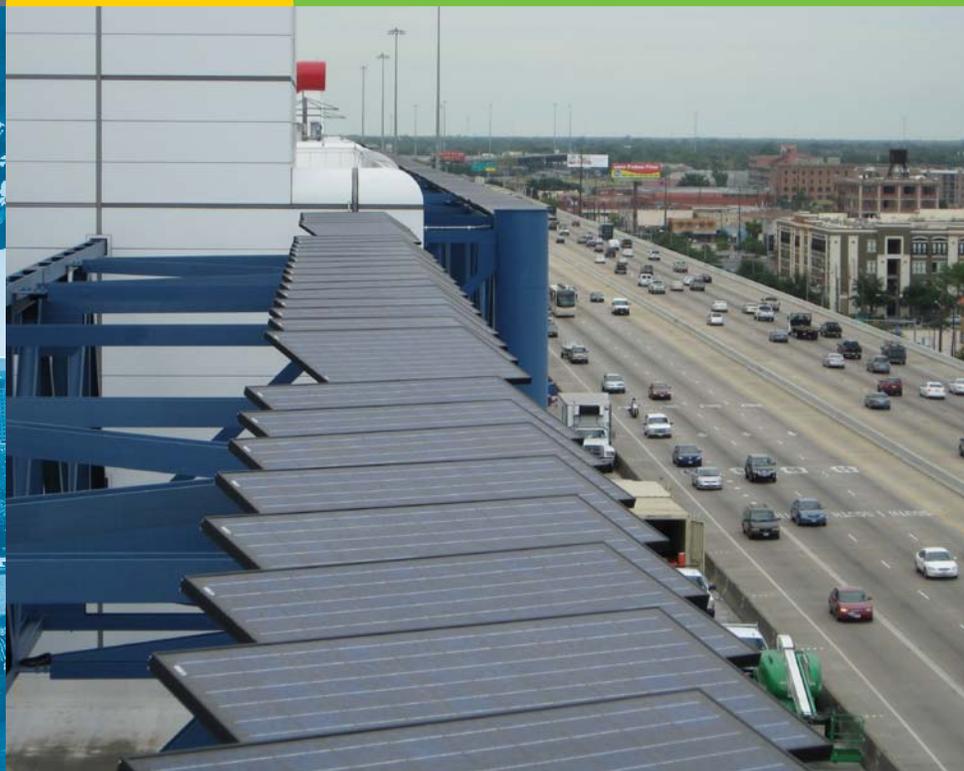


Challenges and Successes on the Path
toward a Solar-Powered Community

Solar in Action



Houston, Texas

Includes case studies on:

- Commissioning the George R. Brown Convention Center PV Demonstration
- Identifying Deed Restrictions for Solar Installations
- Developing an Implementation Plan for the Solar Houston Initiative
- Reviewing the Green Building Resource Center with Solar Showroom



A crystalline PV array, mounted on support structures, is highly visible on the George R. Brown Convention Center. Photo from City of Houston, NREL/PIX19380

Cover photos from iStock/9521436, downtown Houston

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.

Houston's Starting Point

Houston was designated by the U.S. Department of Energy (DOE) on March 28, 2008, as a Solar America City. Prior to its involvement in the Solar America Cities program, the City of Houston had implemented a variety of programs that are complementary to solar energy, including energy conservation measures, clean air initiatives, and pioneering wind power purchasing. Solar did not have a significant role in the city's energy plan primarily because there was no impetus to develop one, and the city did not have a municipal utility that was considering adopting the state's renewable portfolio standard regulatory incentive. In addition, due to the electric market's deregulation and restructuring in 1999, utilities serving Houston were not required to offer net metering to their customers (that is, they were permitted to compensate customers for electricity produced by distributed renewable energy generation systems and exported to the electric grid, but were not required to do so). In general, this has been viewed as an obstacle to solar development in the region.

