Environment and territory

Benefits of solar energy

The solar energy does not make any noise, does not pollute and allows to obtain a hot fluid that can be used as sanitary hot water, for heating, or for different industrial tasks.
The environmental benefits that derive from the installation of photovoltaic systems can be expressed in terms of avoided emissions: the emissions that would have been produced for the generation of an equal quantity of electric power with thermoelectric systems can be calculated.
For example it was estimated that a family of four people consumes around 7.7 kWh a day with an electric water heater. In Italy, to produce an electric kWh, thermoelectric plants release into the atmosphere around 0.58 kg of carbon dioxide, one of the main greenhouse effect gases. Therefore, for an electric water heater 4.5 kg of CO_2 are produced on average every day. With hybrid solar-gas plants, i.e. solar plants integrated with gas boilers, that ensure hot water all year long, a four-members family in Rome can save up to 0.69 kg of CO_2 a day.
Therefore solar energy could significantly reduce the use of fossil fuels, since it would be an electric energy source on a large scale, in particular in Italy, where irradiation levels are high. Directly converting the sun into electric energy is a choice that can be extremely advantageous not only in urban settlements, but also in marginalized and remote areas, especially in the Third World. In those areas the combination of photovoltaic systems with other existing renewable sources can bring electric energy to the most isolated villages and communities, to guarantee lighting, telecommunications, pumps, but also to desalinate seawater and brackish water, to preserve fishing and agricultural products, and to refrigerate drugs and vaccines.

Power density of solar energy

In less than an hour, the Earth receives an amount of energy from the Sun that is equal to the world consumption for a year. Solar energy, unlike the other sources of energy , is present in all over the planet (with some differences depending on the latitude) and it is a source that will accompany us for billions of years more. Solar energy, therefore, besides being abundant and well distributed, is also a renewable resource. These characteristics would make the Sun the principal source of energy, only that solar energy has a low power and is intermittent on a local scale. In fact the flow of energy from the Sun depends on the alternating day and night and the variable meteorological conditions.
Not much power from a great energy
A very useful parameter in order to evaluate how much the energy is worth is the power density, also known as radiance, that indicates the solar radiation per surface unit (Watt per square metre W/sq.m). The amount of solar energy that reaches the Earth's surface, after subtracting all the reflections and absorptions that take place in the atmosphere, is equal to 85,000 billion W. Knowing that the Earth's surface is equal to 5.1 billion sq. km, the result is that every square metre of the Earth's surface, receives an energy of approximately 170 W/sq.m. This value decreases remarkably when it is converted into power that can be utilized. The present lifestyles in the industrialized Countries require a power density that ranges from 20 to 100 W/sq.m for homes, to 300 to 900 W/sq.m. for steel industries. It is evident that with the current solar technology it is not possible to make most of the large structures which have a high energy demand, such as the industries and the hospitals, work. The principal technological challenge of our days is to succeed in storing the immense energy that comes from the Sun and make it available at the right intensity where there is a demand for energy.

Impact on the landscape

The environmental impact of a solar power plant must be evaluated considering the entire life cycle and in particular the building stages of the plant, the stage in which the plant is set up and produces energy, and finally the stage when it is no longer used. The impact that derives from the construction of a photovoltaic plant can be compared to the impact generated by the production of any product of a chemical industry. During the manufacture of the panels, in fact, very toxic substances are used, which require particular safety measures in order to protect the workers, the environment and

the people living in it. The products that are used vary, depending on the types of panels. For crystalline silicon panels, hydrochloric acid and trichlorosilane are used, while for amorphous silicon panels, silane phosphate and diborane are used. The substances that are used for the panels that are not made with silicon are even more toxic and polluting than the ones mentioned above. For example to produce the CIS (copper indium selenium) panels hydrogen selenide is used, while for CdTe (cadmium telluride) panels cadmium is used, which is toxic and cancerogenic, like hydrogen.
However the environmental benefits generated during the life-span of a photovoltaic system (average 20-25 years) are already greatly superior to the damage provoked in the production phases of the panels.
When plant operation comes to a stop, the panels must be treated as special waste, as they contain numerous toxic substances such as lead, cadmium, copper, selenium etc. With regard to the plant operation, the only impact is on the landscape, that varies depending of the type, the extension and the position of the plants. Photovoltaic parks are remarkably large plants, which are usually installed on ground in large open areas, thus subtracting the territory from other uses. The visual impact of photovoltaic power plants is however less than that of thermoelectric plants or any other large industrial plant. This is essentially due to the fact that the plants are much lower than an industrial plant. The visual impact of small and medium sized plants is surely less than that of a large plant and with some adaptations the photovoltaic and solar panels can be fitted well into the landscape. However the compatibility of the landscape for each plant must be evaluated. For example the use of photovoltaic panels should be limited in cities of artistic importance, in the historical town centres and in areas with a high naturalistic value. Instead, the marginal areas that are not used should be exploited, such as the roofs of hangars, or areas that must be reclaimed, or installation of panels on the roofs of houses in the urban areas. The architectural integration of the photovoltaic plants in the buildings allows a remarkable reduction of their visual impact. In fact a plant is considered integrated when the photovoltaic modules become structural elements of the building itself, as for example roofs, facades, windows, etc. In this way the photovoltaic panel, from an external element becomes an integral part of the building.