

## Soft Costs of Solar Deployment

As overall solar prices have dropped, the U.S. has enjoyed unprecedented growth in both solar installations and jobs through the development of successful business and deployment models across the country. Between 2008 and 2012, the U.S. doubled renewable energy generation from wind, solar and geothermal sources. Technology development, commercialization and manufacturing scaling have contributed significantly to rapid reductions in hardware costs since the inception of the SunShot Initiative. Now, however, addressing solar “Balance of System-Soft Costs” present the most substantial opportunities to spur strong U.S. growth in solar deployment in the coming years.

### Total PV System Price, by Sector and System Size (first half of 2012)

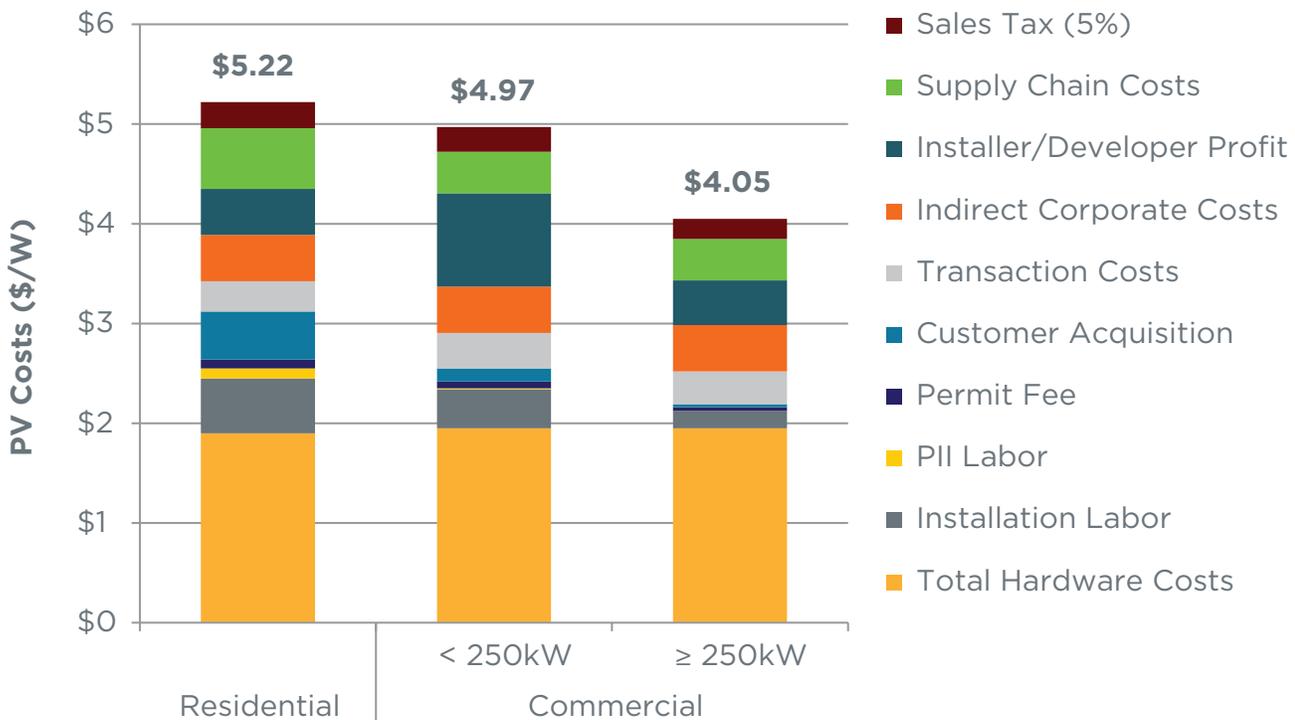


Figure 1. Total PV system price, by sector and system size (first half of 2012).<sup>10</sup>

These soft costs include financing, customer acquisition, permitting, installation, labor, inspection, and other non-hardware costs. Taken together, soft costs and barriers to solar deployment now make up over half the cost of total

system prices for residential, small and large commercial PV systems. In order to achieve the goals of the SunShot Initiative, average soft costs need to be reduced to approximately \$0.65/W for residential systems and \$0.44/W for commercial systems by 2020 (Fig. 1).

10. Friedman et al 2013 <http://www.nrel.gov/docs/fy14osti/60412.pdf>

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Moreover, soft costs can vary significantly as a result of a fragmented energy market system that presents a highly variable landscape for those looking to deploy solar. The same solar equipment may vary widely in its final installation price due to process and market variations across jurisdictions. This creates barriers to even more rapid industry growth. Development and adoption of standards at the local level and applying regional approaches can create a more uniform and accessible business environment. Through SunShot, DOE supports the development of innovative and scalable solutions, enabling communities and leaders to build their local economies and establish clean energy initiatives that meet their needs, while creating sustainable market conditions.

The SunShot Initiative has built a diverse portfolio of soft cost activities. We are working with a broad range of stakeholders to expand access to solar energy to every home, business and community. We are also supporting the development of an exciting new generation of powerful data, network, and IT-related tools that amplify the effectiveness of these local initiatives and help grow markets intelligently. These tools increase market transparency, improve consumer protection, and improve access to low-cost financing for a growing number of consumers. Together, these efforts will make it faster, easier and cheaper than ever before to deploy solar technology.

In order to support reductions in soft costs and promote uniform access to solar, the SunShot soft costs subprogram has focused its efforts into the following activity areas:

- Empowering state and local decision-makers through timely and actionable resources, peer networks, and technical assistance
- Harnessing big data analysis and technical solutions to support the many stakeholders involved in solar deployment

- Training an innovative solar workforce to enable the solar industry to meet growing demand
- Developing solar finance and business solutions to expand access to capital and accelerate market growth

Underlying these efforts are extensive analyses that characterize non-hardware costs and barriers. Work from the national laboratories including the National Renewable Energy Laboratory (NREL), Sandia National Laboratories, Lawrence Berkeley National Laboratory (LBNL) and Argonne National Laboratory (ANL), as well as insightful tools and analyses from project partners like the Rocky Mountain Institute and Optony, Inc., have helped shed light on these costs and the potential pathways to address them. These programs have developed datasets, standards and guides that can serve consumers across the country.

## EMPOWERING STATE AND LOCAL LEADERS

SunShot works to support leaders that develop strategies and solutions to directly reduce the costs and barriers to solar access and that may slow deployment at the local level. Our programs are structured to measure the effectiveness of a variety of these local programs and strategies. Through the Rooftop Solar Challenge (RSC 1 and 2), SunShot has benchmarked hundreds of communities and empowered them to advance their solar market maturity through measures that have saved Americans nearly 800 years of “red tape” related roadblocks to date. These projects have shortened permitting and inspection times by 40% and reduced permitting fees by 12% for participants. Innovations developed through RSC 1 communities in 2013 are now being shared through training and technical assistance from SunShot’s Solar Outreach Partnership (SolarOPs) program.

In April 2014, SunShot launched a new program called Solar Market Pathways to support the development of sustainable, multi-year solar deployment plans. We anticipate that this program will enable new activity to support community efforts like shared solar, financing programs like commercial property-assessed clean energy (PACE), and the incorporation of solar into local emergency response plans. The goal of Solar Market Pathways is to help provide local business certainty, address regulatory challenges, disseminate best practices and lessons learned, and establish a clear path for the next five to ten years of solar deployment in the awarded region.

Building networks that can support the development and diffusion of proven and effective programs for solar deployment continues to be a core strategy we employ for expanding access to solar energy.

## **HARNESSING BIG DATA ANALYSIS AND TECHNICAL SOLUTIONS**

At the most fundamental level, soft costs are the result of the time and effort people spend to accomplish tasks related to solar deployment. Automation, increased access to data and information, and software and information management tools can help reduce the time and effort needed to complete a solar installation. SunShot is supporting the creation, analysis and functionalization of data and information through a number of efforts.

By combining the power of big data with cutting-edge social science, projects funded under SunShot's Solar Energy Evolution and Diffusion Studies (SEEDS) program enable researchers to test, measure and validate local deployment program effectiveness, accelerating innovation in business and market development while advancing foundational knowledge of social science dynamics. In addition, soft costs-related Incubator awards support small businesses and startups that provide solutions to soft cost challenges for a variety

of stakeholders, including installers, finance providers, state and local jurisdictions, and the public. Through these efforts, along with a variety of solutions developed by our partners including national laboratories, non-profit organizations, and others, a wide range of tools are now available to support solar deployment.

