Solar collectors

Speaker
In Europe, solar annual radiation is between 500 and 1800 kWh/m²; The project is targeted on the southern Europe insular belt where the solar radiation incidence is the highest in the whole EU.
Solar data

Some definition:

**Apparent solar day:** The duration of one rotation of the earth on its axis with respect to the apparent sun. Also known as true solar day.

**Direct solar radiation:** That portion of the radiant energy received at the actinometer direct from the sun, as distinguished from diffuse sky radiation, effective terrestrial radiation, or radiation from any other source.
Solar data

Some definition:

**Solar absorption index:** A relation of the sun’s angle at various latitudes and local times with the ionospheric absorption.

**Solar air mass:** The optical air mass penetrated by light from the sun for any given position of the sun.

**Solar constant:** The rate at which energy from the sun is received just outside the earth’s atmosphere on a surface normal to the incident radiation and at the earth’s mean distance from the sun; it is approximately 1367 watts per square meter.
Solar data

Some definition:
**Solar energy:** The energy transmitted from the sun in the form of electromagnetic radiation.
**Solar flux unit:** A unit of solar radio emission per unit frequency interval, equal to $10^{-22}$ watt per square meter per hertz at the earth.
Solar collectors transform solar radiation into heat and transfer that heat to a medium (water, solar fluid, or air). Then solar heat can be used for heating water, to heating or cooling systems, or for heating swimming pools. Solar cooling technologies demand high temperatures and not all the type of solar collectors are capable of producing them. The collectors needed are based on technologies, which can supply hot water at relatively high temperature (90-150°C).
Solar collectors(1)

Flat-plate collectors are the most widely used kind of collectors in the world for domestic water-heating systems and solar space heating/cooling. The first accurate model of flat plate solar collectors was developed by Hottel and Whillier in the 1950's.
Flat-plate solar collectors

A typical flat-plate collector consists of an absorber, transparent cover sheets, and an insulated box.
Flat-plate solar collectors

The absorber is usually a sheet of high-thermal-conductivity metal such as copper or aluminum, with tubes either integral or attached. Its surface is coated to maximize radiant energy absorption and to minimize radiant emission. The insulated box reduces heat loss from the back or the sides of the collector. The cover sheets, called glazing, allow sunlight to pass through the absorber but also insulate the space above the absorber to prevent cool air to flow into this space.
Flat-plate solar collectors have been in service for the last 30 years, without significant changes in their design and operating principles. Collectors are usually oversized in order to satisfy a heat demand and this increases their manufacturing cost.
Different solar collectors

Collettore scoperto in plastica

Collettore piano standard

Collettore con doppia copertura

Collettore con superficie selettiva

Collettore piano sottovuoto

Collettore a tubi sottovuoto
Evacuated (or Vacuum) Tubes

Evacuated (or Vacuum) Tubes are solar panel built to reduce convective and heat conduction loss (vacuum is a heat insulator). Different construction types are available:

- Heat pipes or direct flow
- All glass tubes
- With or without concentrator

It use when it necessary high temperature of fluid.
Evacuated (or Vacuum) Tubes

Glass evacuated tubes are the key component of the Evacuated Tube Heat Pipe solar collectors. Each evacuated tube consists of two glass tubes. The outer tube is made of extremely strong transparent borosilicate glass that is able to resist impact from hail up to 25mm in diameter. The inner tube is also made of borosilicate glass, but coated with a special selective coating, which features excellent solar heat absorption and minimal heat reflection properties.
Evacuated (or Vacuum) Tubes

The manifold is heavily insulated with a 2" thickness of pre-formed rock wool to keep the heat in. Unlike flat plates, these headers are so well insulated that they should not require antifreeze in normal operation - the temperature of the header is unlikely to fall below 10°C even in very cold weather.
Evacuated (or Vacuum) Tubes

The more advanced solar controllers include a low-temperature facility - should the temperature of the collector fall below a defined level, the pump will operate to allow the water at the bottom of the tank to heat the collector slightly. In normal conditions, this would never be necessary, but it acts as a good safety margin.
Evacuated (or Vacuum) Tubes

The air is evacuated from the space between the two glass tubes to form a vacuum, which eliminates conductive and convective heat loss. The vacuum tube solar panel has been around for several years and has proved to be both reliable and dependable. The double wall glass tubes (made from strong borosilicate glass i.e. Pyrex) have a space in the centre which contains the heat pipe.
Evacuated (or Vacuum) Tubes

The sun's radiation is absorbed by the selective coating on the inner glass surface, but is prevented from re-radiating out by the silver-coated innermost lining which has been optimized for infrared radiation. This acts similarly as an one-way mirror. This is very efficient. 93% of the sun light's energy hitting the tube's surface, is absorbed, whereas only 7% is lost through reflection and re-emission. The presence of the vacuum wall prevents any losses by conduction or convection - just like a thermos flask. Because of this, the system will work even in very low temperatures, unlike traditional flat plate collectors.
Evacuated (or Vacuum) Tubes

The heat transferred to the tip of the heat pipe is in turn transferred to a copper manifold in which water circulates to heat the domestic hot water tank. If a tube is placed in direct sunlight on a summer day, the tip temperature can reach $250^\circ\text{C}$ - so the system easily heats domestic hot water cylinders to $60^\circ\text{C}$ even in cooler weather.

A vacuum tube collector
Solar air Collectors

This collectors use air as fluid and heat directly it.

It’s usually employed for pre heating air of ventilation air. It’s no use in solar cooling technology.
CPC Collector

Solar collector use radiation concentration when won't fluid temperature more than 100° C. Radiation concentration can be static or dynamic.
Stationary CPC Collector

This collector use stationary radiation concentration; It’s usually used to heat liquid (water or water with anti freeze or diathermic fluid). It can be use for domestic hot water preparation and can be used in Solar cooling. In this panel there is a reduction of convective losses.
What collector for Solar Cooling

Adsorption chiller need water at 60 –90 °C and can use flat plate solar collector or vacuum tubes.

Absorption chiller (single-effect) need water at 80 –110 °C and can use vacuum tubes and it’s more difficult with flat plate solar collector.

Absorption chiller (double-effect) need water at 120 –150 °C and can use CPC collectors.

Desiccant cooling need water or air at 45-90°C and can use flat plate solar collector or solar air collectors.