

# ***Solar Energy***

*Solar PV (for electricity) and Thermal (for hot water) Systems*

## Data about the Sun

Age	Almost 5 billion years
Mean distance from earth	149 600 000 km
Period of rotation	25 day at the equator
Diameter	1 392 000 km (109 x the earth's diameter)
Mass	$1.993 \times 10^{27}$ tons (333 000 x earth's mass)
Temperature	15 000 000 °C at centre. 6 000 °C on surface
Energy radiation	380 000 000 000 000 000 000 kW
The earth receives	170 000 000 000 000 kW

Solar Energy is so fundamental to the creation and sustenance of life that there simply would be no life without the daily flows of the sun to the earth. Without solar energy the Earth's temperature would drop precipitously, becoming so cold and dark that the conditions that nourish life and humanity would be absent. It was been estimated that 1,000 times more energy reaches the earth's surface from the sun every single year than could be produced by burning all the fossil fuels mined and extracted during that same year.

## ***Thermal Systems (for hot water)***

### **From History**

#### **1455 B.C. - A.D. 1419**

During the reign of the Egyptian King Amenhotep III there were "sound statues" in the temples. The sun shining on the statues heated up the air inside them. This heating caused warm air to rise up through the statues. The sound came about when the air passed through the apertures. This effect occurred when the morning sun was shining on the statues. It became a morning signal. It is also recorded that in the burial chamber of Zari Memnon, son of Amenhotep III, the well-known song of an artificial bird was actually caused by the early morning sun.

In China descriptions have been found dating from the Han dynasty. These show concave bronze or copper mirrors that were used by the "Sun-kindler" to light the sacrificial lamps.

Later attempts to harness solar energy include the story of the burning of the Roman fleet in 212 B.C According to Johannes Tetzes, a thirteenth-century writer, Archimedes set fire to the enemy fleet using burning glasses made of small square movable mirrors on a hinge system. When these were positioned to face the rays of the sun, the rays were reflected towards the Roman fleet. At a distance of a bowshot the fleet was set on fire and destroyed after the sails had been ignited. Whether this story is true or not, it is a fact that solar devices were developed and built early in history. As the number of them grew, man's mythic relationship with the sun altered. Early religious and cultural attitudes and belief in the sun began to disappear, whereas by the seventeenth century there was a greater focus on science than on superstition and magic.

#### **1300 - 1600**

The Renaissance - an age of science and art - brought forth many solar-energy inventions. One of the most original solar inventions was built by Salmon de Caus in France. He used the sun to heat air to pump water in his "sun engine". Although this was a very simple mechanical use of solar energy, it was another 200 years before the "sun engine" was rediscovered.

### **1750 \_ 1800**

Renaissance use of solar energy was mostly in the form of "toys" with no practical application. This trend however took a turn in the latter half of the eighteenth century when solar furnaces capable of smelting iron, copper, and other metals were constructed out of burnished iron, glass lenses, and mirrors. These solar furnaces were in use in Europe and the Middle East. One of them was designed by the French scientist: Antoine Lavoisier. It achieved temperatures of 1,750°C and was made up of one lens with a diameter of 130 cm and a secondary lens with a diameter of 20 cm.

### **1820 \_ 1830**

During this period several hot-air engines were developed. The famous two- cylinder Stirling air engine was ideal for solar use, even though it was not originally developed for this purpose. A wondrous selection of such machines was built during the next hundred years. They drove everything from printing- presses and electric light to distillation processes.

In 1826 the Swedish engineer John Ericsson invented a hot-air engine. He used a 300 horsepower version to power a paddle-steamer. Later he modified the engine and ran it using solar energy.

The Swiss scientist Horace de Saussure is credited with inventing the world's first solar collectors or solar hot box 1767.

