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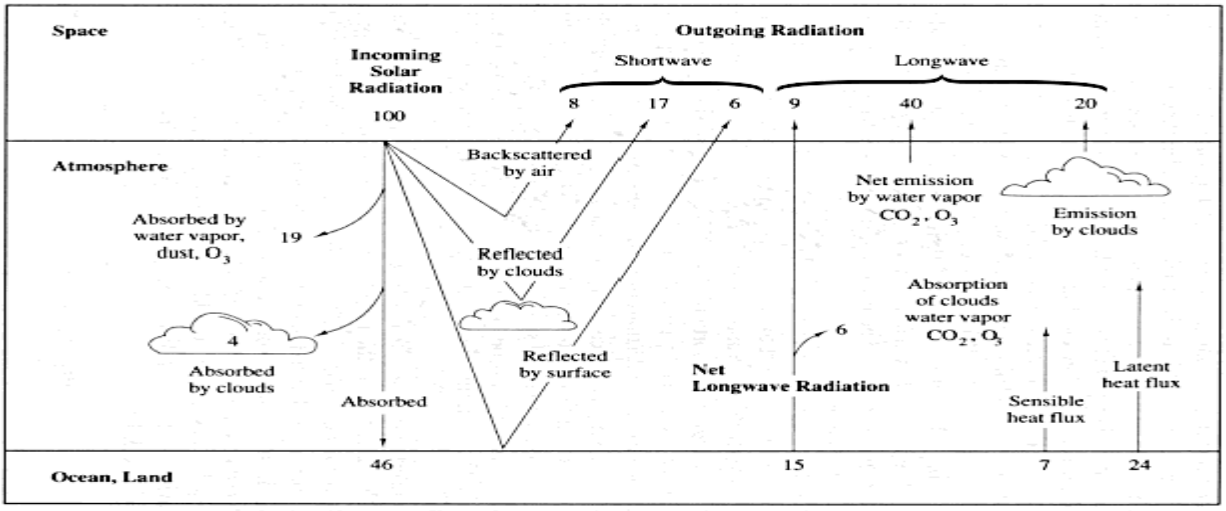
## Basics of Solar Energy

The Sun is always there; and is the ultimate source of Energy

How many photons (energy) reach the surface of the Earth on Average?

The energy balance in the atmosphere is shown here:




The main components in this diagram are the following:

- Short wavelength (optical wavelengths) radiation from the Sun reaches the top of the atmosphere.
- Clouds reflect 17% back into space. If the earth gets more cloudy, as some climate models predict, more radiation will be reflected back and less will reach the surface
- 8% is scattered backward by air molecules:
- 6% is actually directly reflected off the surface back into space
- So the total reflectivity of the earth is 31%. This is technically known as an Albedo. Note that during Ice Ages, the Albedo of the earth increases.

Think: How much energy from the sun reaches the surface of the Earth on Average?

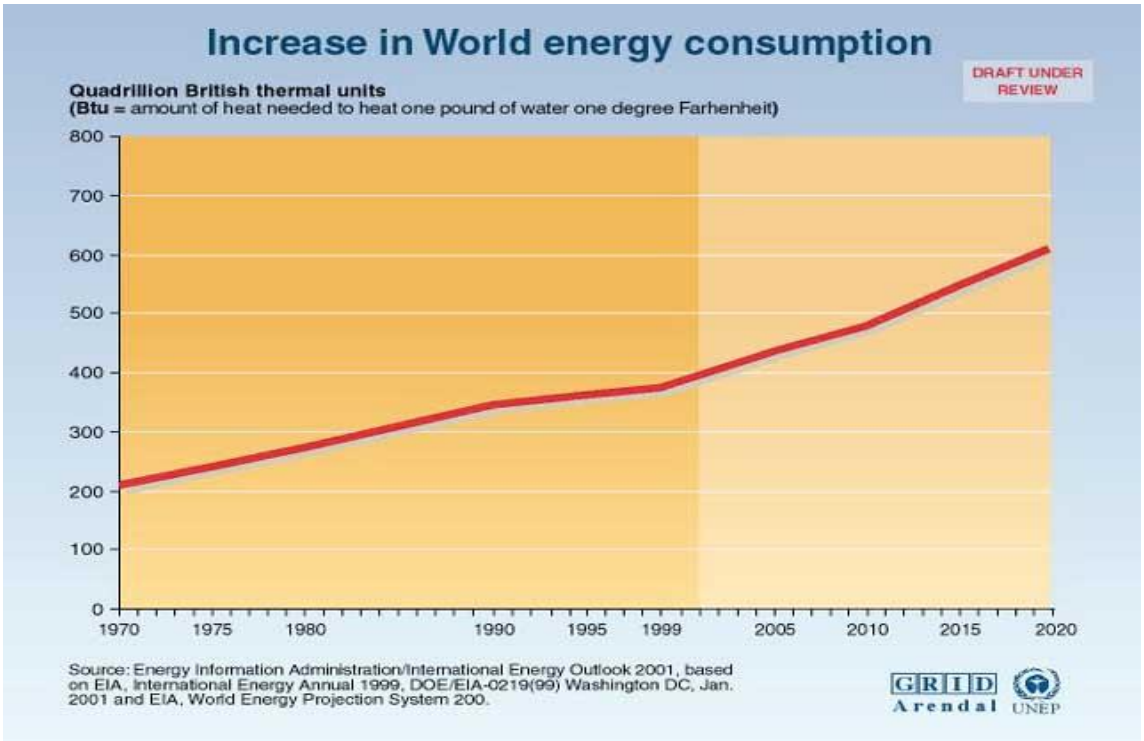
Note: that we measure energy in units of Watt-hours. A watt is not a unit of Energy; it is a measure of power

