U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Challenges and Successes on the Path toward a Solar-Powered Community

Solar in Action

Tucson, Arizona

Includes case studies on:

- Financing with Clean Renewable Energy Bonds
- Solar Ready Homes Ordinance
- Financing with Power Purchase Agreements

SOLAR AMERICA CITIES

Part of the Solar America Communities program

October 2011

Tucson promotes solar in the community through highly visible installations on city-owned buildings. *Photo from The City of Tucson, NREL/PIX 18370*

Cover photos from iStock/10405326, View of the City of Tucson

About the U.S. Department of Energy's Solar America Communities program:

The U.S. Department of Energy (DOE) designated 13 Solar America Cities in 2007 and an additional 12 cities in 2008 to develop comprehensive approaches to urban solar energy use that can serve as a model for cities around the nation. DOE recognized that cities, as centers of population and electricity loads, have an important role to play in accelerating solar energy adoption. As a result of widespread success in the 25 Solar America Cities, DOE expanded the program in 2010 by launching a national outreach effort, the Solar America Communities Outreach Partnership. As the Solar America Cities program evolved to include this new outreach effort, the program was renamed Solar America Communities to reflect DOE's commitment to supporting solar initiatives in all types of local jurisdictions, including cities and counties. Visit Solar America Communities online at www.solaramericacommunities.energy.gov.

Tucson's Starting Point

Tucson was designated by the U.S. Department of Energy (DOE) on June 20, 2007, as a Solar America City. At that time, Tucson was a relatively mature city in terms of its solar development. Prior to receiving assistance through the Solar America Cities program, the city enjoyed the following benefits:

- A major revision of the state portfolio standard increasing funding and requirements for solar energy
- The final stages of regulatory approval for net metering and interconnection agreements
- A solar permit fee waiver introduced in 2005 to waive building department fees in solar installations up to $1,000
- A major investment in solar energy by the local utility
- More than 200 solar energy industry jobs
- A visible market presence for solar in the metropolitan housing market
- A greenhouse gas reduction goal of 25% below 2005 levels by 2030.

Tucson, located in the southwestern United States, also has excellent solar resource potential. In addition, Tucson has an investor-owned utility that was receptive to its efforts to promote solar and is now a partner in the drive to increase the deployment of solar energy technologies.

Building Partnerships and Setting Goals

The City of Tucson set a goal to install 2 megawatts (MW) of solar by 2015. Although Tucson entered the Solar America Cities program with significant resources for solar energy, very few resources had been allocated to technical assistance, market education, and community outreach. High-level objectives for Tucson's Solar America Cities efforts included:

- Expansion of the Tucson solar energy market through accelerated investments
- Transformation of financial market barriers into opportunities for solar energy installations

• Transformation of knowledge market barriers into opportunities for solar energy installations.

One of the first and most important steps taken by Tucson was to hire a solar coordinator. With a solar coordinator, Tucson was able to take stock of its existing solar successes and formulate a plan for leveraging those successes into growing the local solar market. The solar coordinator also helped the city identify opportunities for partnerships and cultivate relationships with partners who could help the city reach its solar goals.

The following partners were involved with the Tucson Solar America Cities project:

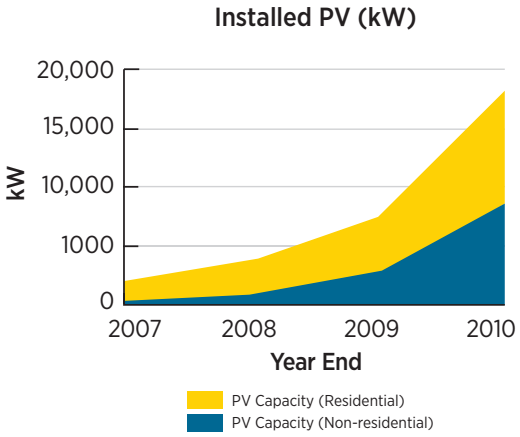
- Arizona State Department of Commerce Energy Office
- Greater Tucson Coalition for Solar Energy
- Tucson Electric Power
- Tucson-Pima Metropolitan Energy Commission.

Tucson established the Southern Arizona Regional Solar Partnership as part of its comprehensive approach to advance solar market expansion and to remove local market barriers. The partnership serves as a forum for coordinating a regional marketing strategy to advance solar power.

