

Solar Irradiance

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1. Solar Irradiance.

Solar irradiance represents the power from the sun reaching a surface per unit area.

- **Direct Normal Irradiance (DNI):** The portion of solar irradiance that directly reaches a surface perpendicular to the sun.
- **Diffuse Horizontal Irradiance (DHI):** The solar energy scattered by the atmosphere and reaching the ground.
- **Global Horizontal Irradiance (GHI):** It includes both Direct Normal Irradiance and Diffuse Irradiance. # $GHI = DNI * \cos(\text{Solar zenith angle}) + DHI$

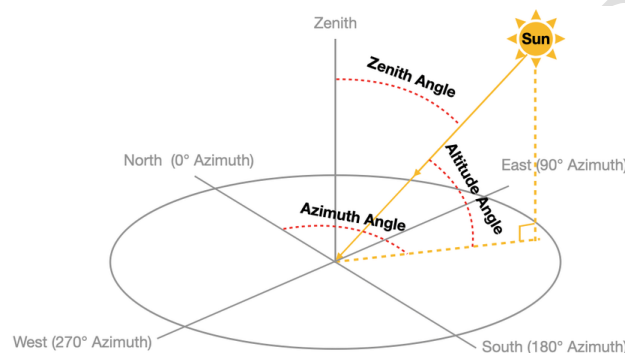


Figure 1: Zenith angle.

Direct Irradiance is solar energy received directly from the sun, while **Diffuse Irradiance** is solar energy scattered by clouds and atmospheric particles.

*(The solar zenith angle is the angle between the sun's rays and the vertical direction.)

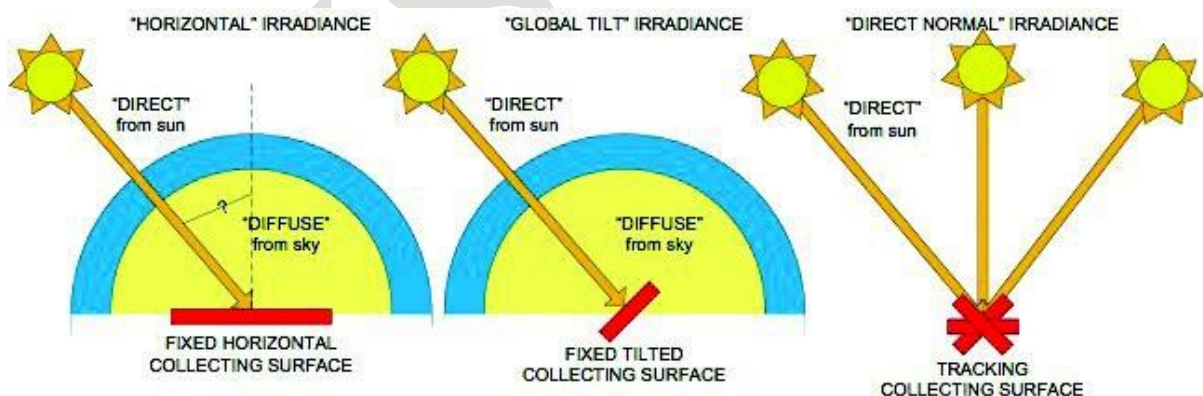


Figure 2: Types of irradiance.

2. Types of irradiance.

- Horizontal Irradiance: Solar energy received on a fixed horizontal surface.
- Global tilt Irradiance: Solar energy received on a fixed tilted surface.
- Direct Normal Irradiance: Solar energy received on a surface that tracks the sun.

3. Solar Power

- Solar electricity systems are rated in kilowatts peak (kWp), which represents the maximum power output they can generate under optimal conditions, such as at noon on a sunny day. This is essentially the rate at which it generates energy at peak performance for example at noon on a sunny day.
- The kWp rating of a residential solar system can vary based on the customer's budget and the space available for installation.
- The photovoltaic (PV) potential is expressed in kWh/kWp and measures the amount of electricity, in kilowatt-hours, that a PV system with a 1 kWp capacity is expected to produce.

Example 1:

Given two identical solar installations, one in the UK and one in Spain, the UK system generates 3 kWh/day, while the Spanish system produces 6.5 kWh/day. This indicates that Spain has a higher solar energy potential compared to the UK. Specifically, Spain benefits from approximately 6.5 hours of peak sunlight per day, whereas the UK receives around 3 hours.

4. Hybrid Photovoltaic Panel

- A standard photovoltaic panel typically converts about 20% of incoming sunlight into electricity, with the remaining energy lost as heat.
- Not only is this heat wasted, but it also reduces the panel's photovoltaic efficiency, which decreases as the panel's temperature rises.
- The DualSun Spring hybrid panel generates electricity on its front side and captures excess energy to heat circulating water through an innovative heat exchanger on its backside.
- The water can reach temperatures of around 70°C and can be used to meet the building's heating requirements.
- Additionally, the circulating water cools down the system, improving the photovoltaic panel's efficiency.