## **TRAINING A STRONG SOLAR WORKFORCE**

As the solar industry has grown, SunShot has focused its efforts on the creation of consistent, high-quality workforce training and skills-credentialing in the solar industry and beyond. The Solar Instructor Training Network (SITN) is a nationwide network of qualified solar instructors who train solar installers, technicians, designers, and sales professionals in every region of the U.S. through partnerships with nearly 400 community colleges. Building on this effort, SITN has also helped provide high-quality training resources to building code officials and local inspectors, helped ensure that consumers receive optimal production and safety from PV installations, and increased consumer confidence.

In addition, the Grid Engineering for Accelerated Renewable Energy Deployment (GEARED) program has created a network of four regional university training consortia that connect utilities and solar manufacturers with university power system engineering programs to train current and future engineers. These new engineers will be able to integrate renewable energy into the grid and transform the electric utility sector into a marketplace that supports innovation. Solar design and grid integration at the utility scale is getting a jumpstart through another award to the National Rural Electric Cooperative Association (NRECA). NRECA will help its coops build solar management expertise locally and create replicable models for deploying solar through its more than 900 member electric cooperatives.

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## DEVELOPING SOLAR FINANCE AND BUSINESS SOLUTIONS

Solar installers and utility professionals aren't the only professionals who need solar skills. SunShot also supports work in finance, real estate, and community and shared solar development. Our national laboratories, universities, non-profits and talented startups have led exciting workshops, gathered stakeholders for work sessions, and built a suite of new tools to support solar growth. Our Solar Access to Public Capital (SAPC) group is working with financial institutions, project developers, and manufacturers to publicly release standardized contracts and methods for assessing risk portfolios in order to unlock new streams of capital to support solar project finance.

Finally, for those who like to both dream and "go" big – we have the SunShot Prize: \$10 million available for anyone who can pull together a team to install solar PV on at least 6,000 rooftops while meeting targeted SunShot goals.

Looking forward, the SunShot soft costs subprogram aims to expand the availability of high-quality data, information, tools and resources to support the solar industry. We continue to provide opportunities for state and local leaders to tap into networks that can help them deploy solar sustainably and economically. We are increasing support for the testing, measuring and analysis needed to ensure that communities (both local and professional) can design programs that work for them and the people they serve. We look forward to expanding access to solar energy and to helping to make it faster, cheaper and easier for all Americans to realize the many benefits of solar energy today and into the future.

### **Dr. Elaine Ulrich**

*Soft Costs Program Manager*

Solar Energy Technologies Office

U.S. Department of Energy

## Empowering State and Local Leaders

SunShot works to support leaders at the local level to develop strategies and solutions to directly reduce the costs and barriers to solar access and deployment. Current efforts are building networks that can support the development and diffusion of proven and effective programs and help leaders establish clear pathways for sustainable and economical solar deployment across the U.S.

## Rooftop Solar Challenge 2

The SunShot Initiative's Rooftop Solar Challenge 2 (RSC2) empowers teams to address various and expensive permitting, zoning, metering, and connection processes that are currently required to install and finance residential and commercial solar systems. The RSC2 supports eight diverse teams from around the country that bring together city, county, and state officials, regulatory entities, private industry, universities, local utilities, and other regional stakeholders to reduce these soft costs, clear a path for rapid expansion of solar energy, and serve as models for other communities across the nation.

Teams will implement step-by-step actions with the goal of cutting red tape to make it faster, easier, and cheaper for Americans to go solar. Teams are streamlining permitting processes, updating planning and zoning codes, improving standards for connecting solar power to the electric grid, and increasing access to financing.

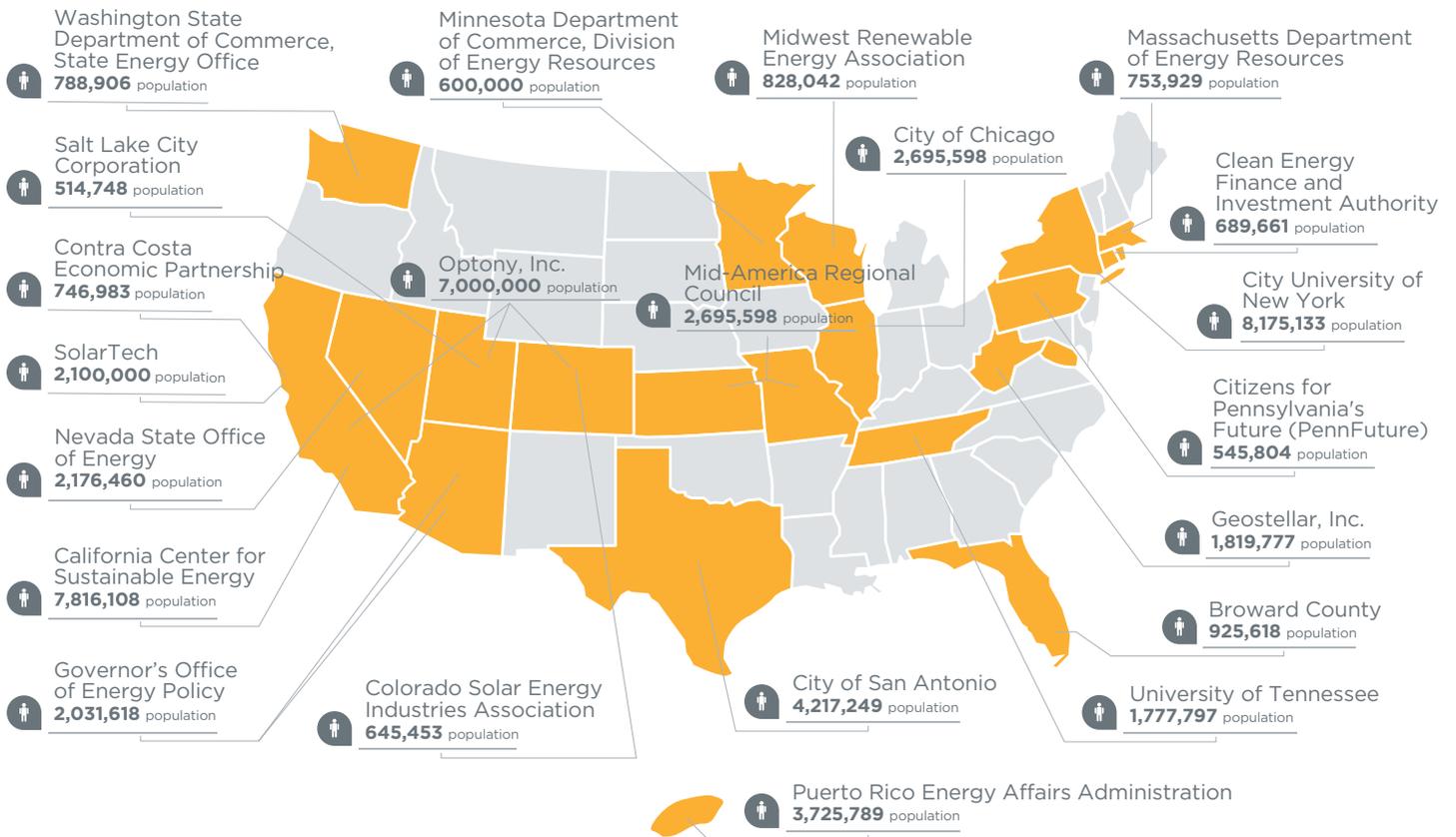
With support from SunShot, 22 teams from across the country participated in the first round of the Rooftop Solar Challenge, launched in 2011. These projects yielded innovative solutions and tools that made a significant impact across the country—making it cheaper and faster to go solar.

### Some highlights of the RSC 1 projects (Fig.2)

- In Broward County, Florida, residents can now get a solar energy system permit and a preapproved set of design plans in just thirty minutes thanks to a new online permitting system. They are receiving follow-on funding to continue their work through the second round of our program.
- Utah Clean Energy and Salt Lake City partnered to create a one-stop online information portal that simplifies the process of going solar by providing online tools and resources for all stakeholders;
- In Chicago, solar permits cost 25% less and can now be obtained in a day instead of a month, while interconnection applications can now be submitted electronically to the local utility, saving time and money.

