



City Homes Go Solar!

Solar energy systems can provide clean, reliable energy for your home today. Solar-electric systems, also called photovoltaics (PV), generate electricity with no moving parts while solar heating systems can provide hot water or space heating. Since solar energy systems are more effective when combined with energy-efficient buildings, it's a good idea to install energy-efficient lighting, appliances, windows, and extra insulation to reduce your overall energy usage.

▲ The 95 energy-efficient homes in the **PREMIER GARDENS** subdivision in **SACRAMENTO, CALIFORNIA** incorporate solar-electricity generating roof tiles as standard features. These homes combine state-of-the-art, energy-efficient construction and appliances with a commercially available solar-electric system to create a home that saves up to 60 percent in electricity costs.



Credit: Energy Trust of Oregon, Inc.

▲ The 3.3-kilowatt photovoltaic system on this **PORTLAND, OREGON** home soaks in the sun. The owners were able to take advantage of financial incentives offered through the Energy Trust of Oregon's solar incentive program.

◀ This project paved the way for the **CITY OF BOSTON'S GREEN AFFORDABLE HOUSING PROGRAM**. In total, the City projects that roughly 900 kilowatts of PV will be installed on affordable housing developments by 2010.



Affordable Housing Goes Solar

▲ **MAVERICK LANDING** is a new mixed-income housing development that replaces an old public housing project in the waterfront community of East Boston. It includes a 37-kilowatt PV system, as well as numerous energy-efficient features. The Boston Housing Authority expects to save \$100,000 per year in energy costs through the use of the solar panels, on-site power generation, fiberglass windows and energy-saving lighting and motors. An information center in the building enables visitors and residents to learn about solar energy and the building's green design features.



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Credit: C. Bruce Foster

Solar Goes Commercial

Businesses in cities across the country are using solar energy to meet corporate sustainability goals and attract customers. From convention centers and baseball stadiums, to office buildings, warehouses and urban retail shops, businesses are choosing solar!

▲ **THE BREWERY BLOCKS**, located at the former site of the Blitz-Weinhard Brewery, is a five-block project in **PORTLAND, OREGON**'s Pearl District neighborhood. Brewery Block 4 features office space, an art institute, and ground floor retail that includes a mix of shopping, entertainment, and dining establishments with people-friendly streetscapes. This green building includes a rooftop photovoltaic (PV) array, in addition to building-integrated PV modules that are mounted on the southern façade between each of the window panels. Combined, the PV systems produce 21,600 kilowatt hours (kWh) of electricity annually.

▲ In May 2008, the World Champion **BOSTON RED SOX** became champions of solar energy. In collaboration with National Grid and the Bonneville Environmental Foundation, the Red Sox are installing a solar water heating system on the roof of Fenway Park. The solar system will provide approximately 37% of the hot water used at the ballpark. This is one of several efforts to make the park more environmentally sustainable before its 100th anniversary in 2012.



Credit: Xynega Solar



▲ This 540-kilowatt photovoltaic system at the **CAL EXPO** in **SACRAMENTO, CALIFORNIA**, produces enough energy to power about 180 homes. The solar arrays serve as an oasis of shaded parking for 1,000 cars in a desert of scorching blacktop. Cal Expo is the site of many events, including the California State Fair.

▲ The 1-MW photovoltaic system planned for the **ORANGE COUNTY CONVENTION CENTER** in **ORLANDO, FLORIDA**, will be the largest PV system in the southeastern United States. It is expected to occupy about 200,000 square feet of roof, and will generate 1.3 to 1.5 million kilowatt hours of electricity per year, equivalent to the amount needed to power 160 to 200 energy-efficient homes.

▲ The **CITY OF BOSTON** used geographic information system (GIS) mapping technology to determine that Boston has the technical potential to site between 670 and 900 megawatts (MW) of PV capacity on existing roofs. This amount of PV could supply approximately 14-19% of the city's 2006 electricity demand. Boston could also site a significant number of solar water heating systems around the city to reduce natural gas and fuel oil demand.





