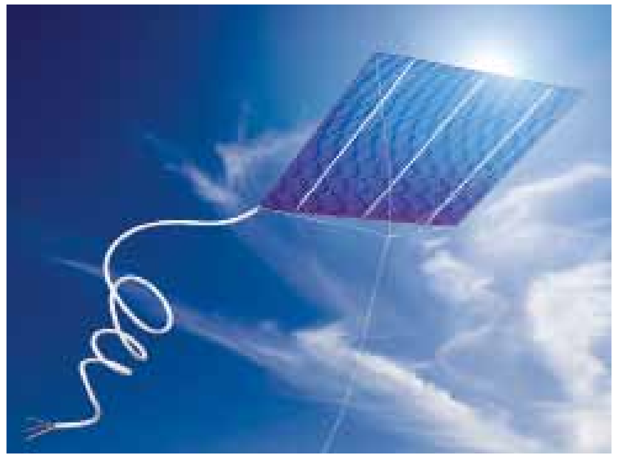
PRODUCTION CAPACITY



The following technical standards provide guidelines for properly estimating the production capacity of a photovoltaic plant, understood to be the quantity of energy produced:

UNI 8477-1: *Solar energy. Calculating energy requirements for building industry applications. Evaluating the radiant energy received.*

UNI 10349: *Heating and cooling buildings. Climatic data.*

CEI 82-25: *Guide to the construction of photovoltaic power generation systems connected to medium- and low-voltage electrical grids.*

The energy produced by a photovoltaic plant depends essentially on the following factors:

- the angle of inclination of the installed module plane with respect to the horizontal plane (TILT) and its angle of orientation with respect to south (AZIMUTH);
- rated power, current-temperature coefficients, voltage and power, decoupling or mismatch losses, or drops in general efficiency caused by the series connection of several photovoltaic mod ules having not-perfectly-identical characteristics;
- BOS ((Balance Of System) efficiency, that is, the set of electrical devices and components needed to transfer the energy produced by the photovoltaic modules to the electrical grid), limited essentially by the inverter conversion losses, Joule effect losses in the cables, voltage drops over diodes and losses due to the contact resistances on switches.

The annual energy that can be produced **Epv** by the photovoltaic plant is given by the following analytical expression:

$$Epv = \eta pv \cdot Apv \cdot H$$

where:
ηpv is the overall conversion efficiency of the photovoltaic plant depending on the factors listed earlier, except for TILT and AZIMUTH angles;
Apv is the area occupied by the assembly of modules of which the generator is composed, expressed in m^2;
H the annual solar radiation incident upon surface of the modules, expressed in kWh/m^2 and dependent upon the TILT and AZIMUTH angles.

The same relation holds for periods other than a year: for example, if we wish to consider just one day, it will be necessary to express **Epv** in kWh/day and **H** in kWh/(m^2 x day). It's possible to determine the solar radiation **H** incident upon exposed surfaces starting from the radiation values reported in UNI 10349 (for horizontal surfaces) and applying the formulas reported in the standard UNI 8477 for surfaces at any inclination and orientation.

Generally **ηpv** assumes values within the range of 0.9 ÷ 0.12, meaning that, on the average, only 10% of the solar radiation at ground level can be converted into electrical energy.

LOCATION	MILAN	ROME	MESSINA
ANNUAL SOLAR ENERGY ON HORIZONTAL SURFACES [kWh/m^2]	1300	1600	1730
ANNUAL SOLAR ENERGY ON SURFACES FACING SOUTH AND INCLINED 30° [kWh/m^2]	1400	1750	1880
ANTICIPATED PRODUCTION OF ELECTRICAL SOLAR ENERGY WITH AN AVERAGE PLANT EFFICIENCY EQUAL TO 75% [KWh/kWp]	1050	1300	1400

Exploiting solar-tracking systems, the average annual solar radiation captured on the module planes increases:

- by 15-20% for single-axis tracking (East-West);
- by 25-35% for biaxial tracking.

The following figures shows, for the territory of Italy, the annual electrical energy that can be produced by a 1-kWp photovoltaic plant *(Source: JRC - Ispra "European Research Center concerned with the technical verification, the applicability of regulations, and scientific consulting").*