# Soft Costs of Solar Deployment

Figure 2. Map of Round 1 Participants



## 47 Million Americans Impacted

Total award amount: **\$12.0M**

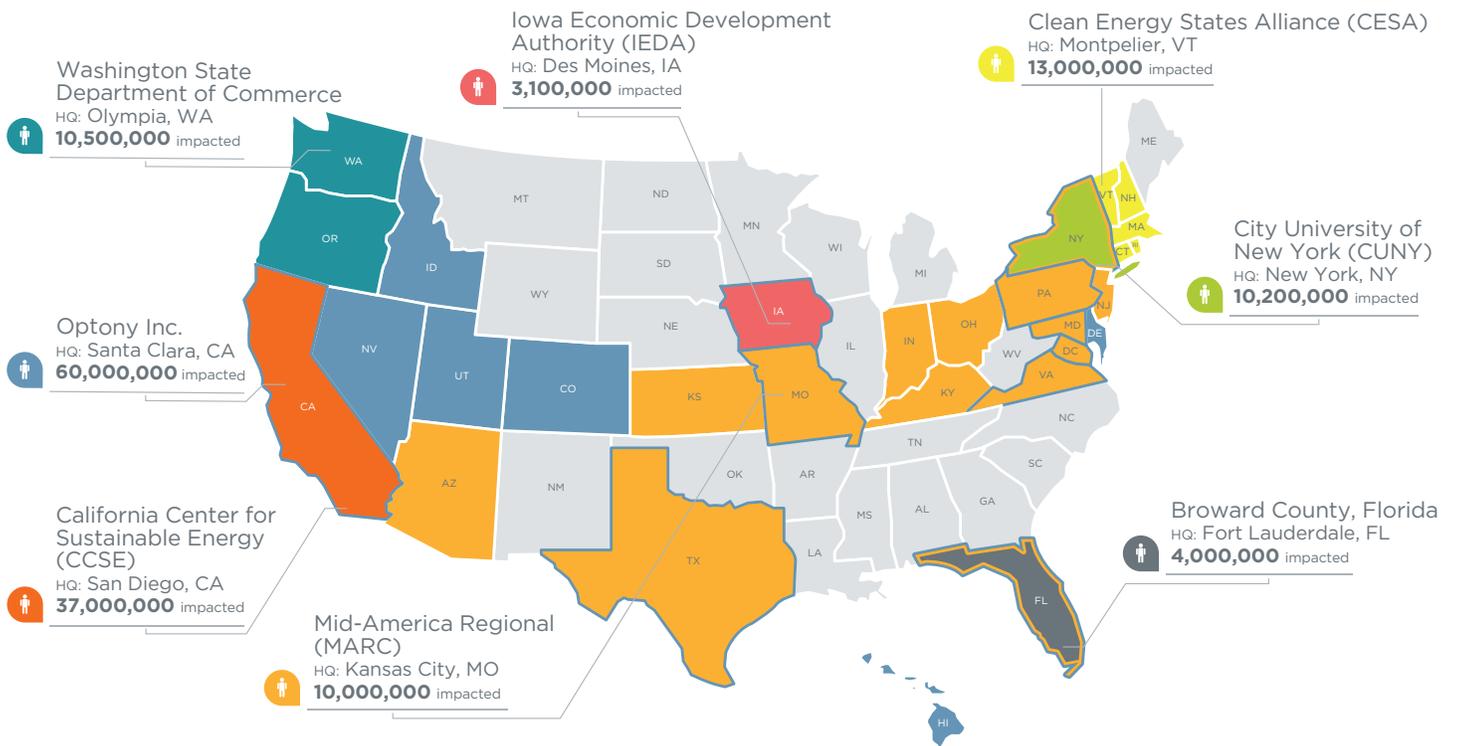
Award duration: **12 Months**

### The results

- Saved Americans nearly 800 years of red tape-related roadblocks—or 10 lifetimes.
- Helped groups of neighbors go solar together by spurring group purchasing programs that drove down total system costs by up to 20%.
- Shortened permitting time by 40% and reduced permitting fees by 12%.
- Eliminated the paper chase and put the permitting and plug-in approval processes online for millions.
- Made it faster, easier, and cheaper for nearly 50 million Americans to go solar.

Building on the Challenge's first round, the eight teams participating in the RSC2 will expand the reach of innovative strategies that are making it easier, faster and cheaper for more homeowners and businesses to finance and install solar systems. From November 2013 to May 2016, these awardees will develop and replicate creative solutions to help standardize complicated permitting and interconnection processes that often vary from jurisdiction to jurisdiction. The solutions will also facilitate easy, cheaper bulk purchasing and support user-friendly, fast online applications.

**Figure 3. Map of Round 2 Participants**



**148 Million Americans Impacted**

Total award amount: **\$12M**  
Award duration: **30 Months**

| Awardee               | Locations | Population Impact | DOE Funding |
|-----------------------|-----------|-------------------|-------------|
| <b>Broward County</b> | FL        | 4M                | \$1.6M      |

**Highlights:** Go SOLAR-Florida will expand its market-leading online permitting solution to nine local municipalities and six additional Florida counties, and will continue to engage Florida stakeholders to expand financing options in the state as it unlocks its full potential as a leader in PV deployment.

# Soft Costs of Solar Deployment

| Awardee   | Locations              | Population Impact | DOE Funding |
|---|------------------------|-------------------|-------------|
| <b>California Center for Sustainable Energy</b>   | CA                     | 37M               | \$1.3M      |
| <b>Highlights:</b> The Golden State Solar Impact Project will transform California's solar market by making permitting and interconnection processes more uniform, rapid, and transparent across the state. The project will implement a standardized permitting process and develop tools such as a statewide interconnection and data portal to dramatically reduce soft costs in California.   |                        |                   |             |
| <b>City University of New York</b>  | NY                     | 10.2M             | \$1.4M      |
| <b>Highlights:</b> NYSolar Smart will create a toolkit of policies, programs, and resources to enable jurisdictions, utilities, industry, and end users to reduce the time and cost of installing solar PV. These include Web-accessible permitting, virtual net-metering guidelines for master-metered buildings, group purchasing programs, and updated model zoning ordinances. NYSolar Smart's IT tools will include a customizable customer acquisition portal, solar maps, market analytics, and a one-stop PV market portal. |                        |                   |             |
| <b>Clean Energy States Alliance</b>   | NH, MA, CT, RI, and VT | 1.3M              | \$1.5M      |
| <b>Highlights:</b> The New England Solar Cost-Reduction Partnership will build a thriving regional solar market by: increasing coordination across Connecticut, Massachusetts, New Hampshire, Rhode Island, and Vermont; refining and deploying innovations developed in Connecticut and Massachusetts during Rooftop Solar Challenge 1; and more widely implementing best practices across the region, including online permitting and group purchasing programs.  |                        |                   |             |
| <b>Iowa Economic Development Authority</b>  | IA                     | 3.1M              | \$1.0M      |
| <b>Highlights:</b> The Iowa Statewide Solar Readiness Initiative is a collaborative effort to promote solar energy adoption in Iowa. The Iowa Economic Development Authority and its partners will work with communities, utilities, and other solar stakeholders to develop educational materials, identify policy barriers and potential solutions, create an online solar toolbox, perform individual market barrier assessments for pilot communities, and create customized community action plans.                            |                        |                   |             |

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| Awardee  | Locations  | Population Impact | DOE Funding |
|--|--|-------------------|-------------|
| <b>Mid-America Regional Council</b>  | KS, MO, AZ, NY, PA, NJ, FL, TX, OH, KY, IN, MD, VA and DC          | 10M               | \$2.6M      |
| <p><b>Highlights:</b> MARC and the National Association of Regional Councils will use established and trusted relationships among regional planning councils and local governments to spread solar-friendly best practices to nine diverse regions across the country, building upon successful efforts in the Kansas City region to create a strong solar market.</p>   |  |                   |             |
| <b>Optony, Inc.</b>  | CA, NV, UT, ID, CO, HI, TX, FL, IA, MO, DC, VA, MD, DE, PA, and NY | 60M               | \$2.6M      |
| <p><b>Highlights:</b> The American Solar Transformation Initiative will use an innovative online Solar Roadmap platform and hands-on engagement to assist over 400 jurisdictions where solar potential is abundant, but resources and information are scarce. The project will improve permitting processes, establish solar friendly planning and zoning guidelines, streamline the interconnection process, expand financing options, and ultimately develop strong solar markets across the country.</p>  |  |                   |             |
| <b>Washington State Department of Commerce</b>   | WA, OR   | 10.5M             | \$1.7M      |
| <p><b>Highlights:</b> The Pacific Northwest Solar Partnership aims to double PV capacity in Washington and Oregon by creating a more uniform and vibrant regional solar market. The collaborative project will establish “solar ready” corridors and simple online permitting and common interconnection processes for 80% of residents. The effort will also continue to expand innovative, locally developed financing solutions such as community solar and Solarize group purchasing programs to provide access to financing options in every utility territory in the two-state region.</p> |  |                   |             |

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## **SOLAR OUTREACH PARTNERSHIP**

International City/County Management Association | Washington, DC | \$4.9M | SolarOPs | 08/2010-07/2015  
ICLEI-Local Governments for Sustainability | Oakland, CA | \$5.1M | SolarOPs | 08/2010-07/2015

The SunShot Solar Outreach Partnership (SolarOPs) Program is empowering local governments to go solar. Comprised of experts in solar soft cost reduction strategies, the team collects, creates and delivers best practices to accelerate solar energy adoption by providing timely and actionable information to local governments across the country. Through regional workshops and e-learning activities, the SolarOPs team has reached more than 4,000 individuals in all 50 states, representing more than 1,500 local government entities.

