Energy production

Solar systems
The definition passive solar systems refers to the systems in which solar energy is used directly. For example greenhouses are glass structures that allow the Sun to enter, but do not let the heat escape. In this way they are able to maintain temperatures inside the structure that are higher than those outside. Then there are the solar distillers, in which in a closed space, covered by transparent panels that are exposed to the Sun, sea water evaporates and condenses and forms water that has no salts, and therefore that can be reutilised.

In the active solar systems instead, solar energy is collected and transformed into thermal or electric energy before it is utilized. This type of system includes solar thermal power systems, solar concentrator systems used for the production of thermal energy and solar photovoltaic panels for the production of electric energy. The best technologies also enable the cogeneration of different types of energy, and it is possible to accumulate thermal energy in many ways and for different uses.

Thermal solar panels
Solar panels catch the energy of the sun and use it to produce hot water (up to 60/70°C) which collected in an ad hoc tank, can be used both for household (i.e. for household and water heating) and industrial purposes, as well as for the production of electric energy on a large scale through thermoelectric solar plants.

- Plate panels
- Concentration collectors
- Vacuum-pipe collectors

Plate panels
A solar panel system includes two elements: the actual solar panel and the accumulation tank. The first includes a solar heat accumulator, i.e. a steel or copper panel crossed by the pipes in which the fluid to be heated by the sun flows: generally antifreeze is added to the water in order to tolerate winter temperature. Above the absorber there is a glass panel that lets the incoming sunrays in but does not them out, so that the environment underneath remains hot. The tank includes a heat exchanger that allows the transmission of the heat from the heated liquid inside the absorber to the water of the house hydraulic system. Thermal solar panels are installed in a fixed position, if possible south-oriented, in order to receive the maximum amount of radiation. A square metre of solar collector can heat between 40 and 300 litres of water every day, at 45-60 degrees. The efficiency varies according to climatic conditions and the type of collector by 30-80%. Efficiency ranges from 30% to 80% depending on the climatic conditions and the type of collector. The yield of the solar panels has increased about 30% in the past decade. This means that if the energy from the Sun is equal to 100, the useful energy supplied by a solar panel is equal to 30.

Concentration collectors
Concentration collectors are thermal solar panels that use a mirror system that reflects the sunrays and makes them concentrate on a receiver. Collectors can be linear, when they concentrate sunrays on a segment of a straight line, or they can concentrate sunrays on a single point, heating the out-flowing fluid of the panel at more than 100°C. The thermal energy produced can be directly sent to the users.

Or the heat produced by the various solar concentrators can activate the motors that are activated by the heat at a medium-high temperature (i.e. to pump water or other mechanic applications).

The thermal energy can also be transformed into electric energy thanks to solar thermoelectric power plants. In those
plants, the thermal energy captured by the collectors is used to transform water into steam which, in its turn, operates a turbine connected to an electric energy generator (see image). These power plants are environmentally friendly, with a very limited environmental impact as compared to fossil fuels plants, since the only substance to be emitted into the atmosphere is steam.

**Vacuum-pipe collectors**

Some thermal solar panels are called vacuum-pipe collectors as they are made of special glass vacuum pipes, covered by a layer that transforms the sun light into heat. In this case the heat absorber has a round shape and is hosted inside the pipe vacuum cavity: in this way the fluid that carries the heat evaporates, and by transmitting the heat to the top part of the pipe, it condenses and goes back to the bottom. Differently from plate panels, this type of vacuum collectors does not carry the heat (as air is the best insulator), therefore there is no loss and its performance is higher. These collectors need a smaller exposure surface with respect to the other panels and are able to retain the accumulated heat also in very tough weather conditions, guaranteeing a high and constant performance during the whole year. For these reasons they can be used also with a medium-low sun or under particularly tough weather conditions in winter, like on high mountains or in northern countries.

**Thermo-solar energy accumulators**

Just like the other renewable sources, solar energy is not constantly available. As a consequence, accumulation systems are extremely important for the evolution and development of technologies.

The energy produced by thermo-solar plants does not have to be limited to sunny hours nor have to be hampered by clouds. For this reason, two techniques have been tested. They also allow a better use of the installation and therefore a lower cost for the production of electric energy:

- accumulation of thermal energy: the heat is used to warm a medium from which, on a specific moment, heat is extracted to produce electric energy. These devices are quite cheap, highly efficient and allow to keep the installation working during peak periods and night hours. They also have the advantage to eliminate, in many cases, fluctuations due to clouds.

- Solar-methane hybrid systems: during prolonged periods where solar heat is absent, the methane can provide the missing energy, with a reduction of costs. A hybrid system can be economically convenient also for the supply of modest solar power.

**Photovoltaic solar panels**

Photovoltaic technology allows the direct transformation of solar energy into electric energy by exploiting the photovoltaic effect.

The photovoltaic effect is based on the characteristics of certain semiconductor materials such as silicon which, after being ad hoc processed, generates electric energy after being hit by the solar radiation.

Photovoltaic cells are the most basic device capable of carrying out the conversion. Each cell produces around 1.5 watts in standard conditions, i.e. the temperature is 25 °C and it is subject to a radiation power of 100 watts per square meter. The outgoing power in standard conditions is called “peak power” (Wp): it expresses the electric power supplied by a photovoltaic generator with 1,000 watt/square meter irradiation, 25°C system temperature and 1.5 air mass. Actually the electric energy produced is lower than the peak value due to higher temperatures and the lower values of the irradiation. Many cells assembled and connected together into a single structure form a photovoltaic module. The traditional module is made up of 36 cells, with an outgoing power of 50 watts, but at the moment, especially due to architectonic needs, modules with a higher number of cells can be bought, reaching a power of up to 200 watts for each system. In order to increase the electric power it is necessary to connect different modules: several modules form a panel, and several panels form a string.