Houston and its surrounding metropolitan area have historically faced significant challenges in terms of air quality and greenhouse gas emissions. In addition to typical metropolitan air quality issues, the city has been further challenged by its petrochemical refining industry and port operations. Therefore, Houston has made a concerted effort to improve air quality through several initiatives involving energy efficiency, conservation, and renewable energy technologies. In 2008, it was awarded the Green Power Leadership Award for being the largest municipal purchaser of renewable energy in the country. Houston has also been an active participant in the Clinton Climate Initiative.

Prior to being designated as a Solar America City by the DOE, Houston was part of a public-private partnership to develop a former brownfield space into an active civic amenity and green space that encompassed solar technologies and sustainable building practices. Discovery Green was developed into an urban park in 2008 and was a stimulus for residential and commercial development in downtown Houston, spurring the local economy. The entire park achieved a Leadership in Energy and Environmental Development (LEED) Gold rating. Contributing to the LEED rating, solar energy technologies produce electricity and heat water,

generating 8% of the park's total energy needs—enough to power the park's office.

The City of Houston also had small demonstration photovoltaic (PV) systems on municipal buildings (City Hall Annex and Code Enforcement Building) that enabled a larger project on the convention center, which is highlighted in this brochure.

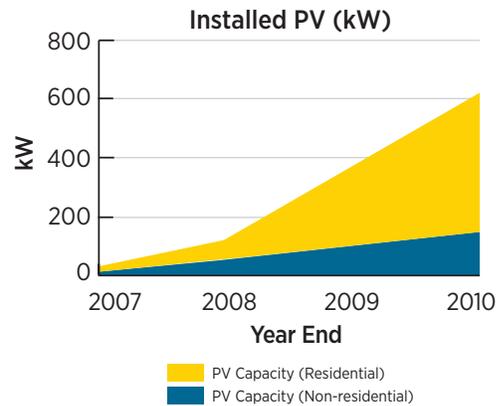
Building Partnerships and Setting Goals

The overarching goal of the City of Houston's involvement in the Solar America Cities program was to develop and implement the Solar Houston Initiative plan, which would guide the city in creating solar-related goals and methodologies to achieve a sustainable solar infrastructure. The city collaborated with the Houston Advanced Research Center (HARC) to manage its Solar Houston Initiative and create the solar plan. To assist in the plan's development and implementation, Houston also created the Solar Houston Advisory Council to work with the DOE technical assistance team. The advisory council consists of several local organizations from research, academia, and industry, including the following:

- City of Houston
- HARC
- BP
- CenterPoint Energy (the transmission & distribution utility serving the Houston area)
- Greater Houston Builders Association

Installed Capacity

Houston



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

- Houston Independent School District
- Houston Endowment
- Clinton Climate Initiative – Houston Office
- Houston Community College
- University of Houston
- U.S. Green Building Council – Greater Houston Area Chapter
- Texas State Energy Conservation Office
- Discovery Green Conservancy
- National Aeronautics and Space Administration



This thin film PV array is mounted on the roof of Houston's George R. Brown Convention Center. *Photo from City of Houston, NREL/PIX 19379*

Key activities that the team identified for inclusion in the solar plan were as follows:

- Identify and remove market barriers for the implementation of cost-effective solar energy.
- Develop and implement significant market-changing activities, including Houston-specific solar energy advancement policies, regulations, and legislation that promote cost-effective solar energy use.
- Develop a plan to make solar energy cost-competitive by 2015 through advancement of current and new technologies (PV and other) in partnership with the University of Houston.
- Identify focused locations (such as affordable housing, public facilities, schools, major campuses, emergency response facilities) with high visibility for demonstration sites, and implement programs to install solar energy systems at these locations.
- Select a focused neighborhood (affordable housing) and implement a solar program.
- Develop and implement educational and outreach programs aimed at consumers, homeowners, facilities managers, building owners, and service personnel (solar installers).
- Work with Houston Community College to incorporate solar technology into its green building curriculum.
- Work with the Houston Independent School District to develop and implement solar education into its K-12 curriculum.
- Work with the University of Houston to install a minimum of 1 megawatt (MW) of solar capacity for the main campus.

