

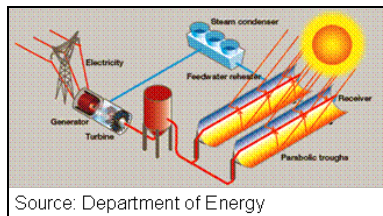
Solar Resources (courtesy of the 2010 Hualapai Master Plan)

Arizona is often called the “solar capital” or the “Saudi Arabia” of solar insolation (incoming solar radiation) for the United States. Despite the state’s tremendous solar and other renewable resources, Arizona lags behind the rest of the region with only a dozen megawatts of installed renewable energy capacity. However, with the approval of a Renewable Energy Standard and Tariff rules by the Arizona Corporation Commission in 2006 designed to boost the development of renewables, especially solar, to 15 percent of the state’s energy portfolio by 2025, a number of new large-scale solar projects are now under construction or contemplated on private and public lands. The new tariff will help ensure the electricity produced in Arizona will stay within the state and be sold by local utilities such as UniSource Energy Services and Arizona Public Service.

Energy from the sun is converted to electricity using a variety of technologies described as follows:

Concentrating Solar Power (CSP) is electricity generated from mirrors to focus sunlight onto a receiver that captures the sun’s energy and converts it into heat that can run a standard turbine generator or engine. These systems range from remote power systems as small as a few kilowatts up to grid-connected power plants of 100’s of megawatts (MW). The systems work best in bright, sunny locations like the Southwest. Because of the economies of scale and cost of operation and maintenance, CSP technology works best in large power plants. Compared to fossil-fueled power plants, CSP power plants generate significantly lower levels of greenhouse gases and other emissions. A typical solar plant requires approximately five acres of land per MW of installed capacity. Enough suitable land is available in the Southwest to generate six times the current U.S. demand for electricity. However, CSP plants using a steam turbine consume approximately 0.83 gallons of water per kWhr of output; of which 0.76 gallons is used for cooling (see Last Straw). This amount of water use is similar to a conventional fossil fuel power plant. The energy payback time of CSP systems is about five months.

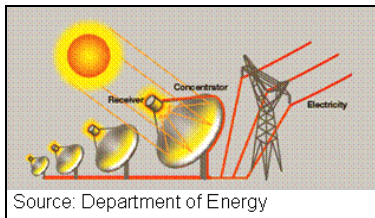
The most common CSP technology is the parabolic trough collector where the sun’s energy is concentrated on an oil-filled, solar



absorbing glass tube running along the focal line of the parabolically



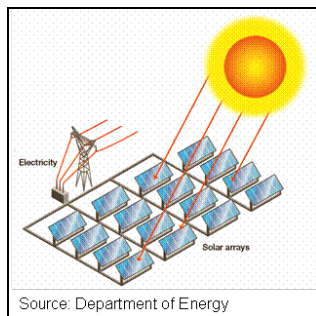
shaped trough. The fluid inside the tube is heated to create superheated steam that powers a turbine generator to produce electricity. This technology, in addition to water use, requires a level site of less than three percent slope. The photo shows the 64 mWhr CSP located in the El Dorado Valley, Boulder City, Nevada, on approximately 400 acres of level ground



Another CSP technology being developed is the Solar Dish-Engine System. Here an electric generator that uses sunlight produces electricity. The dish, a concentrator,



collects the sun's energy and concentrates it onto a receiver. A thermal receiver absorbs the concentrated beam of solar energy, converts it to heat, and transfers the heat to the engine/generator. Unlike parabolic trough collectors, these systems do not employ water as part of their process and do not require a level site for installation but instead can accommodate rolling terrain.



Photovoltaic (PV) technology converts sunlight into electricity and is also known as solar electricity. The most common solar cell material is crystalline silicon, but newer materials for making solar cells include thin-film materials such as cadmium telluride, copper indium diselenide, and amorphous silicon. Solar technology has been developing for over 50 years with application ranging from the mundane hand held battery charger to the exotic power source such as space stations and ETVs. Life-cycle greenhouse gas emissions range from about 25-32 g/kWh and are expected to decrease to 15 g/kWh in

the future. (A coal-fired power plant emits some 915 g/kWh). Using renewable power for manufacturing and transportation could drop emissions to close to zero. Photovoltaic power stations located in the desert Southwest use relatively large amounts of land when compared to fossil fuel power plants with approximately 10 acres of land per MW of installed capacity; however, improvements in solar cell efficiency are reducing the amount of land needed for each MW. Arrays also provide shading for wildlife. Utility-scale PV systems can be placed over existing land used for parking lots and commercial buildings. Water use is typically none aside from cleaning as necessary in dry climates without significant rainfall.

