Producing electricitys from light is photovoltaic engineering essay

Engineering

Producing electricity from light is Photovoltaic. This phenomenon is deployed in converting abundantly available solar light energy to direct current (DC) electricity. The basic device acting as a transducer for the light energy into electrical energy is the solar cell which primarily is a semiconductor that exhibits photovoltaic property. When these semiconductors, which basically are diodes, are exposed to radiation, photons in light excite flow of electrons in the form of electric current. When impurities are introduced (in a process is referred to as " doping") in the crystalline structure – or lattice – of these semiconductors their conductivity can be suitably altered.[1]Silicon, which has four valence electrons, is treated to increase its conductivity. On one side of the cell, boron with three valence electrons (p-donor) creates a greater affinity than silicon to attract electrons while on the other side excessive negative charge is created by adding impurities such as phosphorous atoms with valence of five. With p-type silicon in intimate contact with the n-type silicon, Diffusion of Electrons occurs across a p-n junction. A flow of current is established when semiconductor contacts provided on either side are connected to an external load. Although first detected as far back as in 1839, it was only in 1954 that for the first time the photovoltaic phenomenon was experimentally established in the Bell Labs. Since then there has been a rapid development in choice of semiconductor material and manufacturing processes designing for producing commercially usable solar cells. Since it has been established as a sustainable source of electricity generation, already by 2012 over 100 GW Solar Photovoltaic generation capacities have been built worldwide in over 100 countries, making it the third largest source of renewable energy after Hydro and Wind

Power. Initial disadvantages of stability over the operating life and high cost of material and manufacturing process of solar cells have substantially been overcome. The developmental research both relating to basic material and mass manufacturing processes is ongoing and the costs which have been substantially reduced are likely to go down further. This would permit wider deployment of solar photovoltaic as a source of renewable energy. To start with, solar cells were made from flat-plate silicon. Although most efficient these so called 1st generation cells are cost intensive. To overcome the cost factor, solar cells which are few micrometers (μm) thick, also commonly known as 2nd generation or thin-film solar cells are made from amorphous silicon or non-silicon materials such as cadmium telluride. Consequently, in further pursuance of cost reduction solar cells are being made in the 3rd generation from variety of new materials besides silicon, such as solar inks using conventional printing press technologies, solar dyes, and conductive plastics[2]. Solar cells are made from photovoltaic materials. Most common of these are monocrystalline silicon, polycrystalline silicon and amorphous silicon. Besides, cadmium telluride, and copper indium selenide/sulfide[3]are also increasingly being used to reduce costs. Wafer-based silicon solar cells are approximately 200 μm thick while thin-film solar cells are approximately 1-2 μm thick and therefore contain significantly less active, semiconducting material and hence are significantly less cost intensive. Although thin film solar cells can be manufactured at lower cost in large production quantities, they have lower efficiencies than wafer-based silicon solar cells. For a comparable performance this means more exposure surface and material for the installation is required. A solar cell, which is the primary building block of a solar photovoltaic system are packed under a glass sheet to provide protection from environment. A number of such suitably packed solar cells – usually 40 – are electrically connected by a copper wire to form a solar module in order to obtain higher power output. In turn such solar modules are arranged in series or parallel to form an array. Many such arrays can be connected together to form a usable electrical power system. Solar photovoltaics, either as cells or modules or arrays produce direct current electricity from sun light. Mostly this output can be used to power stand alone solo equipments operating on DC or to recharge a battery. In order to be deployed in grid connected power generation systems, an inverter is required to convert the DC to alternating current (AC). Under standardized test conditions (STC), Photovoltaic power capacity measured is specified as maximum power output in Watts peak (" Wp").[4]Under actual operating conditions, this " rated value of power output" can vary depending upon various factors such as geographical location, time of the day, weather conditions, etc. In terms of capacity factor, which is the ratio of the actual output of a unit in a period of time to its potential output if it would run at its full capacity in the same period of time, solar photovoltaic arrays fare at 25% or lower. Admittedly, this is lower than most other industrial electricity sources.[5]Solar photovoltaic panels are usually mounted in a cluster such that they get a maximum exposure to the sunlight. Consequently, these panels are mounted at an angle to the horizontal. The mounting angle is usually determined by the latitude of the location. Even if the panels are mounted facing the suns path, exposure to light is not optimum in the morning and evening hours of the day. To overcome this limitations solar panels are increasingly being mounted on automated tracking devices which follow the suns path (heliostat) and thereby allow for maximum exposure to sun light. The number of panels forming a cluster is decided by the power requirement of the load. The installation space requirement can widely vary and is usually very large. Residential and commercial building terraces are found to be ideal. In a unique and novel application in the State of Gujarat, the solar panels have been mounted to cover the irrigation canal network. This provides a dual advantage of utilizing a space which otherwise could not be put to any other use and by covering the water body, loss due to evaporation of water was reduced. Cost effective thin film solar cell modules as tiles and slates are increasingly finding application in cladding of buildings in massive commercial and residential building complexes. During the initial period when use of solar photovoltaics came into vogue, the application was restricted to isolated DC loads such as water pumps mounted in remote farms and with a battery backup, for domestic, street and traffic signal lighting and their like. Gradually with the use of inverters the scope of application was extended to AC loads as well. Domestic power packs of 3. 5 - 5 kWp are gaining application. Although high in initial capital cost they make up by saving in use of utility provided power supply. Large scale application of solar photovoltaics is for power grid connection. Generation plants in ever increasing sizes are being installed worldwide. Although Europe is currently leading in number of installations, rest of the world is fast catching up. The largest reported PV Power Station in India is Charanka Solar Park with 214 MW of installed capacity. Currently two PV Power Plants - each of capacity 550 MW - are being built in California in the US utilizing thin film solar cells.

With increasing sizes of power plants and consequent large scale manufacture of solar cells there is a substantial digression in module and installation costs. Consequently, solar PV power is inching towards grid power in cost.

To be continued ----

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