Accomplishments and Highlights

- Completed a 100-kW PV demonstration project at the George R. Brown Convention Center
- Conducted a study to identify deed restrictions for solar installations in Houston and the surrounding area
- Developed an implementation plan for the Solar Houston Initiative.

Case Studies: Successes and Challenges

Commissioning the George R. Brown Convention Center PV Demonstration

The Solar Houston Initiative, managed by HARC, partnered with public and private entities to develop the George R. Brown Convention Center Solar Pilot Program, the largest commercial solar demonstration project in Houston to date. Primary funding for the George R. Brown Solar Pilot Program was provided by the Houston Architecture Foundation through the support of the Houston Endowment,

Inc. The Houston Architecture Foundation contracted with HARC to manage the George R. Brown program. Additional project funding was provided by BP and CenterPoint Energy.

The George R. Brown Solar Pilot Program demonstrates a 100-kW direct current (kW DC) PV system, data measurement, and collection equipment, and a publicly displayed educational kiosk illustrating how solar energy is converted into electricity with real-time energy production data. The key outcomes of the project are as follows:

- Better understanding of the procurement, design, and contracting process for PV systems
- Recommended procedures for commissioning PV systems, including recommended testing and performance protocols
- Performance comparison of different solar PV technologies.

The turn-key installation included the design, installation, and commissioning of one 51.3-kW DC crystalline module array and a 49-kW DC amorphous thin-film system. The crystalline module array consists of BP modules and is located on the I-beam along the south side of the building, and is mounted on supports painted to match the color of the existing beams. The amorphous silicon thin-film array consists of Uni-Solar PV flexible thin-film panels and is installed on the southern portion of the George R. Brown Convention Center roof, adhered with Green Lock membrane adhesive. Each array is connected to a Satcon Photovoltaic PowerGate Plus 50 inverter. A weather station connected to an AcquiSuite DR™

A 100-kW PV demonstration project at the George R. Brown Convention Center is among the highlights of Houston's solar initiative.

data acquisition server gathers weather data, including solar irradiance, crystalline panel temperature, thin-film laminate temperature, ambient temperature, and wind speed. Finally, an information kiosk installed in the convention center's second floor hallway displays the amount of solar energy produced from the arrays, flash animation of how solar works, and an interview with Houston's mayor.

The systems were installed by Standard Renewable Energy (SRE), and were commissioned three times with different procedures. The results of each procedure concluded that the systems were performing as expected. The first commissioning was conducted by SRE in August 2009 under cloudy conditions, which prompted a second SRE commissioning 3 months later under sunny conditions. Different methods were used each time to determine the expected performance and to compare it with the actual performance. However, each instance produced similar conclusions. Sandia National Laboratories performed the third commissioning as a third-party entity. Although Sandia concluded the systems were performing within expectations, it also discovered that some modules were underperforming and suggested recalibrating the existing pyranometer (a device that measures sunlight on a surface) as well as installing an additional pyranometer in the same plane as the BP array.

The George R. Brown commissioning review process and lessons learned have resulted in the following recommended guidelines for commercial solar systems in the Houston area:

- Create a commissioning approach and plan that minimizes the impacts of shading and diffuse lighting on measurement instrumentation.
- Verify that sensors and measurement devices are calibrated and installed properly and appropriately matched to the system requirements.
- Use an appropriate expected system performance model for the installed solar technology; model accuracy varies by technology.
- In addition to evaluating energy production, include in system commissioning a thorough review of all components of the system design, such as sensors, data loggers, wireless transmitters/receivers, software applications, and visual displays.