One of the key features of SolarOPs is the delivery of targeted one-on-one technical assistance to local governments looking to make their community solar-ready. Technical assistance is being delivered to local governments in North Carolina, California, Delaware, and New Jersey, among others.

The SolarOPs team is developing factsheets, case studies, and technical reports based on cutting-edge research related to solar and economic development, solar and resiliency planning, innovative solar financing, solar jobs analysis, community solar and solar and firefighter safety. In addition, the SolarOPs team coordinates communications among the Rooftop Solar Challenge 2 teams whose work covers 28 states and the District of Columbia, representing nearly 150 million people. For more information visit [solaroutreach.org](http://solaroutreach.org).

## **PUBLIC AND PRIVATE SECTOR TECHNICAL ASSISTANCE**

National Renewable Energy Laboratory | Golden, CO | \$3.0M | National Laboratory R&D | 10/2012-09/2015

This agreement helps provide broad introductory information to policymakers and implementers, as well as deep, specific policy development and impact information to directly facilitate market development and technology deployment within jurisdictions. This agreement provides the foundational, unbiased, and in-depth research from which technical assistance responses are tailored to produce decision support information for policymakers and implementers. The technical assistance performed by NREL (and the Lawrence Berkeley National Laboratory as a subawardee) is coordinated with other SunShot technical assistance efforts such as SolarOPs to ensure broad access to experts and critical information upon request to state and local decision-makers across the country who are addressing opportunities and challenges associated with an expanding solar market and increased deployment.

## **REGULATORY AND PERMITTING INFORMATION DESKTOP (RAPID) ROADMAP**

National Renewable Energy Laboratory | Golden, CO | \$0.50M | National Laboratory R&D | 12/2013-09/2014

This agreement at NREL is helping to optimize and streamline the regulatory process for utility-scale solar projects. Through the process of developing roadmap content, the project brings together both state and federal agencies, engaging them in reviewing and coordinating the permitting process for large solar PV developments and helping them reduce developers' costs and time for solar deployment. The Solar Regulatory Roadmap will build off of the existing Geothermal Regulatory Roadmap for 10 western states, which was developed by NREL in support of EERE's Geothermal Technologies Office, and has received overwhelming positive response from industry and agencies.

## Policy Stacking and Foundational Analysis

Achieving the cost reduction and deployment goals of the SunShot Initiative will require effective policy and informed policymakers at all levels of government. This project seeks to inform critical solar-relevant policy decisions at the state, local, and federal levels through strong analytic research that identifies and develops critical policy ordering for effective market development, tracks and evaluates policies and market mechanisms that impact solar costs and deployment, and identifies and evaluates the critical elements within solar policies and market mechanisms that influence their effectiveness.

Lawrence Berkeley National Laboratory | Berkeley, CA | \$1.2M | National Laboratory R&D | 10/2012–09/2015

LBNL researchers, in collaboration with the National Renewable Energy Laboratory, will analyze policy developments, compliance costs, and impacts as they relate to solar energy within state renewable portfolio standards, third party tax equity, third party ownership, and federal tax policies. In addition, this project will conduct analysis of key issues at the intersection of solar deployment, utility regulation, and retail rate design, to address the market drivers associated with customer electricity bill savings.

National Renewable Energy Laboratory | Golden, CO | \$4.7M | National Laboratory R&D | 10/2012–09/2015

NREL researchers, in collaboration with Lawrence Berkeley National Laboratory, will coordinate a Policy Activities Advisory Team to provide insights, feedback, and refinement to the research, and assist in communicating and disseminating research findings. NREL will also develop a variety of effective policy strategies, or “stacks,” in different jurisdictional governance and economic contexts and within different technology pricing scenarios and conduct analyses to identify and understand the impact and effectiveness of implementing policies that interact within the same markets. With respect to the regulatory environment, NREL will analyze the impact of utility rates on grid parity, explore options and considerations for equitably addressing utility system costs of solar, and address interactions between rate design, customer adoption, and the associated impact on utilities. NREL will also identify solar issues in utility supply procurement processes, explore a range of solutions that state and local policymakers could support, and create fair evaluation processes. Finally, NREL will conduct market-responsive analysis on topics such as: voluntary markets that provide technology access; utility community solar programs; providing regulators information needed to identify pathways forward for dealing with increasing levels of distributed solar that are appropriate for their state’s context; net metering policies and caps; and possible approaches to address the expected expiration of maintenance of the California Solar PV Database.

## Harnessing Big Data Analysis and Technical Solutions

SunShot is supporting the creation, analysis and functionalization of data and information in order to reduce the time and effort needed to deploy solar. These programs have accelerated the development of a wide range of tools and solutions addressing soft cost challenges that face a variety of stakeholders, including installers, finance providers, state and local jurisdictions, and the public.

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## Understanding the Evolution and Diffusion of Solar Technologies

Through the Solar Energy Evolution and Diffusion Studies (SEEDS) program, seven research teams are harnessing real-world data to solve solar industry challenges. By charting market evolution and technology innovation, the projects are advancing and applying new branches of science to spur solar cost reduction. Big data, network science, behavioral economics, and social physics have emerged as powerful tools in the SunShot toolbox. For example, mapping out the dynamics of social learning within a community is revolutionizing the basic understanding of innovation diffusion and is also dramatically reducing the soft costs for customer acquisition. Also, decoding the structure and pace of past technological breakthroughs is aiding today's scientists and engineers in their pursuits to make solar hardware more efficient and less costly. Over the next three years, the SEEDS program is poised to make scientific leaps that transform cast-off data into practical strategies underlying the design and implementation of energy policies.

### **UNDERSTANDING THE EVOLUTION OF CUSTOMER MOTIVATIONS AND ADOPTION BARRIERS IN RESIDENTIAL PHOTOVOLTAIC MARKETS**

National Renewable Energy Laboratory | Golden, CO | \$2.3M | SEEDS | 04/2013-06/2016

Decisions of whether to adopt rooftop solar are driven by many factors, including system price, access to information, and the experiences of peers within social networks. Analytical models for projecting market growth typically only account for the price variable, and not other important decision parameters. An agent-based model can elucidate the ways that PV markets will evolve by simulating the complex and interrelated decision dynamics of individuals in a social system. This project, led by NREL and in collaboration with researchers from Portland State University, the University of Arizona and other institutions, is collecting a rich dataset that is being used to train regionally-specific, agent-based models to simulate decision-making under different test scenarios, and to run real-world pilot tests that validate results with market partner Clean Power Finance.

### **DESIGN OF SOCIAL AND ECONOMIC INCENTIVES AND INFORMATION CAMPAIGNS TO PROMOTE SOLAR TECHNOLOGY DIFFUSION THROUGH DATA-DRIVEN BEHAVIOR MODELING**

Sandia National Laboratories | Albuquerque, NM | \$2.3M | SEEDS | 04/2013-03/2016

The project team, including researchers from Sandia National Laboratories, the University of Pennsylvania Wharton School, the California Center for Sustainable Energy, Vanderbilt University, and NREL, is developing an approach for designing social and economic incentives to enhance solar diffusion. The team is integrating individual-level data about solar adoption patterns with

data generated from Lab and field experiments and surveys to construct an individual-level computational model to predict solar adoption. They are using the model to drive agent behavior in an agent-based simulation, with agents' interactions captured using social influence variables. The team will use the model to forecast adoption patterns in response to alternative policy interventions, and use computational optimization techniques to arrive at candidate policies.