Photograph provided courtesy of Acciona

Solar Energy Plants Power Cities

Utility-scale concentrating solar power (CSP) systems capture the sun's heat in order to heat a liquid to produce steam. The steam is then used to power a turbine to generate electricity. CSP's relatively low cost and ability to deliver power when we need it most—during periods of peak demand—mean that it can be a major contributor to the nation's diversifying energy portfolio. With the addition of thermal storage, in which heat can be stored for later use, CSP technologies can provide power even when the sun isn't shining.

▲ **NEVADA SOLAR ONE**, developed by Acciona, is the first utility-scale CSP plant to be built in the United States in 17 years and is the third largest of its kind in the world. This 64-megawatt (MW) parabolic trough plant near Boulder City, Nevada, contains 182,000 curved mirrors spread over 400 acres. The plant was dedicated in February 2008.

Close-up of Nevada Solar One's parabolic troughs. ▼



Abengoa Solar signed a 30-year power purchase agreement with **ARIZONA PUBLIC SERVICE COMPANY (APS)** to build, own and operate a 280-MW CSP trough plant near Gila Bend, Arizona. This will be the largest solar plant in the world when it goes on-line in 2011. Named *Solana*, the plant will cover 1,900 acres, have six hours of thermal molten-salt storage, and will produce enough electricity to power 70,000 homes. Solana marks the first commercial plant in the United States to have thermal storage.



▲ Stirling Energy Systems plans to enter into a contract with **SAN DIEGO GAS & ELECTRIC (SDG&E)** to provide between 300 and 900 megawatts (MW) of solar power, approximately 30 times more solar power than is now being generated in the San Diego region. SDG&E will purchase all the output from the solar power plant over a 20-year period. The plant will consist of 12,000 Stirling solar dishes (like the ones pictured) on approximately three square miles in the Imperial Valley of Southern California.

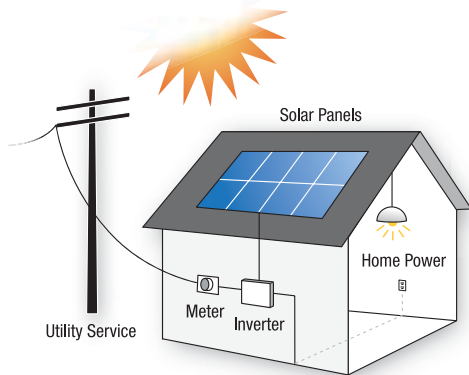


How Solar Works

What is a solar electric or photovoltaic system?

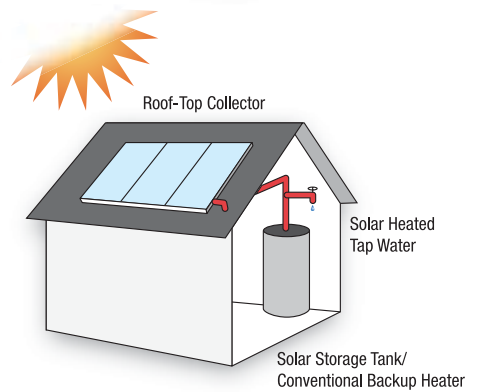
Photovoltaic (PV) systems convert sunlight directly to electricity. Unlike solar thermal systems for heating water, PV does not use the sun's *heat* to make electricity. Instead, electrons freed by the interaction of sun*light* with semiconductor materials in PV cells are captured in an electric current.

Where utility power connections are available consumers can connect their PV systems to the utility grid to supplement electricity they need during cloudy days and at night. And when the PV system produces more energy than the consumer needs, the excess energy can be fed back into the utility grid to be used by others. Optional batteries can be added to a PV system to provide energy storage or backup power in case of a power interruption or utility outage.



What is solar heating?

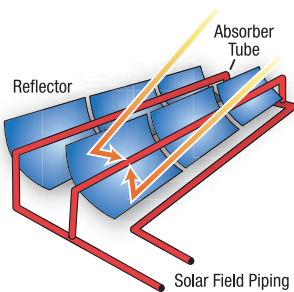
Solar heaters, or solar thermal systems, provide environmentally friendly heat for household water, space heating, and swimming pools. The systems collect the sun's energy to heat air or a fluid. The air or fluid then transfers solar heat directly or indirectly to your home, water, or pool.



