SOLAR CELL – CHARACTERISTICS AND TYPES

Solar cell is a semiconductor device that converts the energy of sunlight into electric energy. These are also called ‘photovoltaic cell’. Solar cells do not use chemical reactions to produce electric power, and they have no moving parts.

Photovoltaic solar cells are thin silicon disks that convert sunlight into electricity. These disks act as energy sources for a wide variety of uses, including: calculators and other small devices; telecommunications; rooftop panels on individual houses; and for lighting, pumping, and medical refrigeration for villages in developing countries. In large arrays, which may contain many thousands of individual cells, they can function as central electric power stations analogous to nuclear, coal-, or oil-fired power plants. Arrays of solar cells are also used to power satellites; because they have no moving parts that could require service or fuels that would require replenishment, solar cells are ideal for providing power in space.

Most photovoltaic cells consist of a semiconductor pn junction, in which electron-hole pairs produced by absorbed radiation are separated by the internal electric field in the junction to generate a current, a voltage, or both, at the device terminals. Under open-circuit conditions (current $I = 0$) the terminal voltage increases with increasing light intensity, and under short-circuit conditions (voltage $V = 0$) the magnitude of the current increases with increasing light intensity. When the current is negative and the voltage is positive, the photovoltaic cell delivers power to the external circuit.

* Characteristics of a Solar Cell: The usable voltage from solar cells depend on the semiconductor material. In silicon it amounts to approximately 0.5 V. Terminal voltages is only weakly dependent on light radiation, while the current intensity increases with higher luminosity. A 100 cm^2 silicon cell, for example, reaches a maximum current intensity of approximately 2 A when radiated by 1000 W/m^2. The output (product of electricity and voltage) of a solar cell is temperature dependent. Higher cell temperatures lead to lower output, and hence to lower efficiency. The level of efficiency indicates how much of the radiated quantity of light is converted into useable electrical energy.

* Cell Types: One can distinguish three cell types 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. This production process guarantees a relatively high level of efficiency.

The production of polycrystalline cells is more cost-efficient. In this process, liquid silicon is poured into blocks that are subsequently sawed into plates. During solidification of the material, crystal structures of varying sizes are formed, at whose borders defects emerge. As a result of this crystal defect, the solar cell is less efficient.

If a silicon film is deposited on glass or another substrate material, this is a so-called amorphous or thin layer cell. The layer thickness amounts to less than 1µm (thickness of a human hair: 50-100 µm), so the production costs are lower due to the low material costs. However, the efficiency of amorphous cells is much lower than that of the other two cell types. Because of this, they are primarily used in low power equipment (watches, pocket calculators) or as facade elements.

* Efficiency: Solar cell efficiencies vary from 6% for amorphous silicon-based solar cells to 42.8% with multiple-junction research lab cells. Solar cell energy conversion efficiencies for commercially available multicrystalline Si solar cells are around 14-16%. The highest efficiency cells have not always been the most economical — for example a 30% efficient multijunction cell based on exotic materials such as gallium arsenide or indium selenide and produced in low volume might well cost one hundred times as much as an 8% efficient amorphous silicon cell in mass production, while only delivering about four times the electrical power.

To make practical use of the solar-generated energy, the electricity is most often fed into the electricity grid using inverters (grid-connected PV systems); in stand alone systems, batteries are used to store the energy that is not needed immediately.

* Advantages of solar cells: Solar cells are long lasting sources of energy which can be used almost anywhere. They are particularly useful where there is no national grid and also where there are no people such as remote site water pumping or in space. Solar cells provide cost effective solutions to energy problems in places where there is no mains electricity. Solar cells are also totally silent and non-polluting. As they have no moving parts they require little maintenance and have a long lifetime. Compared to other renewable sources they also possess many advantages; wind and water power rely on turbines which are noisy, expensive and liable to breaking down.

Rooftop power is a good way of supplying energy to a growing community. More cells can be added to homes and businesses as the community grows so that energy generation is in line with demand. Many large scale systems currently end up over generating to ensure that everyone has enough. Solar cells can also be installed in a distributed fashion, i.e. they don't need large scale installations. Solar cells can easily be installed on roofs, which mean no new space is needed and each user can quietly generate their own energy.

* Disadvantages of solar cells: The main disadvantage of solar energy is the initial cost. Most types of solar cell require large areas of land to achieve average efficiency. Air pollution and weather can also have a large effect on the efficiency of the cells. The silicon used is also very expensive and the problem of nocturnal down times means solar cells can only ever generate during the daytime. Solar energy is currently thought to cost about twice as much as traditional sources (coal, oil etc). Obviously, as fossil fuel reserves become depleted, their cost will rise until a point is reached where solar cells become an economically viable source of energy. When this occurs, massive investment will be able to further increase their efficiency and lower their cost.

5. Nanoparticle with carbon nanotubes based solar cells – more efficient and practical -Experts have demonstrated a way to significantly improve the efficiency of solar cells made using low-cost, readily available materials, including a chemical commonly used in paints. The researchers added single-walled carbon nanotubes to a film made of titanium-dioxide nanoparticles. This process doubles the efficiency of cell for converting ultraviolet light into electrons when compared with the performance of the nanoparticles alone. Titanium oxide is a main ingredient in white paint.

Such cells are appealing because nanoparticles have a great potential for absorbing light and generating electrons. But so far, the efficiency of actual devices made of such nanoparticles has been considerably lower than that of conventional silicon solar cells. That's largely because it has proved difficult to harness the electrons that are generated to create a current. In fact, when electrons generated by absorbing light by titanium –oxide, absence of carbon nanotubes with the titanium-oxide particles make the electrons jump from particle to particle before reaching an electrode. On the path many electrons do not able to reach the electrode, thus fail to generate an electrical current. The carbon nanotubes "collect" the electrons and provide a more direct route to the electrode, improving the efficiency of the solar cells.

The new carbon-nanotube with titanium –oxide nanoparticle system is not yet a practical solar cell, as titanium oxide only absorbs ultraviolet light; most of the visible spectrum of light is reflected rather than absorbed. Researchers have also demonstrated ways to modify the nanoparticles to absorb the visible spectrum.

Several other groups of researchers are exploring approaches to improve the collection of electrons within a cell, including forming titanium-oxide nanotubes or complex branching structures made of various semiconductors. Using carbon nanotubes as a conduit for electrons from titanium oxide is a novel idea, and once it is successful the cheaper variety of efficient solar cells can be developed.

More research is needed towards development of efficient solar cells, as solar energy is renewable, clean and unlike grain based bio-fuel, solar energy is not agriculture based thus do not utilize farm land and do not hamper food production.

Source : http://saferenvironment.wordpress.com/2009/02/02/solar-power-%E2%80%93-sustainable-green-energy-to-protect-our-economy-and-environment/