## **TOWARDS AN EMERGENT MODEL OF TECHNOLOGY ADOPTION FOR ACCELERATING THE DIFFUSION OF RESIDENTIAL SOLAR PV**

University of Texas | Austin, TX | \$0.50M | SEEDS | 04/2013-03/2016

The goal of energy market transformation is to identify and target existing market barriers. Comprehensive analysis is needed to quantify peer influences, information dissemination, and other factors that, in addition to technical and financial factors, are barriers to major adoption. For this project, university researchers are acting as visiting scholars, or scholars in residence, hosted by six Texas electric utilities. Researchers have access to rich datasets that are enabling them to analyze real-world market barriers. The results will inform a pilot project that the researchers will run with partner utilities.

## **THE INFLUENCE OF NOVEL BEHAVIORAL STRATEGIES IN PROMOTING THE DIFFUSION OF SOLAR ENERGY**

Yale University | New Haven, CT | \$1.9M | SEEDS | 04/2013-03/2016

Communities across the U.S. are instituting Solarize programs in which homeowners band together to collectively purchase rooftop solar systems. This project is quantifying the effectiveness, cost-effectiveness, and scalability of this and other strategies that leverage social interactions to accelerate diffusion of solar technologies. Researchers from Yale University and New York University are designing and running a series of randomized field trials to study the new Solarize Connecticut program. The field tests are being implemented with partner SmartPower.

## **EVALUATING THE CAUSES OF PHOTOVOLTAICS COST REDUCTION: WHY IS PV DIFFERENT?**

Massachusetts Institute of Technology | Cambridge, MA | \$0.49M | SEEDS | 04/2013-03/2016

For half of a century, PVs have experienced a 20% cost reduction every time cumulative production doubles. This rate of technological improvement is unmatched by other competing energy technologies. Yet, there exists no practical explanation for this empirically observed trend. This project is investigating a wide range of hypotheses for describing the technology evolution process to form an overarching theory that can be applied to accelerate cost reductions in solar.

## **HELIOS: UNDERSTANDING SOLAR EVOLUTION THROUGH TEXT ANALYTICS**

SRI International | Arlington, VA | \$0.60M | SEEDS | 04/2013-06/2015

Machine learning is a powerful computational tool that underlies an array of complex tasks from weather prediction to email spam filtering. By reading and organizing a massive amount of data from disparate sources, the tool can uncover and exploit buried patterns in the data. For this project, SRI is developing the Helios platform to detect unseen technological breakthroughs and bottlenecks for solar technologies by analyzing decades' worth of scientific publications and patents.

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## FORECASTING AND INFLUENCING TECHNOLOGICAL PROGRESS IN SOLAR ENERGY

University of North Carolina | Charlotte, NC | \$0.95M | SEEDS | 04/2013-03/2016

Researchers from University of North Carolina-Charlotte, Arizona State University, and University of Oxford aim to make better forecasts of future cost reductions for new energy technologies. By abstracting the process of technological progress as a time-varying network of interconnected components, the team is employing a new theory to help inform optimal investment strategies in the R&D pipeline. This will help the industry more quickly and cost-effectively achieve technical and deployment goals. By analyzing hundreds of years' worth of patent data and historical cost and production data, the team is constructing a network—called a “technology ecosystem”—to forecast and influence technological progress

## NATIONAL UTILITY RATE DATABASE

Illinois State University | \$0.85M | Soft BOS | 09/2011-08/2014

The National Utility Rate Database was created by the National Renewable Energy Laboratory in 2010 as a free, web-based tool in which the energy analysis community could contribute, edit, and download utility rate data. Illinois State University was selected to populate, maintain, and improve the database.

## PVMAPPER UTILITY SCALE SITING TOOL

Boise State University | \$2.8M | Soft BOS | 09/2011-08/2014

This project created an open source, project planning tool based on geographic information systems that optimizes siting for utility-scale solar developments. The tool enables users to assess sites based on quantifiable physical characteristics and constraints of the natural resource as well as military, land use, solar resource, water resource, and public acceptance factors.

## NATIONAL SOLAR PERMITTING DATABASE

Clean Power Finance | \$3.0M | Soft BOS | 09/2011-08/2014

This database is designed to help streamline and reduce the time and costs attributed to the solar permitting process. The community-based online tool compiles the most complete and accurate permitting requirements from solar professionals and local authorities in one single online location.

## REGULATORY AND UTILITY SOLUTIONS TO ADVANCE SUNSHOT INITIATIVE GOALS

Interstate Renewable Energy Council | \$3.0M | Soft BOS | 09/2011-08/2014

IREC and its sub-partners, Keyes, Fox & Wiedman, and others, will work to dramatically expand market opportunities for solar PV by pursuing fair and transparent solar pricing and interconnection policies (for all parties – utilities, solar developers and consumers) in the 20 states with the highest potential for significant solar PV market growth. IREC will work to analyze and suggest collaborative remedies (for debate by all stakeholders) to the technical and administrative barriers still impacting cost-effective interconnection and transmission in the 10 states poised to achieve the highest penetrations of solar PV. This award will support IREC in encouraging technical and policy studies that drive solutions to the incorporation of high-penetration solar PV scenarios into utility planning and operations management activities in the five states with the highest solar PV penetrations. IREC will also provide technical assistance to communities and states that wish to explore community and shared solar models.

## INNOVATIVE SOLAR BUSINESS MODELING

Rocky Mountain Institute | \$0.68M | Soft BOS | 09/2011–08/2014

RMI is developing and pilot testing a new utility business modeling tool: EDGE—the Electricity Distribution Evaluator. EDGE is a MATLAB-based simulation tool designed to comprehensively assess the distributed energy resource value proposition in different regulatory and utility business model environments based on a detailed assessment of the technical and operational implications. With its SunShot funding, RMI has accelerated the creation and adoption of innovative approaches to utility regulation, rate design, and business models to enable high-penetration deployment of distributed solar PV. New approaches are necessary to avoid conflicts between the interests of solar customers, utility ratepayers, utilities, and other stakeholders as penetration of solar PV increases. RMI will convene leading experts, policymakers, and industry thought leaders to identify best practice solutions to potential barriers, taking into consideration new technologies and value-creation opportunities in grid integration. RMI will disseminate information about best practice solutions to regulators, utilities, and other stakeholders nationwide. Intensive engagements with regulators and utilities in targeted states will accelerate innovation, implementation, and learning in areas with high penetration of solar PV.

## HAWAII'S CLEAN ENERGY TRANSFORMATION AND GRID CONNECTION

Hawaii Dept. of Business, Economic Development & Tourism | \$0.70M | Soft BOS | 09/2011–08/2014

The Hawaii State Energy Office, housed within the HDBEDT, will use SunShot funds initially to support a technical review committee (TRC) to provide technical assistance and advice to the Public Utility Commission on grid interconnection-related tasks, advised by the Reliability Standards Working Group. TRC staff will evaluate and further refine the findings of the reliability standards studies developed by Hawaiian utilities, and then establish technical reliability standards. To the extent that the existence of reliability and/or curtailment challenges of integrating more variable renewables—including feed-in tariff resources—on any of the islands served by the Hawaiian Electric Companies are validated, this award will support the HDBEDT in performing and managing state utility commission studies by qualified technical entities to identify near-term, mid-term and long-term solutions for each island, and work to implement those solutions as quickly as possible. The award will also support updates to Hawaii's state clean energy permitting tools.

## LONG-TERM MONITORING OF UTILITY-SCALE SOLAR ENERGY DEVELOPMENT AND APPLICATION OF REMOTE SENSING TECHNOLOGIES

Argonne National Laboratory | Chicago, IL | \$0.38M | National Laboratory R&D | 11/2013–09/2014

To date, a comprehensive approach to long-term monitoring for utility-scale solar development in the desert southwest has not been established. Under this agreement, Argonne National Lab's researchers are developing appropriate, cost-effective approaches for long-term monitoring of potential environmental impacts, including the evaluation of **1)** actual direct, indirect, and cumulative impacts compared to predicted environmental impacts; **2)** the effectiveness and/or appropriateness of measures taken to avoid or minimize impacts at the project site; and **3)** the effectiveness of regional, compensatory mitigation investments. As part of this effort, Argonne is partnering closely with the U.S. Bureau of Land Management, which is actively engaged in developing such programs for solar development in designated solar energy zones on public lands. Ultimately, this agreement helps lay the foundation for rapid and streamlined installation of large-scale solar on public lands, lowering the costs and helping to double renewable energy generation again by 2020.