The pilot program also charted the monthly and annual energy production for year 1 (August 2009 – July 2010) of the BP and Uni-Solar arrays with 61,757 kilowatt-hour (kWh) and 59,807 kWh AC generated, respectively, exceeding the solar

contractor guaranteed annual combined energy production by 15%.

Identifying Deed Restrictions for Solar Installations

The City of Houston was interested in having a better understanding of the potential barrier presented by deed restrictions and restrictive covenants in adopting solar energy technologies. Houston is unique when compared with other cities in the United States in that it does not have a formal zoning code that the city can use to plan what types of developments and uses will be permitted in certain areas of the city. Instead, developers, their attorneys, and property owners are left to protect the property by drafting restrictive covenants or deed restrictions. The city then enforces these individual restrictions when a conflict arises. City officials heard on numerous occasions that deed restrictions impede solar projects. Through its Solar America Cities grant, Houston commissioned a preliminary study to identify examples of how residential deed restrictions address solar energy systems. The following are results from the preliminary study:

- Within the Houston city limits, no examples of deeds were identified that address solar energy systems.
- Extending to the Houston suburbs, two examples of “positive” or “pro-solar” deed restrictions were found (ones that explicitly allow or encourage the development of solar).
- Based on examples that were found outside the Houston city limits (suburbs and other Texas cities), the study concluded that no neighborhoods explicitly prohibited solar, but some contained language suggesting that it may be difficult to receive neighborhood association approval for solar installations in certain neighborhoods, especially dependent on the orientation of the house.

The city concluded that despite anecdotal evidence of restrictive covenants posing problems for solar installations, there is little proof that such restrictions exist within the Houston city limits. It is possible that there is a perception of restrictions that promulgates by word of mouth, but in reality, they may not exist. If the perception continues and it remains a barrier to solar development, Houston may commission a more exhaustive search of each neighborhood within city limits to definitively determine the current state of deed restrictions for solar.

Solar advocates have proposed to the Texas Legislature that homeowners associations be prevented from using restrictive

language in their covenants that deter the installation of solar technologies, but no bills have been signed as of this writing.

Developing an Implementation Plan for the Solar Houston Initiative

The overarching goal of the City of Houston's involvement in the Solar America Cities program was to develop and implement the Solar Houston Initiative plan, which would guide the city as it creates solar-related goals and methodologies to achieve a sustainable solar infrastructure.

The plan describes all the activities and tasks of Houston's Solar America Cities efforts and makes recommendations for further actions.

The Process

Houston engaged HARC to assist with project management and formed a Solar Houston Advisory Council. The advisory council consisted of a broad cross-section of businesses, nonprofit organizations, and educational institutions.

The key activities undertaken to develop the plan are the following:

- Establish an advisory council.
- Research and identify barriers and best practices for solar deployment.
- Install PV demonstration projects.
- Participate in and support educational and outreach programs.
- Review the research conducted by the DOE technical assistance team.

Results

By coordinating with other local stakeholders and the DOE technical assistance team, and through researching various topics, Houston created a comprehensive plan specific to the conditions currently in place. The city determined that despite many of the barriers (perceived and actual), there are multiple ways that solar technologies can be promoted.

The following four program areas were identified for Houston's implementation plan:

Policy: The city should participate in a state-level solar policy group, working with the Public Utility Commission of Texas, Texas Renewable Energy Industries Association, or another group with similar goals. This would ally Houston with other communities to achieve state-level solar friendly initiatives.

Solar Integration: The city will maximize the use of solar through integration with all the various possible applications (lead by example through solar on municipal facilities), as well as incorporate solar requirements in energy, climate, and environmental planning, and through high-visibility projects.

Public Outreach and Education: An effective campaign can increase awareness of solar energy, demonstrate the viability of solar in Houston, inform the public about various resources that are available, and noticeably increase solar adoption.

