

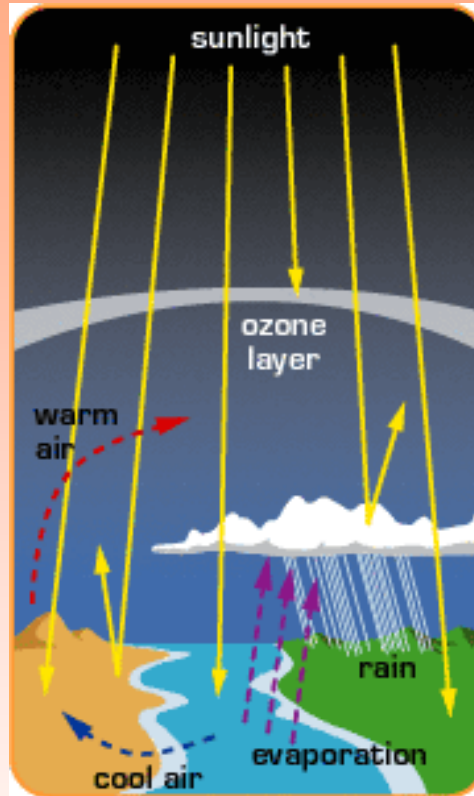
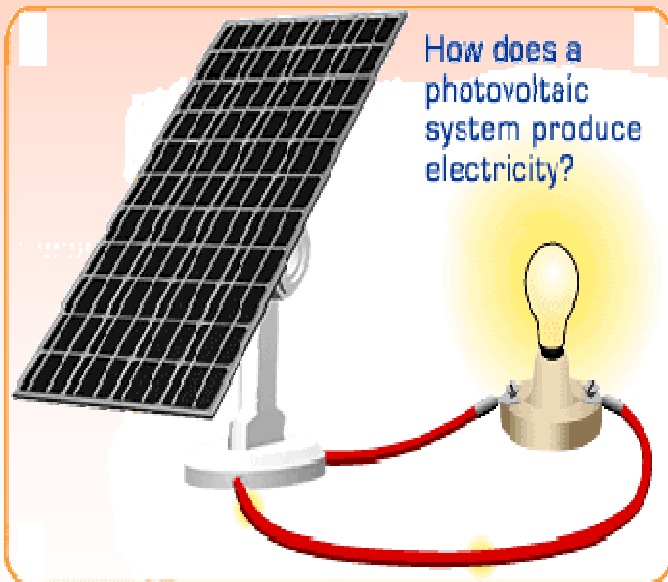
SOLAR ENERGY

**ARIZONA PUBLIC SERVICE
COMPANY**



WHAT IS SOLAR ENERGY?

Solar energy is the energy that comes from the sun that supports life on earth as we know it.



Solar energy can be used as a source of heat and light and can be used to generate electricity.



HOW WAS SOLAR USED IN THE PAST?

➤ *People have been trying to harness the power of the sun for centuries.*

➤ *In 1877, air blowing over sun-heated iron was used to heat homes.*

➤ *In 1910, The first patent involving a solar collector was awarded.*

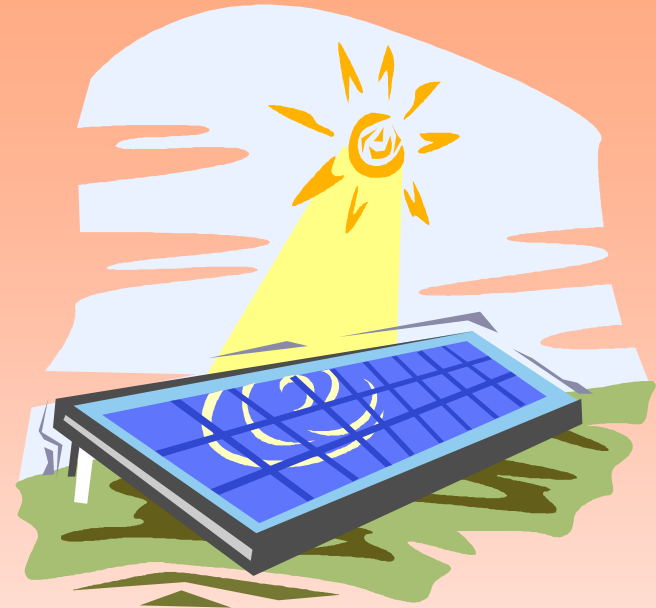
➤ *The 1930's saw the first widespread use of solar power for heating.*



SOLAR ENERGY POWER PLANTS

There are two ways to use solar energy to generate electricity;

- ❖ ***Photovoltaic: The direct conversion of sunlight to electricity***
- ❖ ***Thermal: The use of heat to generate electricity***