# Soft Costs of Solar Deployment

## **WATER USE BY PV SUPPLY CHAIN**

National Renewable Energy Laboratory | Golden, CO | \$0.35M | National Laboratory R&D | 10/2013-09/2014

NREL will build off the foundational work conducted in the *Sunshot Vision* Study to provide a more comprehensive assessment of the water use benefits and tradeoffs associated with high penetration of solar power technologies. NREL proposes to fill gaps in the analysis of use and trade-offs (economic and environmental) concerning PV water use relative to water use by other energy technologies. The results of this project will provide deliverables supporting the DOE SunShot Program as well as the United States' leadership of and contribution to the International Energy Agency (IEA) Implementing Agreement on Photovoltaic Power Systems Task 12 on Environmental Health and Safety.

## **REDUCING PROJECT RISK THROUGH ANALYSIS OF SOLAR PV RELIABILITY DATA**

Sandia National Laboratories | Albuquerque, NM | \$1.3M | National Laboratory R&D | 10/2012-09/2015

This research builds a database of operational PV production in existing installations, eventually targeting 100 MW of long-term operating data. Through analysis of production and system maintenance, Sandia's research will help delineate the actual maintenance costs and optimal maintenance schedules for various sizes and configurations of PV equipment, helping to reduce uncertainty and risk in financing and insuring PV installations. The work refines the PV Reliability, Operations & Maintenance (PVROM) database and calculator, an open platform tool to track reliability.

## **SOLAR LOADS AND ROOFING STRUCTURES: WHEN IS ADDITIONAL ENGINEERING NEEDED?**

Sandia National Laboratories | Albuquerque, NM | \$1.4M | National Laboratory R&D | 10/2012-09/2015

In many jurisdictions, building inspectors require a stamped engineer's review of blue prints to assure that solar rooftop installations will not require structural upgrades to comply with building codes. This can add hundreds, if not thousands of dollars to an individual installation's cost. Through this agreement, Sandia tested the most common residential roof structures in U.S. domestic housing to determine actual load bearing capacity based on applicable national structural regulations (i.e., ASCE 7-10) and developed mitigation designs as necessary to bring inadequate structures up to code. Sandia is now disseminating this information and educating solar professionals on structural aspects of rooftop installations through workshops, conferences, and publications in peer reviewed and trade journals. In early 2015, Sandia will issue a final nationally-applicable Solar Structural Guide.

## **SOLAR GLARE HAZARD ANALYSIS AND SITING TOOL**

Sandia National Laboratories | Albuquerque, NM | \$1.1M | National Laboratory R&D | 10/2012-09/2015

With growing numbers of solar energy systems being proposed and installed throughout the United States, the potential impact of glint and glare from PV modules, concentrating solar collectors, receivers, and other components is receiving increased attention as a potential hazard or distraction for pilots, air-traffic control personnel, motorists, and residents. (Glint is defined as a momentary flash of light, while glare is defined as a more continuous source of excessive brightness relative to the ambient lighting.) Through this agreement, Sandia has developed a free, internet accessible tool (SGHAT) that allows participants to input simple installation assumptions and orientation, and receive within minutes a detailed analysis of potential glint and glare by time of day and seasonally across the year for that installation.

## Training a Strong Solar Workforce

SunShot supports the creation of consistent, high-quality workforce training and skills credentialing in the solar industry and beyond. These programs ensure that consumers receive optimal production and safety from PV installations, and increase consumer confidence. In addition, SunShot also supports partners that are training current and future engineers to not only integrate renewable energy into the grid, but to transform the electric utility sector into a marketplace that supports innovation.

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## Integrated Skills for a Growing Clean Energy Workforce

SunShot created the Solar Instructor Training Network (SITN) to help establish a well-trained and highly-qualified solar energy workforce of sufficient size and diversity to meet the estimated needs of the United States for PV installation, based off of projections by the National Renewable Energy Laboratory and the Solar Foundation that the U.S. will require up to 250,000 workers by 2030. Through SITN, the number of qualified instructors in the U.S. for PV installation and skills training has grown from less than 60 in 2006 to nearly 1,000 today. These qualified, credentialed instructors are based in approximately 400 accredited community colleges, technical high schools and labor training centers. SITN is coordinated by a national administrator, which manages nine Regional Training Providers (RTPs) who partner with local institutions in each state the RTP serves. Through SITN, SunShot has supported the development of the Solar Career Map, best practice training manuals, open source curricula, specialty support for veterans and commercial installers, solar rooftop inspection training for municipal building inspectors, and more.

### **NATIONAL ADMINISTRATOR OF THE SITN**

Interstate Renewable Energy Council | Latham, NY | \$4.9M | SITN | 10/2010-12/2015

IREC serves as the national point of contact for the network, conducting outreach to disseminate its products and best practices. IREC has led the development of a robust national infrastructure that can meet the employment needs of a rapidly growing domestic solar industry. The group manages the network's collaboration, coordinates joint activities, and works with a broad set of stakeholders to prioritize and address issues related to solar workforce training. IREC assesses instructional quality by credentialing programs and led the formation of the North America Board of Certified Energy Practitioners.

### **NORTHEAST SOLAR PHOTOVOLTAIC INSTRUCTOR TRAINING PROVIDER**

Hudson Valley Community College | Malta, NY | \$0.96M | SITN | 01/2010-12/2014

**States served:** Maine, Vermont, New Hampshire, New York, Massachusetts, Rhode Island, Connecticut

Hudson Valley has worked with 25 partner institutions in the Northeast to establish a network of Institute of Sustainable Power Certified instructors across the seven northeastern states and develop a solar PV training facility (the Training and Education Center for Semiconductor Manufacturing and Alternative and Renewable Technologies, or TEC-SMART) that will support future instructor training in the region.

# Soft Costs of Solar Deployment

## **NORTHEAST SOLAR INSTRUCTOR TRAINING PROVIDER-NORTH**

Kennebec Valley Community College | Fairfield, ME | \$1.0M | SITN | 01/2010-06/2015

**States Served:** Maine, Vermont, New Hampshire, New York, Massachusetts, Rhode Island, Connecticut

Kennebec Valley Community College serves the same northeastern states as Hudson Valley, with a specialty in commercial PV installation training. SunShot previously supported KVCC as the National Solar Thermal Training Provider, and KVCC retains solar thermal training equipment and instruction expertise. KVCC partners with additional community colleges and International Brotherhood of Electrical Workers (IBEW) labor training centers in the Northeast.

## **NORTHERN MID-ATLANTIC STATES SOLAR INSTRUCTOR TRAINING PROVIDER**

Pennsylvania State University | University Park, PA | \$1.1M | SITN | 01/2010-12/2014

**States Served:** Pennsylvania, New Jersey, West Virginia, Delaware

By engaging a broad spectrum of stakeholders, including roofing industry and organized labor partners, the Pennsylvania State University's Northern Mid-Atlantic Solar Regional Training Center will support a comprehensive training infrastructure for sales, design, installation, commissioning, and service of both solar PV and solar heating and cooling technologies.

## **SOUTHERN MID-ATLANTIC PROVIDER OF SOLAR INSTRUCTOR TRAINING**

North Carolina State University/ NC Solar Center | Raleigh, NC | \$1.0M | SITN | 01/2010-12/ 2014

**States Served:** North Carolina, South Carolina, Maryland, District of Columbia, Virginia

SMAPSIT provides classroom and mobile training instruction in PV installation and technical sales, and training for building code officials throughout the five states it serves. By collaborating with a local energy industry leader, North Carolina State University will also provide additional professional development opportunities to the local workforce such as providing apprenticeships with companies.

## **SOUTHEASTERN SOLAR TRAINING NETWORK**

Florida Solar Energy Center-University of Central Florida | Cocoa, FL | \$1.0M | SITN | 01/2010-12/2014

**States/Territories Served:** Florida, Georgia, Alabama, Mississippi, Tennessee, Kentucky, Arkansas, Puerto Rico and the U.S. Virgin Islands

SSTN has developed industry-recognized energy training centers throughout the southern U.S, building courses in Master of Science, Technical Sales and other related PV and electrical coursework. SSTN's programs will create a trained pipeline of workers to meet current and future employment demands needed by the solar industry.