Tucson's Solar America Cities program focused its activities on bringing together local government officials, utilities, and private partners to streamline regulations, educate citizens, and increase large-scale solar installations on city buildings.

Installed Capacity

Tucson



Installed PV capacity increase from December 31, 2007, to December 31, 2010

Key activities that the team identified to meet its overall solar goals were:

- Developing a City of Tucson Solar Energy Integration Plan and a Greater Tucson Solar Energy Development Plan
- Improving city regulations and building codes to help streamline the installation of solar systems
- Increasing the number of large-scale solar installations on city buildings. This was accomplished through the use of Clean Renewable Energy Bonds (CREBs) and Power

The Lee H. Brown Family Conservation Learning Center opened as Tucson's first Leadership in Energy and Environmental Design (LEED) Platinum-certified facility.
Photo from The City of Tucson, NREL/PIX 18372

The Hayden-Udall Water Treatment Facility phase I array is the first City of Tucson solar project to take advantage of the many large parcels of land in the metropolitan area. *Photo from The City of Tucson, NREL/PIX 18373*

Purchase Agreement (PPA) financing programs to fund larger photovoltaic (PV) systems than the city had ever installed

- Forming new partnerships with local organizations designed to educate the Tucson community. This effort included frequent speaking opportunities with these organizations, as well as coordinating with U.S. Representative Gabrielle Giffords' office in their monthly Solar 101 presentations.

Accomplishments and Highlights

Unlike other Solar America Cities, Tucson focused the majority of its resources on developing large-scale solar installations. Highlights of Tucson's accomplishments include:

- Seven projects totaling 1 MW were constructed in 2009 after the successful sale of nearly $8 million in CREBs.
- Tucson Mayor Bob Walkup and the Tucson City Council adopted the Solar Ready Homes Ordinance for solar hot water and PV.
- A PPA to construct a 1-MW PV solar energy facility was negotiated and signed.
- The city worked with other local governments in the Tucson area to share relevant experience with solar financing and planning.

Unlike most cities, Tucson focused resources on large-scale solar installations.

Case Studies: Successes and Challenges

Financing with Clean Renewable Energy Bonds

Tucson successfully developed and implemented a CREBs program, but not without some challenges. CREBs may be used by certain entities— primarily in the public sector— to finance renewable energy projects. The list of qualifying technologies is generally the same as that used for the federal renewable energy production tax credit.

CREBs may be issued by electric cooperatives, government entities (states, cities, counties, territories, Indian tribal governments, or any political subdivision thereof), and by certain lenders. CREBs are theoretically issued with a 0% interest rate. The borrower pays back only the principal of the bond, and the bondholder receives federal tax credits in lieu of the traditional bond interest.

For Tucson, there were few examples to follow for structuring a program that was favorable to the city. Eventually, Tucson was able to issue a 13-year bond that covered $7.6 million for seven projects.

The city obtained authorization for these bonds from the IRS in 2006. They carry no interest charges but allow the purchaser to take a tax credit in lieu of interest to allow cities that are not eligible for the 30% federal solar investment tax credit to finance renewable energy projects.

Due to the unique nature of these bonds, the city was able to place them even in difficult economic times. City staff and advisors have worked since then to complete the transaction.

The seven projects will net the city more than $3.4 million over the 25-year life of the solar equipment. The City of Tucson used the bond funds to expand its solar capacity from 220 kilowatts (kW) to more than 1.2 MW.

The projects are located throughout Tucson, from the far southeast side at the Public Safety Training Academy to the Hayden Udall Central Arizona Project (CAP) Plant west of town, and include two neighborhood centers—El Pueblo and El Rio—as well as Tucson's Information Technology

Building, a warehouse at Reid Park, and the Roger Road Reclaimed Water Reservoir.

At each location, the solar panels will produce electricity to cover a portion of the facility's electric load.

SPG Solar of Novato, California, installed the solar systems and will maintain them for 10 years under a service contract.

This is the first issuance of such bonds in the state of Arizona, although Sulphur Springs Valley Electric Cooperative in Wilcox, Arizona, received money from similar bonds issued by a national group of rural utilities last year and used the funds to pay for solar shade structures at schools.

