

THE BASIC FACTS ABOUT SOLAR ENERGY

Alternative forms of power have become increasingly popular due to government incentives and mandates, volatile fuel prices, and environmental concerns. This page provides some solar energy facts and other practical information that can help you better understand photovoltaics and make an informed decision about your choice of energy.

FACTS ABOUT SUNLIGHT ENERGY

Irradiance (average [solar power](#) measured at the top Earth's atmosphere perpendicular to the sun's rays): 1366 watt per square meter (or 1361 according to NASA).

Note that 1 sq.ft=0.0929 sq.m. So, all the numbers per square foot will be more than 10 times less than per square meter.

"Standard sun" (peak power that reaches the Earth at a bright noon per square meter at sea level): 1000 watt/sq.m, which is 1 kW/sq.m.

This value is used in rating of PV systems.

Here and below all numbers are given for surfaces tilted toward sun according to latitude. For horizontal surfaces you get less sunlight: the further from equator the less energy density value per square meter.

Insolation (the average amount of equivalent hours of "standard sun" per day): from 4-5 hours typical in Northeast of US to 5-7 hours in Southwest. Insolation is often stated in kW-hr, which is numerically the same since the "standard sun" is 1 kW. For more details see [Solar Energy Information](#).

Total amount of **sunlight radiation per day** per square meter at sea level:

(Energy per Day)=1kW×(insolation in hours).

Given an average US insolation of 5 hours, this amount is typically 5 kilowatt-hours/sq.m.

Solar watts averaged over an entire day:

$Watts_{average} = (Energy\ per\ Day) / 24$.

For an insolation of 5, the watts averaged over an entire day are $1000W \times 5 / 24 = 208$ W/sq.m. Note that only a small portion of this radiation can be converted to electricity due to not very high efficiency of PV systems.

Typical **efficiency** of PV panels: crystalline silicon (CSi)- 12-17%; thin-film (amorphous silicon and other materials)- 8-12%.

Watts per square meter generated from a PV array is:

$PV_{watts} = (Solar\ watts) \times (PV\ Efficiency)$, where the efficiency is stated in decimal.

Particularly, **peak wattage** from PV module per square meter at bright noon:

$PV_{watts-peak} = 1000W \times Efficiency$, which is typically 120-170 W/sq.m for CSi and 80-120

W/sq.m for thin-films (TF).

Total energy per day produced in average from a PV module per square meter:

$$PV_{\text{day}} = PV_{\text{watts-peak}} \times (\text{Insolation}_{\text{hours}}).$$

For an insolation of 5 sun-hours this value would be typically 0.6-0.85 kWh/sq.m for CSi and 0.4-0.6 kWh/sq.m for TF .

PV output averaged over an entire day:

$$PV_{\text{watts-average}} = PV_{\text{day}} / 24. \text{ This is about 25-35 W/sq.m for CSi and 17-25 W/sq.m for TF.}$$

Total energy generated by PV modules per sq.m during a year:

$$PV_{\text{year}} = (\text{Total Energy per Day}) \times 365, \text{ which would be about 219-310 kWh for CSi and 146-219 kWh for TF.}$$

Expected **cost of electricity saved over a year** per square meter of PV panels:

$$\text{Saving} = PV_{\text{year}} \times (\text{Inverter Efficiency}) \times (\text{Utility Rate}).$$

At an average US rate of \$0.12/kWh and inverter efficiency = 0.95, this yields \$24-35 for CSi and \$17-24 for thin films.

QUICK REFERENCE INFORMATION ABOUT SUN

Diameter: 1,392,000 km (863,040 miles);

Mass: 1,989,100 × 10²⁴ kg;

Temperature at surface: ~5700 °C;

Average Earth-Sun Distance: 150 million km (93 million miles);

Content by mass: 74% Hydrogen, 25% Helium, 1% other;

Luminosity (total amount of power radiated in all directions): 3.85 × 10²⁶ watt (~385 billion megawatts);

Radiated power density at sun's surface: 63,300 kW per square meter.

HTML version: [Solar Energy Facts](#)

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