losing proposition for the campus.

Generally, the more modest the PPA escalation rate, the more secure the deal. Also, it's important to be clear about minimum and maximum solar production and how that impacts the school. Most PPA providers will provide a guarantee for the minimum amount of solar kWh production annually.

There are several other issues to watch for in terms: Buy-out provisions. When can the system be purchased and at what cost? We like performance guarantees. It's also best to be clear on how much over-production the school is required to purchase. Suppose a system expected to produce 1 million kWh at 10 cents each, produces 1.1 million. That's an extra \$10,000. If that amount of extra energy can't be used or net metered, then it's a loss.

Warning #5: Use an expert to negotiate financing and the PPA contract

For most educational institutions, obtaining financing (equity, debt, and tax) is necessary to achieve the benefits of the U.S. Investment Tax Credit (ITC) and depreciation. Ensure the solar developers have financing in place before a deal is agreed upon, this ensures "skin in the game." From there, agreeing to an economically favorable Power Purchase Agreement (PPA) between the parties can be accomplished.

Caveat Emptor. Buyer beware. Beyond the price and escalation rate are a myriad of factors that need to be understood and addressed. The term, the buyout opportunities, the accuracy of the system monitoring, the determination of Fair Market Value, the maintenance responsibilities, the system removal at the end of the term, the transferability of the deal, the equipment substitution allowance, and many more.

Warning #6: Seek transparency, recognize emotions, and keep an objective perspective

When developing a project, realize that prospective developers are basing their bids on best-case assumptions, meaning that at the end of the day, the final deal will be contingent on all of the assumptions and representations made by the developer remain true. In reality, even the best assumptions made by the most experienced developers change throughout the sales process.

Some changes are for the better, while some for the worse. Anytime there is a change, there is a potential to feel slighted. Fluctuations of value and economics are inevitable, so it is important to deal with these changes not emotionally, but rationally.

Staying rational and objective is harder said than done, especially considering how long some deals can take. To prevent a deal from collapsing, institutions and developers must maintain transparency and clearly communicate how a given change can impact the institution's economics. A financial model should be shared by the parties; one that clearly demonstrates the basic economics, so each change can be modeled and compared to the original economics represented at the beginning of the process.

7. Conclusion

The global solar revolution is on fire... the invisible fire of combustion-free energy. We live in exciting times, times in which solar is growing in leaps and bounds, out of the closet, ready for prime time, now a legitimate resource that is supporting campuses across the country.

What a great way to save the Earth and save money. Campus PV systems create benign power, proximate to the demand for their energy. And campuses are vibrant living laboratories; solar systems and self-generation is a profound lesson for students, faculty, and the entire university community.

This report presents a lot of numbers and trends. We end with some major do's and don'ts! We hope it is at once inspirational and pragmatic.

Suffice to say, the takeaway is that solar is on the rise worldwide, in the United States as a whole, and on college and university campuses in particular. There are ample best practices that serve as resources for taking solar to scale on American campuses and fully integrating the clean tech message into the curriculum.

The AASHE Solar Special: Technical Solar Support for Members

EcoMotion – based in California and Massachusetts -- is an “honest broker” of solar systems, with no financial ties to suppliers of any kind. We provide solar advisory services for cities, corporations, and campuses coast to coast.

EcoMotion sponsors the AASHE Solar Database and provides Solar Advisory Services to AASHE members.

AASHE members are entitled to up to eight hours of no-cost consulting to support solar developments on campuses across America. Custom consulting takes many forms, from financial analysis to curricular integration. Call us, the AASHE Solar Hotline: (949) 450 - 7155.