

A

Seminar report

On

SOLAR TREE

Submitted in partial fulfillment of the requirement for the award of degree
Of Civil

SUBMITTED TO:

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Preface

I have made this report file on the topic **SOLAR TREE**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude towho assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

INTRODUCTION

It is a form of renewable energy resource that is some measure competitive with fossil fuels. Hydro power is the force of energy of moving water. It provides about 96% of the renewable energy in the united state. Hydro electric power plants do not use any resources to create electricity or they do not pollute the air.

The sun is a hydrodynamic spherical body of extremely hot ionized gases(plasma), generating energy by the process of the thermonuclear fusion. The temperature of interior of sun is estimated at 8×10^6 k to 40×10^6 k, where energy is released by fusion of hydrogen and helium.

Solar energy is available in abundance and considered as the easiest and cleanest means of tapping the renewable energy. For direct conversion of solar radiation into usable form, the routes are: solar thermal, solar photovoltaic and solar architecture. However the main problem associated with tapping solar energy is the requirement to install large solar collectors requires a very big space. To avoid this problem we can install a solar tree in spite of a no of solar panels which require a very small space.

WHAT IS A SOLAR TREE

A solar tree is a decorative means of producing solar energy and also electricity. It uses multiple no of solar panels which forms the shape of a tree. The panels are arranged in a tree fashion in a tall tower/pole.

TREE stands for

T= TREE GENERATING

R=RENEWABLE

E=ENERGY and

E=ELECTRICITY

This is like a tree in structure and the panels are like leaves of the tree which produces energy.

SPIRALLING PHYLLATAXY

It is a technique used in designing of solar tree . it provides the way to help the lower panels from the shadow of upper ones, so that it can track maximum power from sun.

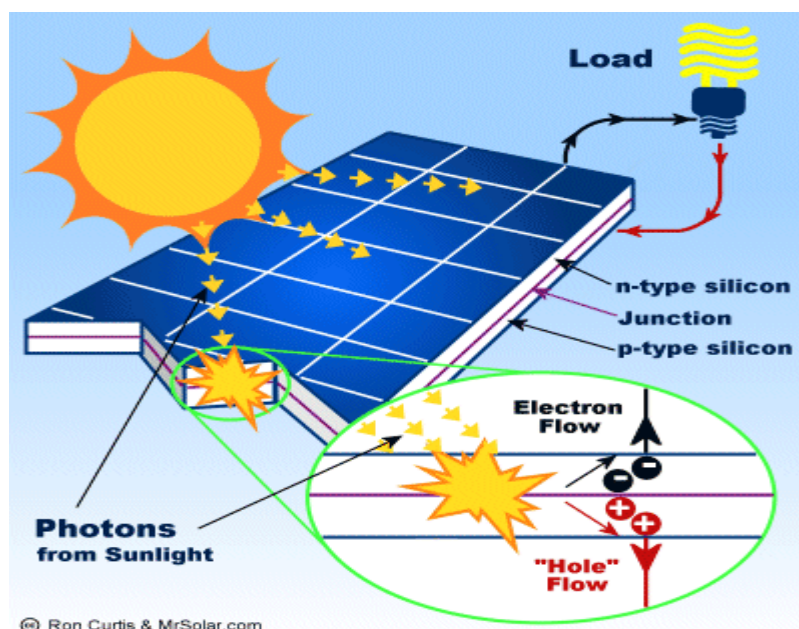


INTRODUCTION ABOUT SOLAR CELL

A solar cell (photovoltaic cell or photoelectric cell) is a solid state electrical device that converts the energy of light directly into electricity by the photovoltaic effect. The energy of light is transmitted by photons-small packets or quantum of light. Electrical energy is stored in electromagnetic fields, which in turn can make a current of electrons flow.

Assemblies of solar cells are used to make solar modules which are used to capture energy from sunlight. When multiple modules are assembled together (such as prior to installation on a pole-mounted tracker system), the resulting integrated group of modules all oriented in one plane is referred as a solar panel. The electrical energy generated from solar modules, is an example of solar energy. Photovoltaic is the field of technology and research related to the practical application of photovoltaic cells in producing electricity from light, though it is often used specifically to refer to the generation of electricity from sunlight. Cells are described as photovoltaic cells when the light source is not necessarily sunlight. These are used for detecting light or other electromagnetic radiation near the visible range, for example infrared detectors, or measurement of light intensity.