Workforce Development: Focused training on green jobs is an effective way to encourage participation in renewable energy by low-income and minority populations. Green jobs career tracks include energy efficiency, weatherization, and solar installation. Several cities across the nation have taken the lead on this, and Houston's efforts can easily be modeled on these efforts.

Reviewing the Green Building Resource Center with Solar Showroom

An unexpected result that occurred during Houston's Solar America Cities effort was an unplanned outreach effort that educated building contractors and the general public with essentially no added investment by the city. Houston opened a Green Building Resource Center within its Code Enforcement Building with the purpose of demonstrating green building technologies. The resource center has one dedicated staff member from Public Works and Engineering who serves as the program director and is an advocate of energy efficiency and solar energy. The Green Building Resource Center has been designed as a combination waiting room for contractors obtaining building permits, a showroom, and a classroom, as well as a library of information. The space itself serves as a green building demonstration project. Members of the public may bring interim plans for review by the program director to identify opportunities to add green strategies to save energy and water, and make their building healthier. Visitors can peruse the shelves and displays, look at samples, learn about green building options, use an interactive workstation, or ask questions of the Green Building Resource Center director or the volunteer staff.

Many of the materials and technologies were donated or provided via other grants. The site includes a PV system with modules donated by BP Solar. Although the resource center was developed and funded to promote energy efficiency and green building technologies, the program director has taken the initiative to heavily promote solar energy by hosting solar workshops, providing input to contractors on the solar

permitting process and requirements, and hosting school groups interested in solar energy. It has become a tremendous solar resource and outreach medium for the solar community, the general contractor community, and the general public. The success of this resource center and its outreach efforts for solar energy is an example of how such a valuable resource can be created with minimal investment from the city (i.e., only one paid staff member and the space to house the center).

Top Takeaways

- Texas has a deregulated electricity market with the exception of municipal utilities and electric cooperatives, and the statewide “net metering” law is unclear and does not define net metering in the way that it is traditionally used in other locations—where customers receive a credit for the retail value of any excess electricity they produce. This has posed a challenge to solar PV development in Houston because only one retail electric provider in Houston has an established program to pay the retail value of any net excess generation from a customer’s PV system. Other retail electric providers offer only wholesale cost for exported energy. Other Texas Solar America Cities (Austin and San Antonio) have municipal utilities and are able to offer more incentives to customers to install solar energy systems. Houston, therefore, must focus on other efforts to encourage solar project development.
- All perceived barriers to solar development should be explored; however, it is possible that there is a perception of restrictions that promulgates by word of mouth but in reality may not exist. However, such perceptions should be taken seriously and researched so they can be supported with facts.
- The commissioning procedure for a PV system is essential to ensuring that a high-quality system is installed.

- Due to staff turnover and changing responsibilities, multiple advocates within the city should be identified and involved in solar initiatives to maintain momentum.
- Identify activities that require little or no city funding that can buffer the impact on city-run renewable energy efforts when political leadership changes. For example, the Green Building Resource Center provides tremendous public outreach for solar energy at minimal investment.

Next Steps

The city will use the recommendations made in the Solar Houston Initiative plan to identify the next set of actions to build the local solar market. Below is a sampling of recommended activities within each of the four program areas identified in the plan:

- **Policy:** Participate in a state-level solar policy group.
- **Solar Integration:** Continue to lead by example by installing renewable energy systems on municipal facilities.
- **Public Outreach and Education:** Create a community-based social marketing campaign for solar in the city.
- **Workforce Development:** Create partnerships involving training of low-income residents, and use trainees on municipal or other installations.

Additional Resources

- Solar Houston Initiative: www.solarhoustontx.org/
- Green Houston: www.greenhoustontx.gov
- City of Houston Green Building Resource Center: www.codegreenhouston.org

For more city information, contact:

Calvin Curtis, General Services Department, City of Houston Email: calvin.curtis@houstontx.gov Telephone: 832-393-8127

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/

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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)

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