Solar Ready Homes Ordinance

On June 17, 2008, the mayor and city council unanimously voted to require all new residences to be solar ready for electric (PV) and solar hot water. These rules are part of Tucson's effort to promote solar energy and reduce the amount of greenhouse gases produced by the city and its residents.

For PV, starting July 1, 2009, the rules required that all new single family homes or duplexes include a PV site plan for either installation of an actual PV system, or preparation for later installation of a PV system, in order to receive a building permit. This site plan must identify the best location(s) for a PV system, provide a roof structure strong enough to support the system, show an electrical load calculation for the system, and provide an electrical panel 240-volt circuit breaker labeled "reserved for photovoltaic."

For solar hot water, starting March 1, 2009, the rules required that all new single family homes or duplexes include in the plans either a solar hot water system or a stub out for later installation of a solar hot water system to receive a building permit. The water heater area must contain a 120-V electrical receptacle and have sufficient room for an 80-gallon water heater, an expansion tank, and a heat exchanger.

The Pennington Street Garage was the first city garage in Tucson to utilize solar power and was one of the first large-scale solar projects on a city facility. *Photo from The City of Tucson, NREL/PIX 18374*

The partnerships developed through Tucson's participation in the Solar America Cities program were an important part of the city's success in promoting solar. *Photo from Austin Energy, NREL/PIX 18402*

Financing with Power Purchase Agreements

Tucson was able to negotiate and sign a PPA for the construction of a 1-MW solar energy plant adjacent to a Tucson Water facility. The city wanted to utilize this new method of financing to allow a comparison with the CREBs financing and determine the strengths and weaknesses of each of these methods. The third-party PPA model allows a developer to build and own a PV system on the customer's property and sell the power back to the customer (who avoids most or all initial costs, as well as operations and maintenance responsibilities). The customer can receive a guaranteed price of electricity over the life of the contract, typically 15–25 years. The most common pricing scheme is fixed price, but some PPAs use a fixed-escalator scheme, where the cost of electricity produced increases at a predetermined rate, usually 2%–5% over the life of the contract.

An important component of a PPA is negotiating an appropriate and fair contract. At the heart of the issue is whether the city writes the PPA itself, or accepts the PPA provided by the PV contractor. In Tucson's case, the city chose to use the PPA provided by the contractor, which had both positive and negative results. On the positive side, the city was able to use an existing contract that had been vetted and used by others in the industry. On the negative side, there were many PPA contract details that, in the end, were more favorable to the contractor than to the city. Unexpected costs related to insurance, inspections, and permitting arose that the city had to cover or deal with. In the final analysis, the city determined that the real lesson learned was that it should develop a city-specific PPA for all future engagements that would provide for favorable conditions for the city and an even playing field for contractor responses to requests for proposals.

Top Takeaways

- For Tucson, recognition of the importance and value of partnerships was a key to the success of its solar program. From negotiating PPAs to developing ordinances for solar-ready homes, expertise shared by a variety of partners contributed greatly to increasing solar installations in Tucson.
- Encouraging solar on a tight budget is a challenge many cities face, and Tucson is continuing to successfully navigate this hurdle. By learning how to use creative financing and leveraging solar activities by others in and around Tucson, the city has been able to continue its solar program despite challenging financial times.
- Implementation of solar energy solutions by a city should be seen as an ongoing learning process. For example, as the city attempts to educate the population about solar technology and incentive programs, it is also educating itself about emerging technologies, policies, lessons learned, and best practices of other municipalities and organizations, as well as ever-changing incentive programs at the federal, state, and local levels. One enduring benefit of DOE's Solar America Cities program has been the knowledge sharing gained from the many meetings, conferences, and regional partnerships developed within the program. This network has greatly expedited the information sharing among the 25 cities and provided a boost to local programs.

From negotiating PPAs to developing rules for solar-ready homes, leveraging shared expertise is key.

Next Steps

Tucson developed groundbreaking solar financing models and streamlined solar permitting processes. New funding from the American Recovery and Reinvestment Act helps Tucson to scale up its most promising projects and concepts to overcome key barriers to urban solar energy use. As part of the Solar America Cities Special Projects funding, Tucson focuses on the following activities:

- Creative financing for municipal solar installations—Tucson explores innovative financing mechanisms for solar systems on city facilities, including Build America Bonds, New Market Tax Credits, and partnership flipping.