ENERGY = POWER x TIME

1 Kilowatt Hour = 1KWH = 1000 watts used in one hour = 10 100 watt light bulbs left on for an hour

Incident Solar Energy on the ground:

- Average over the entire earth = 164 Watts per square meter over a 24 hour day So the entire planet receives 84 Terawatts of Power our current worldwide consumption is about 12 Terawatts.




There is a large amount of infrastructure (e.g. cost) required to convert from *potential* to deliverable energy.

- 8 hour summer day, 40-degree latitude - 600 Watts per sq. meter

So over this 8 hour day, one receives:

- 8 hours x 600 Watts per sq. m = 4800 watt-hours per sq. m which equals 4.8 kilowatt-hours per sq. m
- This is equivalent to 0.13 gallons of gasoline
- For 1000 square feet of horizontal area (typical roof area) this is equivalent to 12 gallons of gas or about 450 kWh

## Basic Solar Maths

How much electricity is produced by a solar panel? What about a roof-top installation? You will find some basic calculations here below.

The Watt measures the rate of energy conversion and it is the main unit of power used in photovoltaic.

| | |
|---|---|
| 1 kilowatt (kW) | 1000 watts |
| 1 megawatt (MW) | 1000 kW or 1000000 watts |
| 1 gig watt (GW) | 1000 MW or 1000000000 watts |
| 1 Terawatt (TW) | 1000 GW or 1000000000000 watts |
| PW | P = peak (peak-performance of a module) |

**How much energy does one panel produce?**

Electrical energy is generally measured in kilowatt-hours (kWh). If a solar panel produces 100 watts for 1 hour, it has produced 100 watt-hours or 0.1 kWh.

The amount of energy produced per day will depend on the area, shading, orientation, and watt-class of the panel. In areas with high irradiation, a properly oriented panel that produces 100 Watts at noon on a sunny day will produce an average of about 0.5 kWh/day during the winter and 0.8 kWh/day during the summer months.

In an area with low irradiation, the same panel will still produce about 0.25 kWh/day during the winter and 0.6 kWh/day during summer months.

An effective orientation for a solar panel installation is 100 per cent south, at an angle of 10-20°. There are several standard measurements to describe a solar panel installation.

**System Sizing Calculation Method**

This is a simplified, “laypersons” overview of how solar energy systems calculations are made. The solar estimates provided via our Agencies and Earth Ambassador Agents are much more complex and complete. This simplified overview is meant only to provide the reader with a very basic understanding of some solar energy system calculation methods.

The easy way is to use the My Solar Estimator – Solar Calculator link below but you should read this entire page to gain an understanding of how Solar PV system is properly sized and outputs calculated.

General Terms

Photovoltaic (PV) is the direct conversion of light into electricity. Certain materials, like silicon, naturally release electrons when they are exposed to light, and these electrons can then be harnessed to produce an electric current. Several thin wafers of silicon are wired together and enclosed in a rugged protective casing or panel. PV panels produce direct current (DC) electricity, which must be converted to alternating current (AC) electricity to run standard household appliances. An inverter connected to the PV panels is used to convert the DC electricity into AC electricity. The amount of electricity produced ¡s measured in watts (W). A kilowatt (kW) is equal to 1,000 watts. A Megawatt (MW) is equal to 1,000,000 Watts or 1,000 Kilowatts. The amount of electricity used over a given period of time is measured in kilowatt-hours (KWh).

*What is a solar rating?*

The solar rating is a measure of the average solar energy (also called "Solar Irradiance") available at a location in an average year. Radiant power is expressed in power per unit area: usually Watts/sq-meter, or kW/sq-meter.

The total daily Irradiation (Wh/sq-meter) is calculated by the integration of the irradiance values (W/sq-meter).

**Solar Electric (Photovoltaic) System Calculations – Off grid system only**

*Estimating Solar Electric (PV) System Size: Are of Solar Panels*

On average (as a general "rule of thumb") modern photovoltaic (PV) solar panels will produce 8 – 10 watts per square foot of solar panel area. For example, a roof area of 20 feet by 10 feet is 200 square feet (20 ft x 10 ft). This would produce, roughly, 9 watts per sq-foot, or 200 sq-ft x 9 watts/sqft = 1,800 watts (1.8 kW) of electric power.