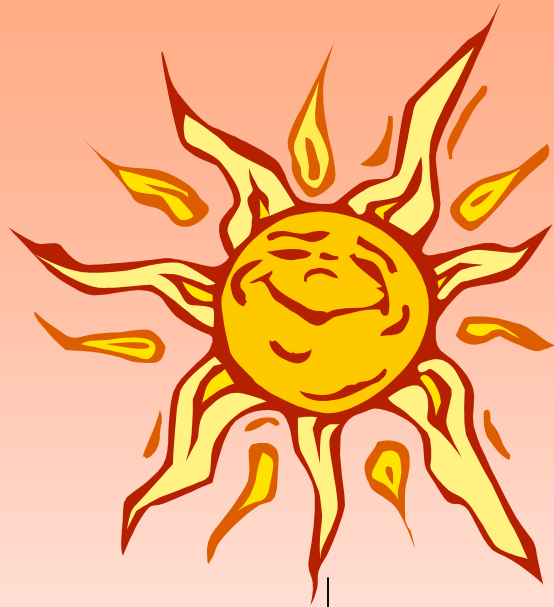
A Photovoltaic Solar Power Plant contains:

- ❖ ***Solar Arrays***
- ❖ ***Inverter***
- ❖ ***Transformer***

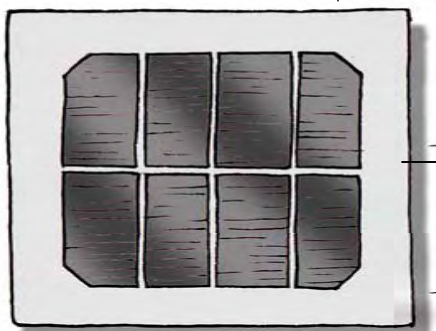
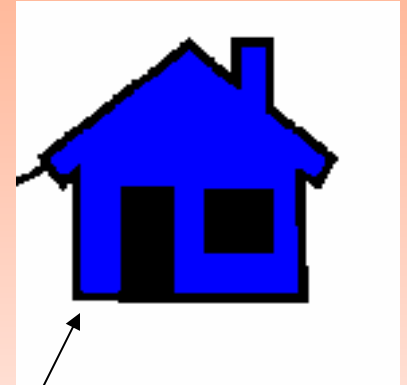
A Thermal Solar Power Plant contains:

- ❖ ***Collector Field***
- ❖ ***Turbine***
- ❖ ***Generator***
- ❖ ***Cooling Tower***
- ❖ ***Transformer***

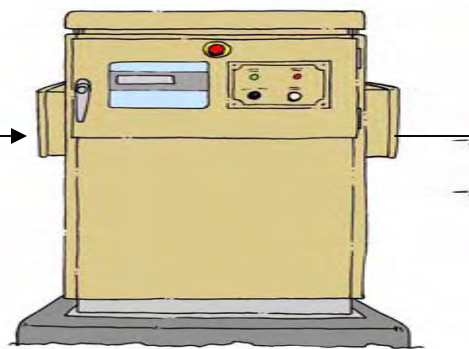
HOW A PHOTOVOLTAIC SOLAR SYSTEM WORKS



The sun illuminates the solar cells in the PV Array, which convert the energy in the sunlight into electricity. The electricity goes into an inverter and into the power lines to your home.



PV Array



Inverter



PHOTOVOLTAIC POWER PLANTS



Glendale Airport, Single Axis and High Concentration Photovoltaic

Prescott Airport, Single Axis, Tilted Tracker Single Axis and High Concentration Photovoltaic

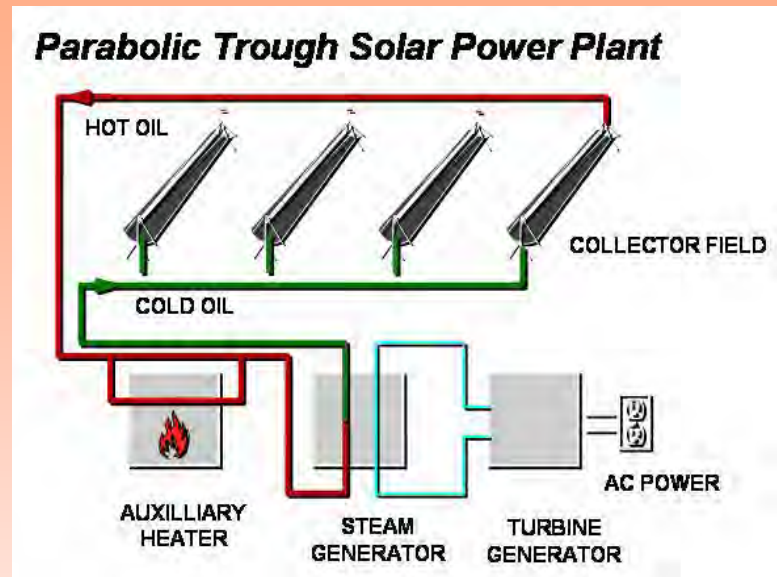


Scottsdale Covered Parking, Fixed Photovoltaic panels



HOW A SOLAR THERMAL POWER PLANT WORKS

- *Parabolic (trough) mirrors can focus the sun at 30 to 60 times its normal intensity on a receiver pipe located along the focal line of the trough.*
- *Synthetic oil captures this heat as it circulates through the pipe, reaching temperatures as high as 750°F. The hot oil is pumped through a heat exchanger on the power production side of the plant to produce steam.*
- *Electricity is produced in a conventional steam turbine/generator*
- *The power cycle is completed with the condensing of the steam through a cooling tower and then pumping it back through the heat exchanger connected to the solar energy collection field.*