Build America Bonds are taxable municipal bonds that carry special tax credits and federal subsidies for either the bond issuer or the bondholder. New Market Tax Credits are used to spur revitalization efforts of low-income and impoverished communities. Partnership flipping is a financing arrangement in which a renewable energy developer and tax investor become partners in the ownership of a project. Typically the tax investor makes a larger initial investment in the project in exchange for a larger share of the income that is generated from power sales and tax incentives. Once an agreed-upon rate of return is reached for the tax investor, the income stream "flips" and the developer earns the majority of the project income.

- Solar one-stop shop—The city partners with Pima County to establish and maintain a central location and website that provide information and referral services for consumers, businesses, and the solar industry, including training opportunities and permitting assistance.
- Solar integration into green building codes and infrastructure planning—Tucson coordinates with planning and permitting staff to integrate solar and solar-ready requirements into green building certification processes and long-range city infrastructure planning.
- Additional PPAs—The city creates more PPA projects for solar development and implementation in addition to the one already developed.
- Refinement to codes—Tucson will continue with additional changes to the city and county zoning and land use code to facilitate large-scale solar development.
- More standardized permitting processes—Tucson will simplify and unify permitting requirements for solar throughout the region. Because administrative or "balance of system" costs including permitting can make up approximately 40% of the cost of a solar system, streamlining these processes helps make solar more affordable.
- Attract the solar industry—The city continues efforts to draw solar manufacturers and installers to the area to provide for job growth and economic prosperity.

View of the City of Tucson. *Photo from iStock/10405326*

Additional Resources

- City of Tucson Energy Office Web Page (with case studies of all city solar installations): www.tucsonaz.gov/energy/solarintucson.htm
- Tuscon Green Pueblo Map (with solar sites identified): www.greenpueblomap.org
- Southern Arizona Regional Solar Plan: www.pagnet.org/Programs/EnvironmentalPlanning/SolarPartnership/StrategicPlan/tabid/723/Default.aspx
- City of Tucson Solar Integration Plan: www.tucsonaz.gov/energy/Solar%20Plan%20Final.pdf
- Solar Ready Homes Information: http://cms3.tucsonaz.gov/devnews/news/solar-ready-ordinance
- Statewide Solar Information website (sponsored by the Arizona Corporation Commission): www.arizonagoessolar.org

For more city information, contact:
Bruce Plenk, Tucson City Solar Energy Coordinator Email: bruce.plenk@tucsonaz.gov Telephone: 520-837-6322

For more information on going solar in your community, visit *Solar Powering Your Community: A Guide for Local Governments* at http://solaramericacommunities.energy.gov/resources/guide_for_local_governments/

For more information on individual cities' solar activities, visit www.solaramericacommunities.energy.gov/solaramericacities/action_areas/

Ann Arbor Austin Berkeley Boston Denver Houston
Knoxville Madison Milwaukee Minneapolis-Saint Paul
New Orleans New York Orlando Philadelphia Pittsburgh
Portland Sacramento Salt Lake City San Antonio San Diego
San Francisco San José Santa Rosa Seattle **Tucson**

Clockwise from top left: *Photovoltaic system in Philadelphia Center City district (photo from Mercury Solar Solutions); rooftop solar electric system at sunset (photo from SunPower, NREL/PIX 15279); Premier Homes development with building-integrated PV roofing, near Sacramento (photo from Premier Homes, NREL/PIX 15610); PV on Calvin L. Rampton Salt Palace Convention Center in Salt Lake City (photo from Utah Clean Energy); PV on the Denver Museum of Nature and Science (photo from Denver Museum of Nature & Science); and solar parking structure system at the Cal Expo in Sacramento, California (photo from Kyocera Solar, NREL/PIX 09435)*

U.S. DEPARTMENT OF
ENERGY
Energy Efficiency &
Renewable Energy

EERE Information Center
1-877-EERE-INFO (1-877-337-3463)
www.eere.energy.gov/informationcenter

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

Prepared by the National Renewable Energy Laboratory (NREL)
NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

DOE/GO-102011-3221 • October 2011