## **MIDWEST PROVIDER OF SOLAR INSTRUCTOR TRAINING**

Midwest Renewable Energy Association | Custer, WI | \$1.0M | SITN | 01/2010-12/2014

**States Served:** Wisconsin, Minnesota, Iowa, Illinois, Indiana, Ohio, Michigan

With leader campuses in each state served, annual conferences and robust web-based curricula sharing tools, the Midwest Provider of Solar Instructor Training has energized the heartland with instructor development opportunities and trainings for

local building inspectors. The program has used team learning methods and collaborative technologies to create instructional resources. It maintains a mobile training unit and offers a broad array of professional solar development courses.

## **SOUTH CENTRAL SOLAR INSTRUCTOR TRAINING PROVIDER**

Energy Institute at Houston Community College | Houston, TX | \$0.75M | SITN | 01/2010-12/2014

**States Served:** Texas, New Mexico, Arizona, Louisiana, Missouri, Oklahoma

This partnership will establish a network of educational, industry, and state partners to ensure the availability and effectiveness of solar installation training throughout the region. This project will also provide professional development opportunities for educators at institutions that wish to start or improve training and education programs in solar installation.

## **ROCKY MOUNTAIN SOLAR TRAINING PARTNERSHIP**

Salt Lake Community College, Solar Energy International, and the Utah Solar Energy Association | Salt Lake City, UT | \$1.3M | SITN | 01/2010-06/2015

**States Served:** Utah, Colorado, Wyoming, Nevada, Arizona, Alaska, Washington, Oregon, Montana, Idaho, North Dakota, South Dakota, Kansas, Nebraska

Rocky Mountain covers the vast Western Plains, providing PV training equipment and instruction to PV trainers at community, tribal and technical colleges. RMSTP also trains county and city building code officials in solar inspection techniques. Participating institutions from states within the region will be selected through a competitive process. RMSTP provides train-the-trainer courses via mobile training vehicles, the Internet and hands-on workshops, based on Solar Energy International's nationally recognized solar PV curricula.

## **CALIFORNIA-HAWAII SOLAR INSTRUCTOR TRAINING PARTNERSHIP**

California Community College Chancellors Office and the University of Hawaii System | San Francisco, CA | \$1.0M | SITN | 01/2010-12/2014

**States Served:** California and Hawaii

Serving the more solar-developed markets of California and Hawaii, this partnership offers more advanced training, veteran-specific partner institutions, a Spanish-language PV training curricula, and certification program for solar PV instructors. CA-HI organizes building code official trainings, and provides professional development and curricular resources to California Community College faculty, Hawaiian university and community college faculty, regional occupational programs, and technical high schools.

## **ONLINE MULTIMEDIA VIDEO MODULES FOR TRAINING CODE INSPECTORS AND PV INSTALLERS**

Sandia National Laboratories | Albuquerque, NM | \$0.14M | National Laboratory R&D | 10/2012-09/2014

Sandia and New Mexico State University have partnered to produce multimedia training tools and resources, and deliver trainings to solar installers, building and electrical inspectors and others regarding technical topics in PV installations (rooftop and ground mount, residential and commercial scale). Materials are available in print, video, flash memory, and through PDA devices and are Internet accessible, at no cost, to installers and inspectors in the field. NMSU and Sandia have produced more than 20 "special topics" in short video format, delivered through the web, on PV installation practices.

## Human Talent for a New, Robust and Integrated Electrical Grid

Grid Engineering for Accelerated Renewable Energy Deployment (GEARED) is designed to help support increased power system research, development, and analytical capacity nationwide at the university and graduate level while simultaneously growing the expertise and preparedness of current and incoming electric utility sector professionals for high penetrations of solar and other distributed energy technologies.

### **NATIONAL NETWORK ADMINISTRATOR OF GEARED**

Interstate Renewable Energy Council, Solar Energy Power Association | Latham, NY & Washington, DC | \$1.1M | 10/2013–09/2018

IREC and SEPA co-lead the GEARED network, presenting innovative approaches and networking strategies to grow the expertise and preparedness of current and future electric utility sector professionals for high penetrations of solar and other distributed technologies. This unique partnership of utility and workforce expertise will connect utilities, clean energy businesses, educational institutions, and credentialing organizations as integrated national stakeholders.

### **FEEDER: FOUNDATIONS FOR ENGINEERING EDUCATION FOR DISTRIBUTED ENERGY RESOURCES**

University of Central Florida | Orlando, FL | \$3.2M | GEARED | 10/2013–09/2018

The FEEDER center will help establish cross-institutional smart grid curriculum, facilitating research collaborations among its academic, utility and industrial partners, and incorporating the latest and most relevant research findings into new educational materials and courseware. The new power systems engineers and engineering faculty emerging from FEEDER will accelerate the deployment of distributed renewable energy technologies onto the electric utility grid. FEEDER will also research technological components such as distributed control, optimization, advanced communication, renewable generation and smart grid integration.

Consortia: University of Central Florida, Auburn University, Florida State University, University of Arkansas, University of Florida, University of Kentucky, University of South Carolina, National Renewable Energy Laboratory, Los Alamos National Laboratory, Southern Company, Duke Energy, Florida Power & Light, Tennessee Valley Authority, Kentucky Power, Orlando Utilities Commission, Lakeland Electric, East Kentucky Power Cooperative, ABB, LEIDOS, L-3 Communications, Mitsubishi Power Systems Americas, Northern Plains Power Technologies, OSIssoft LLC, S&C Electric Company, SAIC, Schneider Electric, Siemens, United Technology Corp.

### **LEVERAGING INDUSTRY RESEARCH TO EDUCATE A FUTURE ELECTRIC GRID WORKFORCE**

Electric Power Research Institute | Knoxville, TN | \$4.2M | GEARED | 10/2013–09/2018

EPRI will define and develop educational offerings for all levels: high school students, undergraduate and graduate students, practicing engineers pursuing a professional master's degree or graduate certificate, and mature and experienced engineers keen on understanding and developing skills to design, plan, operate, and protect the evolving energy systems which constitute the smart grid. To accomplish this task, EPRI will rely on previous and ongoing high-level research within the project team. The implementation phase will have undergraduate and graduate program components, as well as a variety of custom tailored short courses, tutorials, workshops, symposia, open access courses, and other methods of delivery in accordance with the program priorities set in consultation with our utility members for the benefit and development of all aspects of their diverse workforce.

Consortia: Georgia Institute of Technology, Clarkson University, University of North Carolina-Charlotte, University of Puerto Rico-Mayaguez; Central Hudson Gas and Electric, Consolidated Edison, Inc., CPS Energy, DTE Electric Company, Duke Energy, First Energy, Lincoln Electric System, LG&E and KU, National Grid, New York ISO, New York Power Authority, and Southern Company Services.

## **SOUTHWEST UNITED STATES OF AMERICA: DISTRIBUTED TECHNOLOGY TRAINING CONSORTIA (SWUSA)**

Electricore | Valencia, CA | \$2.3M | GEARED | 10/2013-09/2018

SWUSA will create power and energy systems training, curricula, and workforce preparedness through the inclusion of data collection and analysis, power systems expertise, and application-specific training activities which build on fundamental principles, modeling and simulation tools, field-immersed training and methods of performance validation. The outcome of the program will result in better prepared and greater numbers of graduates ready to contribute to the field of power systems which depend upon the safe, reliable and efficient generation sources which make up an increasingly diverse mix of renewable power. Additionally, the program will deliver critical training modules which are intended to support mid-career professionals and be woven into utility training programs used all over the country.

Consortia: University California-San Diego, San Diego State University, Arizona State University, University of Hawaii-Manoa, San Diego Gas & Electric, Southern California Edison, Pacific Gas & Electric, Maui Electric Company, Lawrence Berkeley National Laboratory and California Independent System Operator Corporation.

## **MARMET: MIDAMERICA REGIONAL MICROGRID EDUCATION AND TRAINING CONSORTIUM**

Missouri University of Science & Technology | Rolla, MO | \$4.3M | GEARED | 10/2013-09/2018

MARMET will integrate cutting-edge research and advanced instructional methods to create a flexible, evolving approach to microgrid training for all levels of students. Scalability, reliability, stability, controllability, and resiliency are just a few of the operational areas to be impacted, especially by electric utilities. Researchers globally are addressing these issues, but MARMET proposes to rapidly develop modular material to capture and reflect the newest trends in electric power engineering and to make it available in traditional and non-traditional settings.