SOLAR THERMAL POWER PLANTS



***10 MW Solar II
Experimental Power
Plant, California***



***25 kW Dish/Stirling
Engine System,
Arizona***

***350 MW Parabolic
Trough Power Plant,
California***




SOLAR TRIVIA

Every second 657 million tons of hydrogen are converted to 653 million tons of helium in our sun. The missing 4 million tons are converted to light and heat energy via Einstein's $E=MC^2$ equation and radiated into space. At an average distance of 93 million miles from the sun, the earth collects approximately **4 lbs. of total energy**, which supports life on earth as we know it.

For every kWh of electricity generated by solar energy, the following emissions are avoided since that kWh need not be generated from a fossil fuel power plant. In one year, the approximate avoided emissions in lbs/year are:

SOLAR POWER PLANT SIZE	CO ₂	NO _x	SO _x	PARTICULATES
1 kW	2,508	6.3	5.2	0.36
10 kW	25,800	63	52	3.6
100 kW	258,000	630	520	36
1 MW	2,580,000	6300	6200	360

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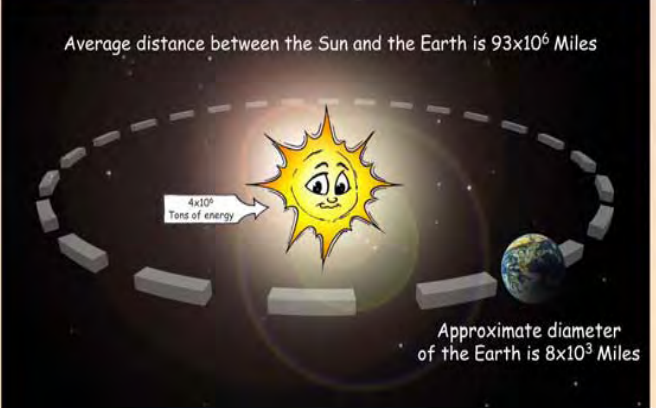



Photo Courtesy of NASA

Average distance between the Sun and the Earth is 93×10^6 Miles



If you assume the diameter of the earth is 8000 miles and using 2240 lb/ton (British Ton), the 4 lbs. can be calculated using the following formula:

$$\frac{4 \times 10^6 \times \pi \times (8 \times 10^3)^2}{4 \times \pi \times (93 \times 10^6)^2 \times 4} = 4.14 \text{ lbs.}$$



HOW MUCH SOLAR WOULD BE NEEDED TO POWER ARIZONA

In order to power Arizona's electrical energy needs, 400 square miles of land will be required.



***20 X 20
= 400 sq MI***

➤ ***We get about 2,400 hours of “productive” sunshine each year.***

➤ ***The state of Arizona consumes about 60,000,000 MWh of electricity each year.***

➤ ***As of 2004 APS has 13 solar power plants around the state generating some 8,801 MWh of electricity per year***

SOLAR

Solar Cell

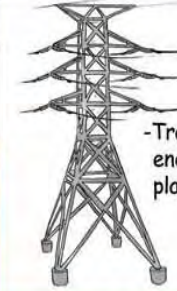


-The basic building block of a photovoltaic (PV) solar power plant is the solar cell which is typically made of silicon.

-On a sunny day, each square foot of PV cells generates approximately 12 watts of electrical power.

-A typical PV cell converts 15% of the incident solar energy to DC electricity.

Power line



-Transports the electrical energy from the power plant to your home.

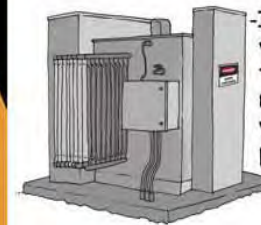
Inverter



-Converts DC power to AC power

-Has a typical efficiency of 92%

Transformer



-Increases the voltage from the inverter to match the voltage on the power lines.

Photovoltaics: The direct conversion of sunlight to electricity.



Additional Sources of Information

<http://science.nasa.gov/ssl/pad/solar/default.htm>

<http://www.sandia.gov/>

<http://www.nrel.gov/ncpv/pvmenu.cgi?site=ncpv&idx=3&body=infores.html>

<http://www.eere.energy.gov/RE/solar.html>

<http://rredc.nrel.gov/solar/>

http://www.nrel.gov/clean_energy/solar.html

<http://solarhistory.com/>

http://www.solarenergy.com/info_history.html

http://www.californiasolarcenter.org/history_solarthermal.html

<http://www.jjsviewbox.com/ImageCatalog/MonumentValley/ThumbnailFrame.htm>

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