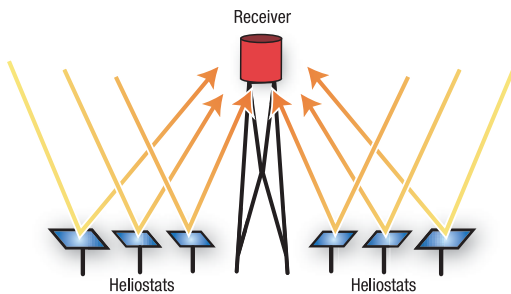
What is concentrating solar power?

Unlike solar-electric and solar heating systems that are usually installed on buildings, concentrating solar power (CSP) systems are large-scale solar thermal power plants that use mirrors to convert the sun's energy into high-temperature heat. The heat is then used to produce steam which powers a turbine to generate electricity. There are three main types of CSP systems, each of which uses a different type of mirror configuration to attract the sun's heat: parabolic trough, power tower, and dish/engine.

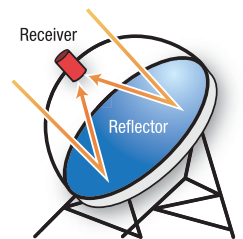
Parabolic Trough CSP



Power Tower CSP



Dish/Engine CSP





Affordable \$olar for Homeowners

Solar energy systems have decreased in price over the past 15 years. Generous state and federal incentives can reduce the retail price of a solar system by 40% to 50%. Several cities offer additional financial incentives, making it even more affordable for homeowners to install solar.

▼ **NEW ORLEANS** residents can take advantage of a 50% state tax credit for solar energy systems.



▼ The PV system on this home in **AUSTIN, TEXAS**, was made possible with rebates from Austin Energy. The municipal utility provides one of the highest rebates in the country to help residential customers install solar energy systems—\$4.50 per watt for photovoltaic systems (which covers between 45% and 75% of the total cost), and \$1,500 to \$2,000 for solar hot water systems.



◀ **PORTLAND, OREGON**, residents can take advantage of cash incentives from the Energy Trust of Oregon and tax credits from the state and federal government to cover a significant portion of the total cost of a solar electric system, as shown in the example below:

2-kilowatt system for Portland General Electric customers

\$20,000	Total installed cost
-\$4,500	Energy Trust incentive (\$2.25 / watt x 2,000 watts)
\$15,500	Amount paid by customer to contractor
-\$6,000	Oregon tax credit (\$3.00 watt x 2,000 watts, \$6,000 cap)
-\$2,000	Federal tax credit (30% of \$15,500, \$2,000 cap)

\$7,500 Final net cost to customer



Property Tax Financing of Solar

BERKELEY, CALIFORNIA is the first city in the nation to propose a financing program that would allow property owners to pay for solar energy systems and energy efficiency improvements as a voluntary 20-year assessment on their individual property tax bill. The city would cover the up-front costs of the solar installations, and the tax assessment would be transferable between owners. Several cities are examining the possibility of adopting a similar program.

SAN FRANCISCO'S SOLAR ENERGY INCENTIVE PROGRAM

provides the following incentives for residential solar installations:

	Total Rebate to Homeowner
Basic incentive	\$3,000
City installer incentive for using a San Francisco-based installer	\$4,000
Environmental justice incentive for installations in designated lower income and racially diverse neighborhoods	\$5,000



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\$olar Financing for Business & Government

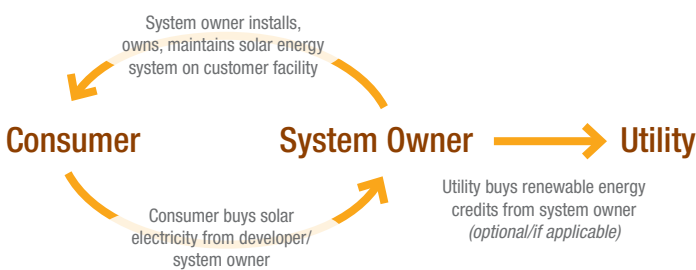
Businesses and local governments are finding creative ways to finance solar energy projects. In addition to financial incentives such as rebates and tax credits, many commercial businesses and government agencies are taking advantage of power purchase agreements to eliminate the high up-front costs of solar installations.