A PV module pays for itself in terms of energy in a few years (1-5 years). With life expectancies of 30 years, 87 percent to 97 percent of the energy produced by a PV system will be free of pollution and greenhouse gas emissions. Concentrator PV energy payback is estimated at eight months on a site having a good solar resource because they use more common materials such as steel and plastic and their production plant costs are low.



Flat-plate PV panels, such as the Tucson Electric Power array shown in Springerville, Arizona, convert sunlight into electricity. Flat-plate panels do not require direct sunlight and they generate energy regardless of where the light source is

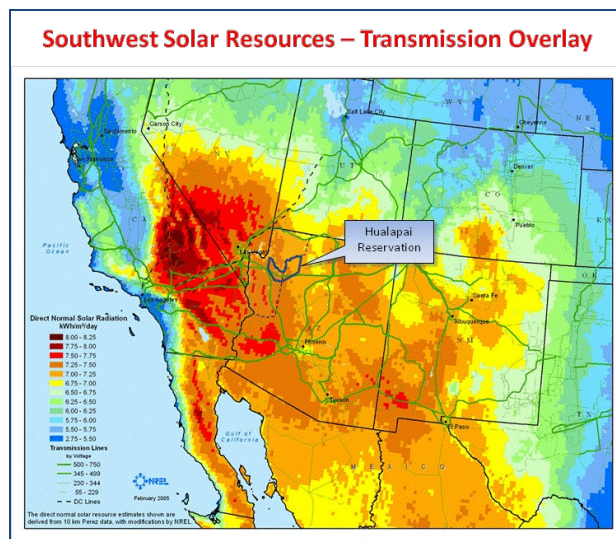
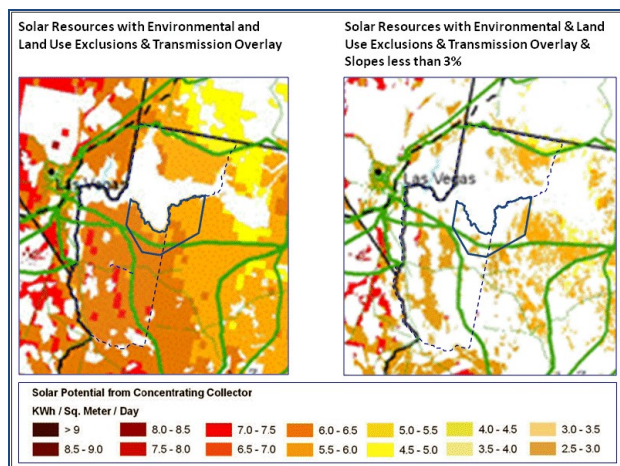
located. They can be fixed in place or allowed to track the sun with solar trackers. A single-axis array tracks the sun from East to West during the day, which provides 30 to 40 percent more energy than a fixed array. Output power is also more uniform. They use light sensors or computer programming to avoid unnecessary tracking movement.



Concentrator photovoltaic (CPV), such as shown in Puertollano, Spain at left, uses inexpensive materials such as mirrors or plastic lenses to capture the sun's energy and focuses it onto PV solar cells. CPV technology differs from flat-plate PV modules in several ways: they are usually made using high-efficiency, multi-junction PV solar cells and they use mirrors or lenses to concentrate sunlight onto the solar cells. The primary reason for using concentrators is to be able to use less solar cell material. Concentrator systems increase the

power output by over twice when compared to flat plate PV while reducing the size or number of solar cells needed.

Siting criteria for solar arrays include: 1) high solar insolation values, typically expressed in kilowatt hours of electricity that may be converted from a single square meter of land on a typical day (see map), 2) having few cloudy or overcast days, 3) occupying a large level site, preferably less than a three percent slope over several square miles, 4) being close to a major transmission line with available capacity, and, 5), in the case of concentrating solar parabolic troughs, an adequate supply of water.



The Hualapai Reservation has several sites that meet most or all of the above criteria, several of which occur along an existing 500 kV transmission line. See Energy Section of Infrastructure Element for more detail on siting of utility scale solar and wind facilities on lands adjacent to Peach Springs