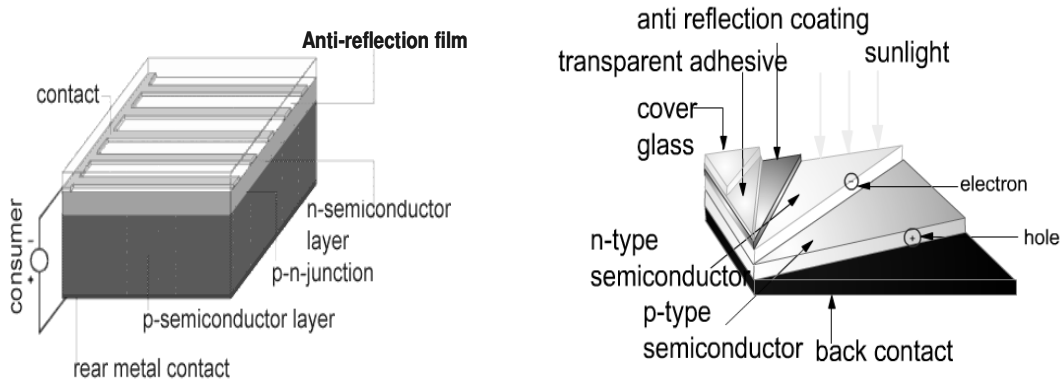
Solar Cells

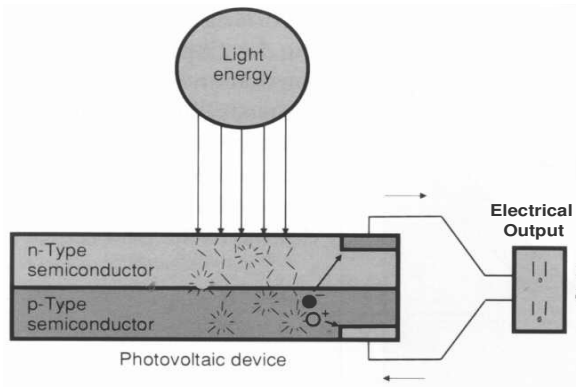
Solar cell is the basic photovoltaic device which generates electricity when exposed to sunlight. This process these perform without the use of either chemical reactions or moving parts. A typical solar cell uses semiconductors made from silicon.

Solar cells represent the fundamental power conversion unit of a photovoltaic system which has much in common with other solid-state electronic devices, such as diodes, transistors and integrated circuits. For practical operation, solar cells are usually assembled into modules. Its operation is based on the ability of semiconductors to convert sunlight directly into electricity by exploiting the photovoltaic effect.



Schematic diagram and various components of a typical solar cell

In the conversion process, the incident energy of light creates mobile charged particles in the semiconductor which are then separated by the device structure and produce electricity. Silicon is by far the commonest of a variety of semiconductors from which solar cells are made. A typical modern solar cell is squared-shaped measuring 10 cm × 10 cm. It is covered by a clear anti-reflection coating (ARC) that reduces the amount of light lost to reflection at the cell surface.



Solar cells[1] are classified in three categories according to the type of crystal: monocrystalline, polycrystalline and amorphous. To produce a monocrystalline silicon cell, absolutely pure semiconducting material is necessary. Monocrystalline rods are extracted from melted silicon and then sawed into thin plates.

The usable voltage from solar cells depends on the semiconductor material. In silicon it amounts to approximately 0.5 V. Terminal voltage weakly dependent on incident light radiation, while the current intensity increases with higher luminosity. Typically a 100 cm² silicon cell, reaches a maximum current of approximately 2A when radiated by 1000 W/m².

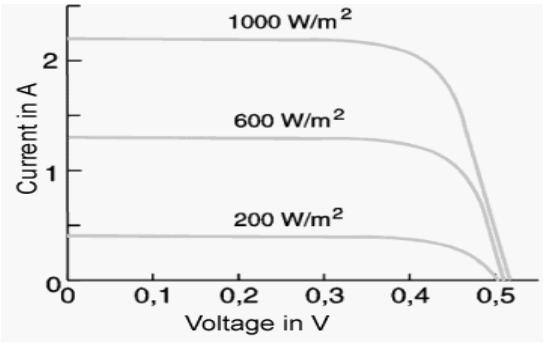


Figure 8. Electrical output under different Solar Irradiance

The efficiency (η) of a solar cell is defined as the power P_{max} supplied by the cell at the maximum power point under standard test conditions, divided by the power of the radiation incident upon it. Most frequent conditions are; solar irradiance 100 mW/cm², standard reference spectrum, and temperature 25°C. The use of this standard irradiance value is particularly convenient since the cell efficiency in percent is then numerically equal to the power output from the cell in mW/cm².

[1] **Monocrystalline cells** are made from polished, wafer thin slices of single crystals of silicon. Originally, all PV cells were made in this way. These tends to be expensive, as the crystals take time to grow, but it does produce the most efficient cells (~16%). These cells have a life span of about 40 years.
Polycrystalline cells are made from slices of ingots cast from raw silicon crystals giving the characteristic flaked appearance. This method gives a better surface coverage than monocrystalline cells and is cheaper than growing large crystals. These cells have the second highest efficiency (~12%) and are fast becoming the most popular form of cell.
Amorphous cells are made by spraying the silicon directly onto glass or ceramic in layers. these types of cells are the cheapest to produce but contain impurities, so the overall conversion of light to electricity is low (~5%).