What is a Power Purchase Agreement?

Instead of purchasing a solar energy system, the customer agrees to host the system and purchase the electricity from the system owner/developer at a locked-in rate over a long-term period. The contract to purchase this electricity is called the power purchase agreement or PPA. PPAs are typically used for large installations at commercial or municipal facilities.



▲ The **CITY OF SAN DIEGO** installed a 1-megawatt solar power system atop three water reservoirs at the city's Alvarado Water Treatment Plant. This system generates about 20 percent of the plant's power, with annual savings estimated at \$40,000. The system was built under a power purchase agreement with SunEdison. Under the agreement, the company installed the photovoltaic system at no cost to the city, avoiding an estimated \$6.5 million installation cost. SunEdison owns and maintains the solar system, and sells the solar energy to the city's Water Department at rates lower than market price.



► Through its 28-store partnership with SunPower, **MACY'S** has committed to installing a total of 8.9 megawatts of solar power systems on its California stores. For 17 of the 28 stores, Macy's will purchase solar-generated electricity under the SunPower Access™ program, a solar services agreement that allows the retailer to purchase just the electricity generated at its stores—not the solar power systems.





Credit: Urban Ecology Center

Solar: Bringing Jobs to a City Near You!

A strong local solar industry not only lays the foundation for a sustainable solar market—it brings job growth and economic development to local communities. Cities recognize these benefits, and are working to develop a solar workforce by establishing training programs for solar installers and attracting solar businesses to the local area.

▲ Workers install photovoltaic panels on **MILWAUKEE, WISCONSIN's** Urban Ecology Center. The decline of manufacturing jobs in the city has increased unemployment rates and left the city with brownfield sites. The city is striving to revitalize its manufacturing base by promoting a local solar manufacturing industry. In 2006, 17,600 new solar jobs were created in the United States.

Solar Installer Training

Colleges and universities in several cities are developing training programs for solar installers. This is a just a small sampling:

- **Los Rios Community College District in Sacramento, California**
- **The City University of New York (CUNY)**
- **Houston Community College and the University of Houston**

◀ The **FLORIDA SOLAR ENERGY CENTER** offers a number of photovoltaics training programs and workshops.



Credit: Florida Solar Energy Center

Attracting Solar Businesses

TUCSON, ARIZONA, is the new home of Global Solar Energy, Inc.'s cutting-edge 40-MW thin-film Copper Indium Gallium diSelenide (CIGS) solar factory—the largest CIGS plant in the United States and one of the largest thin-film photovoltaic (PV) factories in the world. ▶

SACRAMENTO, CALIFORNIA, is working to attract existing and start-up solar companies to its Clean/Green Technology Incentive Zone. This will help spur growth in the solar market and will help Sacramento become a center of innovation while creating new jobs for its residents.

PACIFIC GAS & ELECTRIC, the utility that serves San Francisco and much of northern and central California, has entered into a contract to buy 177 megawatts of power from a solar thermal power plant that will be built by Ausra, a company that develops and deploys utility-scale solar technologies. Ausra projects that the power plant will create over 350 skilled jobs on-site during construction, and an additional 100 permanent jobs in the area.



Credit: Global Solar Energy



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Credit: Russell Harner, Jr.

Schools Go Solar!

Schools around the country are installing solar energy systems, and using them as teaching tools for their students. Schools are an excellent public location to showcase the benefits of solar energy. Not only do they educate our children, they also teach the entire community about the benefits of solar energy.

▲ Energize Minds for Solar Design!

The **SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)**, the city's publicly-owned electric utility, provides grants to educators and students for solar projects that help teach about solar technology and practical applications. **WILL ROGERS MIDDLE SCHOOL**, the first recipient of the SMUD grant, broke ground in June 2007 on a new 144-square-foot, solar-powered broadcasting studio. The students will educate classrooms across the country about solar technology and environmental sustainability through podcasts and live radio and television broadcasts.