### **What are the Solar thermal systems**

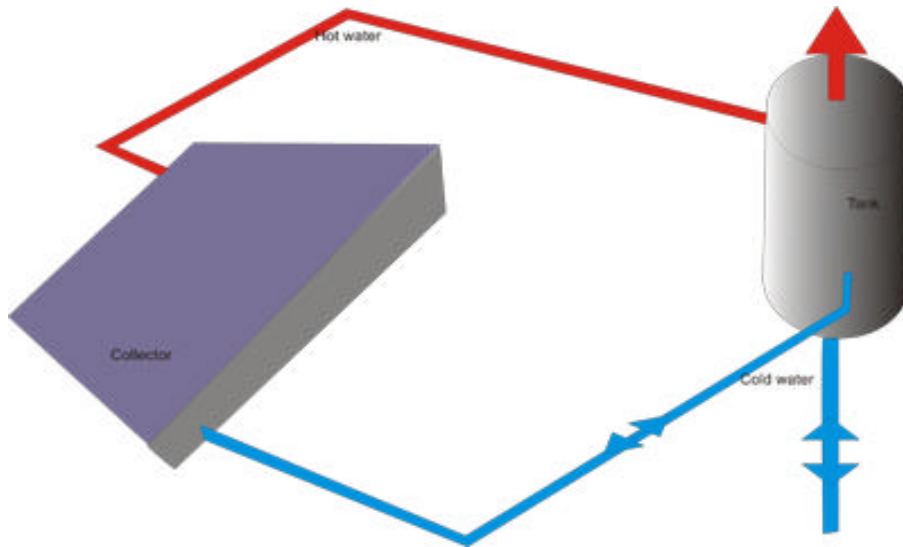
This is systems which convert solar radiation into heat and transmit it to hot water or air. The system usually is made from copper, aluminum (high quality), plastic or other metal.

### **How does it work**

This system consists of several main parts: solar collector, water tubs (through this tubs the cold and hot water is circulating) and water tank (this is a reservoir of cold and hot water). There also has to be a control system. There is two kind of system: self circulating and system which using pumps. There is several kind of solar collector: flat-plate, focusing types and evacuated types. Factors determining the choice of type are: its use (for what we need to use), the climate; kind and amount of radiation, efficiency and economy. The solar collector including small tubes painted by black color, where flow water, glass and number of layers. Clear glass admits most of solar energy reaching it (85-90%). The rest is reflected off the surface of the glass or is absorbed by the glass. The cleanness of the glass and the number of layers determine how much energy penetrates. When short wave solar rays meet objects behind the glass, they are converted into long-wave heat radiation. Unlike the short-wave rays, the long-wave rays do not escape, but are trapped under the covering layer of glass or plastic. This is known as the greenhouse effect.

### What does it cost

It depends on the Systems. Usually 1 qm.m solar collector cost \$90 - \$110 USD.



### *Solar PV (for electricity)*

#### History

In 1839, a French scientist Edmund Becquerel discovered the photovoltaic effect – that light falling on certain materials can produce electricity. Twentieth – century physicist including Albert Einstein found that tiny photons or particles of sunlight can interact with the electron shell surrounding the nucleus of an atom. The interaction causes a free stream of electrons – the basis of electricity. Using this knowledge, scientists developed primitive photovoltaic cells made of selenium. The first photovoltaic cells (PV) converted less than 1% of the sun's photons into electricity, were very expensive and little more than a scientific curiosity. However in 1954, a small team of scientists at Bell laboratories tried to find a practical way to generate electricity for telephone systems in rural areas not connected to a power grid. They knew that higher cell efficiencies were essential to make the technology practical. The key to developing a more efficient solar cell was to find the right semi-conductor material. Crystalline silicon became the focus of the Bell team's research. Using that material, Bell inventors D.L. Pearson, D.M. Chapin and C.S. Fuller fashioned an unprecedentedly large solar cell capable of turning 6% of the sun's light that struck it into electricity. Soon the efficiency was raised to 11%.

#### What are the Photovoltaic

Photovoltaic are solid state semiconductor devices that convert Solar light into electricity. They are usually made of silicon with traces of other elements.

#### How does it work

A photovoltaic device (generally called a solar cell) consists of layers of semiconductor materials with different electronic properties. Solar PV system including battery (for storing energy which

generated by the PV array), controller (it is electronic device to control charging or limit the discharging of the batteries), inverter (large systems usually including DC/AC inverters to supply AC power in standard voltages and frequencies).

### What does PV cost

It depends on the application. Systems containing 100 watts or more of PV will generally cost between \$6 - \$12 USD per watt of PV. Smaller systems will be more expensive on a per watt basis.