Consortia Organizations: University of Illinois, Iowa State University, University of Wisconsin, Ameren Services, City Utilities, National Rural Electric Coop Association, and Perfect Power Institute.

# Soft Costs of Solar Deployment

## **SOLAR UTILITY NETWORK DEPLOYMENT ACCELERATION (SUNDA)**

National Rural Electric Cooperative Association | Arlington, VA | \$3.6M | SUNRISE | 10/2013-09/2017

The National Rural Electric Cooperative Association (NRECA) with its partners, the National Rural Utilities Cooperative Finance Corporation, the Federated Rural Electric Insurance Exchange, and Power Secure will work closely with a cohort of 15 rural electric cooperatives (coops) in 17 states to integrate more than 23 MW solar assets rapidly and cost-effectively. The team helps accelerate solar adoption at electric coops through standardized designs, streamlined financing, packaged insurance, group equipment purchasing, and extensive training and outreach. The number and diversity of cooperatives that are participating in this program is impressive. Not only are the coops geographically diverse, but they also differ in the number of customers they service, workforce and solar expertise. The team has an aggressive target of getting to a solar installed cost of \$1.6/W without subsidies by 2017. The project is designed to help lower the cost of solar deployment across rural America. The impact of NRECA's work will be felt beyond the over 900 cooperatives serving our rural communities in bringing de facto standards for integrating solar assets in rural communities.

Participating cooperatives include: Anza Electric Cooperative, Inc. (CA), Brunswick Electric Membership Corp. (NC), CoServ Electric (TX), Eau Claire Energy Cooperative (WI), Great River Energy (MN), Green Power EMC (GA), Maquoketa Valley Rural Electric Cooperative (IA), Oneida-Madison Electric Cooperative (NY), Owen Electric Cooperative (KY), Pedernales Electric Cooperative (TX), Plumas-Sierra Rural Electric Cooperative (CA), Sandhills Utility Services, LLC (NC), Sussex Cooperative (NJ), Tri-State Generation & Transmission Association (CO), Vermont Electric Cooperative (VT).

## Developing Solar Finance and Business Solutions

SunShot supports work in finance, real estate, community and shared solar development by working with financial institutions, project developers, and manufacturers to unlock new streams of capital to support solar deployment.

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### SOFT COST MODELING AND ANALYSIS

Achieving the SunShot cost targets will require aggressive cost reductions in every aspect of the PV supply chain. In order to track progress and identify key pathways to reducing those costs, DOE and stakeholders need transparent and credible information and analysis to quantify soft and hard costs more accurately.

Lawrence Berkeley National Laboratory | Berkeley, CA | \$2.2M | National Laboratory R&D | 10/2012–09/2015

LBNL researchers, in partnership with the National Renewable Energy Laboratory, will collect, synthesize, analyze, and disseminate comprehensive data on the installed price of U.S. PV systems via its annual Tracking the Sun report series and derivative journal articles and outreach activities. LBNL researchers will also track and analyze the installed utility-scale solar cost, price, and performance data—a rapidly growing sector of solar deployment. Finally, LBNL and NREL will partner with academic researchers to pursue innovative, “deep dive” research projects, such as an analysis of the impact of city-level permitting processes on residential PV prices and development times, and conducting a comparative analysis of residential PV system prices in the United States and Germany.

National Renewable Energy Laboratory | Golden, CO | \$4.5M | National Laboratory R&D | 10/2012–09/2015

NREL researchers, in partnership with LBNL, will provide quarterly syntheses of industry trends and detailed breakdowns of total and soft costs using bottom-up PV cost modeling; conduct analyses that will facilitate industry benchmarking and the development of future cost roadmaps, projections, and cost models; provide up-to-date, accurate project-level installed price data to populate the OpenPV Project database; and conduct analysis to better understand how third-party PV products are fundamentally changing customer-adoption decisions and ownership preferences. Finally, to better understand the domestic and global solar market, NREL researchers will perform international comparative analysis to inform the development of predictive models for future cost trajectories in the United States.

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### ADVANCED FINANCING MECHANISMS TO ACHIEVE SUNSHOT

National Renewable Energy Laboratory | Golden, CO | \$4.0M | National Laboratory R&D | 10/2012–09/2015

The project is designed to expand the availability and lower the cost of capital to deploy solar installations in the United States. The project will standardize, inform, and provide data to investors, developers, lenders, regulators, rating agencies, and other stakeholders in the renewable energy community to enable wide-scale adoption of solar energy through low-cost, consistent, and ubiquitous financing opportunities. This effort will engage solar, legal, financial and advisory industries to standardize solar

# Soft Costs of Solar Deployment

lease and PPA documents; educate various stakeholders on system and credit performance; develop best practices for system installation, operation and maintenance, and independent engineering in order to facilitate investor confidence systems; and comprehend rating agency and investor risk perspective by engaging rating agencies to provide “shadow ratings” on mock portfolios of residential and commercial assets. To help create these products, NREL organized the Solar Access to Public Capital Working Group, an assembly of over 150 leading organizations in the fields of solar deployment, finance, counsel, and analysis. Under this agreement, NREL also conducts thorough analysis of opportunities and barriers to capital market investment and bank lending for expanded solar deployment, and develops the datasets necessary to quantify the relevant risks enabling institutional investment in the asset class. Finally, NREL engages the banking industry to standardize solar loan documents, educate banks and their regulators on system and loan performance, and expand comprehension of best practices and activities in commercial PACE programs in order to materially expand lending activity for solar deployment.

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## RESIDENTIAL AND COMMERCIAL REAL ESTATE AND PV ENERGY SYSTEMS

When selling or purchasing a property with a solar installation attached, one might expect that installation to add value to the overall property. Prior to this agreement, however, property appraisers had no consistent valuation methodology and so often assigned a value of “zero” to the solar component of the home or building in question.

[Lawrence Berkeley National Laboratory | Berkeley, CA | \\$0.60M | National Laboratory R&D | 10/2012-09/2015](#)

LBL researchers (in collaboration with Sandia) are compiling data on residential and commercial solar installation pricing in a home sale transaction and developing an appropriate valuation tool (an algorithm and web tool) that calculates fair market value to solar installations that are part of a home/building. LBNL is pursuing a “cost” approach in developing a method for estimating historical average net-installed costs of PV systems, as well as labor and building costs, and correlating those net installed “cost” estimates of PV systems to actual PV property sales premiums to determine if, and to what degree, “cost” drives prices. This agreement addresses two SunShot objectives: decreasing costs by expanding access to low-cost financing options, and addressing policy and regulatory barriers to increase deployment.

[Sandia National Laboratories | Albuquerque, NM | \\$0.55M | National Laboratory R&D | 10/2012-09/2015](#)

Sandia researchers (in collaboration with Lawrence Berkeley National Laboratory) are compiling data on residential and commercial solar installation pricing in a home sale transaction and developing an appropriate valuation tool (an algorithm and web tool) that calculates fair market value to solar installations that are part of a home/building. Sandia is pursuing an “income” approach to improve this PV Value tool, in order to accommodate more complex utility rate structures, lease to purchase options, utility rate escalation, and tax and revenue considerations. Sandia will correlate the PV Value tool’s “income” value estimates with actual PV property sales premiums to determine if, and to what degree, “income” drives sales prices. The team also prepared and are disseminating training materials for property appraisers.

## THE SUNSHOT PRIZE: RACE TO THE ROOFTOPS

Open for registrations and applications | \$10.0M | 09/2012-01/2015

In September 2012, the Energy Department launched an audacious new market stimulation prize in support of the goals of its SunShot Grand Challenge, which aims to make solar competitive with fossil fuels by the end of the decade. The \$10 million SunShot Prize challenges the ingenuity of America's businesses and communities to make it faster, easier, and cheaper to install rooftop solar energy systems. Successful competitors will deploy at least 6,000 new rooftop PV installations in the U.S. at an average pre-subsidy, non-hardware cost of \$1 per watt. Winners will break this significant price barrier, considered to be unachievable a decade ago, and prove that they can repeatedly achieve a \$1 per watt, non-hardware cost using innovative, verifiable processes and business practices. The winners of the first phase of the competition will be announced in Fiscal Year 2015 with cash awards likely to be made in 2016. The prize competition is still open for registration and applications until December 31, 2014.