▲ Students at **O'HENRY MIDDLE SCHOOL** in **AUSTIN, TEXAS** celebrate their new solar installation, made possible through Austin Energy's Solar for Schools Program. O'Henry is one of 14 Austin area solar schools participating in the program. Students can monitor the energy production from the solar installations via a statewide Web site. The Texas Solar for Schools Program hopes to eventually install solar panels at every school in the state.



◀ A monitor in the front lobby of the **BRONX HIGH SCHOOL OF SCIENCE** in **NEW YORK CITY** allows students and faculty to monitor the status of the school's rooftop solar array. The solar data collected by the students can be used in analysis activities in the classroom.





Credit: Atlantis Energy Systems

Cities Leading by Example

Cities looking to reduce energy costs and combat climate change are setting an example for their communities by installing solar energy systems at city facilities. Public buildings are great locations for educating the public about environmental sustainability. Cities are also looking to solar energy to help prepare for emergencies.

Solar for Emergency Preparedness

Studies have shown that large-scale deployment of solar photovoltaics (PV) could have prevented the New York City blackouts of 1999 and 2003. When connected to batteries, PV can serve as an uninterruptible power supply to buildings and critical infrastructure, and solar thermal systems can provide heating and hot water if utility service is interrupted. Emergency power and disaster response needs can be met with mobile PV generators, PV-powered back-up systems, and grid-independent emergency phones—all of which can be cost-effectively and reliably integrated into cities' ongoing emergency and homeland security planning efforts.

▲ This 40-kilowatt, building-integrated photovoltaic array at **NEW YORK CITY'S WHITEHALL FERRY TERMINAL** generates electricity and allows sunlight to stream through the canopy panels, providing daylight to interior areas. New York City is one of several Solar America Cities making a *major commitment* to solar energy. In April 2008, Mayor Michael R. Bloomberg announced plans to install 2 megawatts of solar panels on city-owned buildings in all five boroughs.



▲ **THE CITY OF BERKELEY'S SHOREBIRD PARK NATURE CENTER** is the first city-owned straw bale building in the United States. It has a solar hot water radiant system to provide heating year-round in the cool marina climate, and a solar electric system to power the aquarium's computers, lighting and other equipment.



◀ In October 2007, **ANN ARBOR'S FIRE DEPARTMENT HEADQUARTERS** became the first fire station in Michigan to install a solar hot water system. The system provides the Ann Arbor firemen with hot water for showers, clothes washing, and other hot water needs. If there is an interruption to power or heating fuel supplies at the local utility, this solar hot water system will ensure that the firemen are taken care of and better able to serve their community during emergencies. The system is expected to save \$600/year in natural gas costs—savings that could help the city pay for additional first responder resources.



Credit: John Thornton

▲ The **FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)** helps to distribute trailer-mounted, solar emergency power generators to areas that are recovering from disasters.





Credit: AstroPower

Building-Integrated Solar Technologies

New advances in solar technology and roof-mounted systems have created more stylish systems that blend into their surroundings. Some systems are nearly invisible and can replace traditional building materials such as roof shingles and window awnings.



Credit: Andrew Gordon Photography and Fox & Fowle Architects

▲ The 4 Times Square building in **NEW YORK CITY** has a photovoltaic "skin" on the upper floors, in which thin-film PV panels replace traditional glass cladding material. The system provides enough energy to power the equivalent of five to seven homes.



Credit: Adam Friedberg

▲ The first model for demonstrating the integration of photovoltaics (PV) into a federal building is the sky-lighted entryway of the Thoreau Center for Sustainability at **PRESIDIO NATIONAL PARK** in **SAN FRANCISCO, CALIFORNIA**. Laminated to the skylight glass are PV cells that produce electricity while providing shading and day lighting.



Credit: Davis Energy Group

▲ Solar electric roof shingles can be integrated seamlessly into the roof structure, as shown on this California home.

◀ In this first-of-its-kind application, low-cost, thin-film photovoltaic panels (210 kilowatts) were combined with clear glass in custom glazing units to provide the right balance of shelter, lighting, and electricity generation at **CONY ISLAND'S STILLWELL AVENUE TERMINAL** in **NEW YORK**.