

## Solutions for Today's Energy Needs

### Overview

Solar energy is the cleanest, most abundant renewable energy source available. The U.S. has some of the world's richest solar resources. Today's technology allows us to harness this resource in several ways, giving the public and commercial entities flexible ways to employ both the light and heat of the sun.

There are three primary technologies by which solar energy is commonly harnessed: photovoltaics (PV), which directly convert light to electricity; concentrating solar power (CSP), which uses heat from the sun (thermal energy) to drive utility-scale, electric turbines; and heating and cooling systems, which collect thermal energy to provide hot water and air conditioning.

Solar energy can be deployed through distributed generation, whereby the equipment is located on rooftops or ground-mounted arrays close to where the energy is used. Some technologies can be further expanded into utility-scale applications to produce energy as a central power plant.



Workers mount PV modules on a private home. These modules use sunlight to generate clean, pollution-free electricity and can reduce or eliminate monthly electrical bills

### Photovoltaics

Photovoltaic (PV) technologies directly convert energy from sunlight into electricity. When sunlight strikes the PV module, made of a semiconductor material, electrons are stripped from their atomic bonds. This flow of electrons produces an electric current. PV modules contain no moving parts and generally last thirty years or more with minimal maintenance.

PV electricity output peaks mid-day when the sun is at its highest point in the sky, and can offset the most expensive electricity when daily demand is greatest. Homeowners can install a few dozen PV panels to reduce or eliminate their monthly electricity bills, and utilities can build large "farms" of PV panels to provide pollution-free electricity to their customers.

Semiconductors are used in most electronic products, including computer chips, audio amplifiers, temperature sensors and solar cells. Traditionally, PV modules are made using various forms of silicon, but many companies are also manufacturing modules that employ other semiconductor materials often referred to as thin-film PV. Each of the various PV technologies have unique cost and performance characteristics that drive competition within the industry. Cost and performance can be further affected by the PV application and specific configuration of a PV system.

## Concentrating Solar Power

Concentrating solar power (CSP) plants use mirrors to concentrate the sun's thermal energy to drive a conventional steam turbine to make electricity. The thermal energy concentrated in a CSP plant can be stored and used to produce electricity when it is needed, day or night. Today, over 1,400 MW of CSP plants operate in the U.S., and another 340 MW of CSP projects will be placed in service within the next year.



The two commercialized CSP technologies are Power Towers and Parabolic Troughs. Other CSP technologies include Compact Linear Fresnel Reflector (CLFR) and Dish Engine. CSP specific conditions to produce power, such as areas where direct sunlight is most intense (e.g., the U.S. Southwest) and contiguous parcels of dry, flat land.

## Solar Heating and Cooling

Solar heating and cooling technologies collect thermal energy from the sun and use this heat to provide hot water and space heating and cooling for residential, commercial and industrial applications. There are several types of collectors: flat plate, evacuated tube, Integral Collector Storage (ICS), thermosiphon and concentrating. These technologies provide a return on investment in 3-6 years.

Water heating, space heating and space cooling accounted for 69 percent of the energy used in an average U.S. household in 2005 – representing significant market potential for solar heating and cooling technologies. For example, solar water heating systems can be installed on every home in the U.S., and a properly designed and installed system can provide 40 to 80 percent of a building's hot water needs. Similarly, solar space heating and cooling systems circulate conditioned air or liquid throughout a building using existing HVAC systems, without using electricity.



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