*Converting Power (watts or kW) to Energy (kWh)*

One kilowatt-hour (1 kWh) means an energy source supplies 1,000 watts (1 kW) of energy for one hour. Generally, a solar energy system will provide output for about 5 hours per day. So, if you have a 1.8 kW system size and it produces for 5 hours a day, 365 days a year: This solar energy system will produce 3,285 kWh in a year (1.8 kW x 5 hours x 365 days).

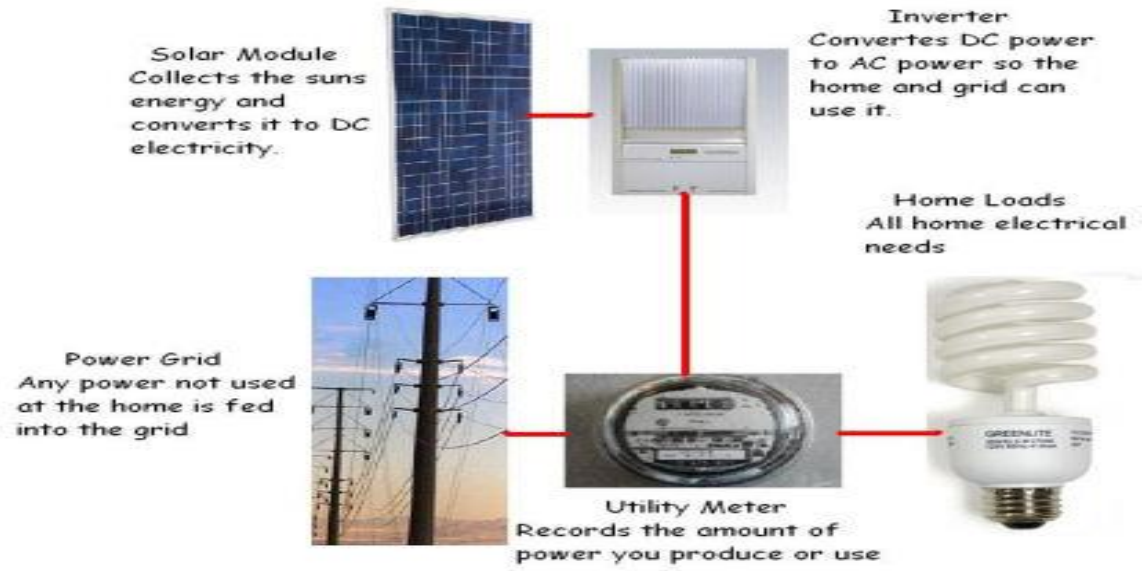
If the PV panels are shaded for part of the day, the output would be reduced in accordance with the shading percentage. For example, if the PV panels receive 4 hours of direct sun shine a day (versus the standard 5 hours), the panels are shaded 1 divided by 5 = 20% of the time (80% of assumed direct sunshine hours received). In this case, the output of a 200 square-foot PV panel system would be 3,285 kWh per year x 80% = 2,628 kWh per year.

*Estimating Solar Electric (PV) System Size to Replace a Specified Amount of Utility (grid) electricity*

**PV System Capacity Required (kW of PV) can be roughly calculated as follows**:-Annual electricity usage = Monthly Usage x 12 months. Electricity usage is express in kilowatt-hours (kWH).

Energy production from a solar electric (PV) system is a function of several factors, including the following … the "78% used above assumes the following losses across the PV system:

| **Factor** | **Assumption** |
|---|---|
| Solar resources | Assumed solar availability: As per PV Watts |
| Soiling or contamination of the PV panels | Clean, washed frequently: 98% design sunlight transmission |
| Temperature | 25C, calm wind |
| System configuration (battery or non-battery) | Non-battery |
| Orientation to the sun | tilted at your latitude, South facing |
| Shading | None |
| PV Energy delivered as % of manufacturers rating | 95% |
| Wiring & power point tracking losses | 9% (91% delivered) |
| Inverter Efficiency | 90% |
| Total Energy Delivered | 95% x 91% x 90% = 78% |



# Project (Ideas) & Application on Solar Application

## Project: - Solar - School Projects

**1. Solar Water bulb**

**2. The solar roof on the bus**

**3. Solar lantern or Solar charging Light**

**4. Solar Mobile charger**

**5. Solar water Irrigation system**

**6. Solar room heating system**

**7. Solar Charging station**

**8. Solar LED Tree**

**9. Solar Garden spic light**

**10. Solar fountain Light**

**11. Solar Portable system**

**12. Solar Bag**

**13. Solar Cap**

**14. Solar Helmet**

**15. Solar Rooftop system**

**16. Solar home Application**

**17. Solar for farming**

**18. Solar Bus Station Charging System**

**19. Solar Thrasher**

**20. Solar Grass Cutter Machine**

**21. Solar Decorated LED Light**

**22. Solar Gift Products**

**23. Solar Bamboo Light**

**24. Solar Mushroom Light**



Angoora LED Rice Light