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HOW SOLAR CELL WORKS

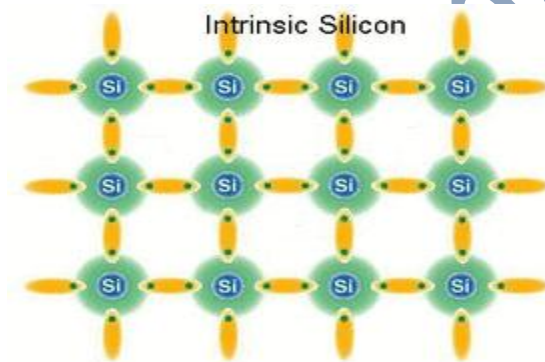
Solar cells, which largely are made from crystalline silicon work on the principle of Photoelectric Effect that this semiconductor exhibits. Silicon in its purest form- Intrinsic Silicon- is doped with a dopant impurity to yield Extrinsic Silicon of desired characteristic (p-type or n-type Silicon). When p and n type silicon combine they result in formation of potential barrier.

Working of Solar cells can thus be based on two crystalline structure

- Intrinsic Silicon
- Extrinsic Silicon

Pure Silicon (Intrinsic) Crystalline Structure

Silicon has some special chemical properties, especially in its crystalline form. An atom of silicon has 14 electrons, arranged in three different shells. The first two shells- which hold two and eight electrons respectively- are completely full. The outer shell, however, is only half full with just four electrons (Valence electrons). A silicon atom will always look for ways to fill up its last shell, and to do this, it will share electrons with four nearby atoms. It's like each atom holds hands with its neighbours, except that in this case, each atom has four hands joined to four neighbours. That's what forms the crystalline structure. The only problem is that pure crystalline silicon is a poor conductor of electricity because none of its electrons are free to move about, unlike the electrons in more optimum conductors like copper



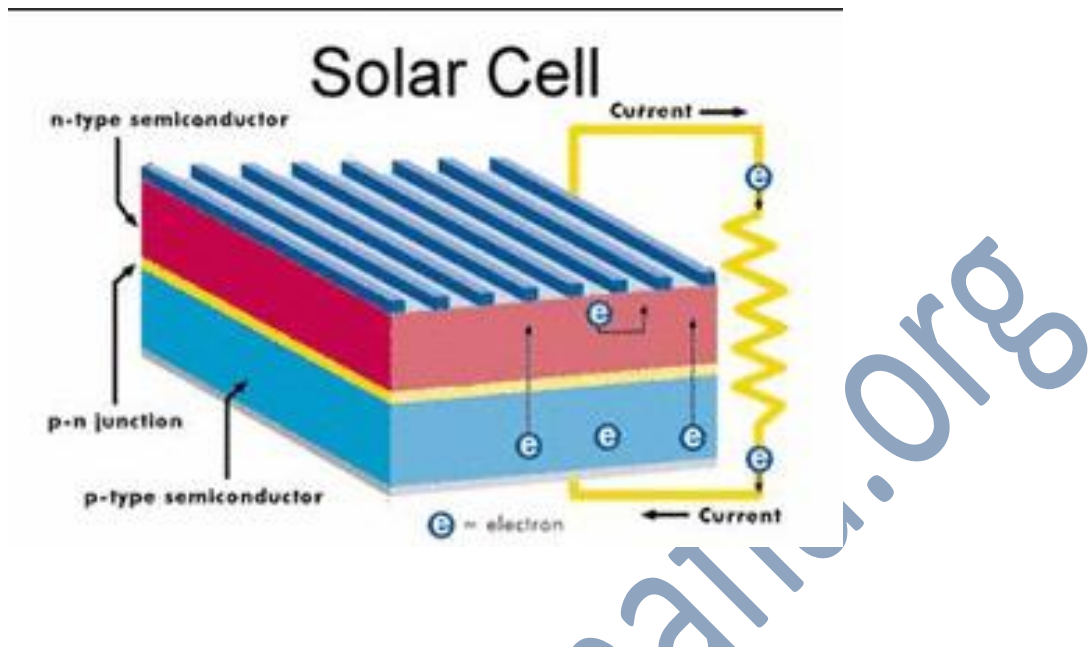
Impurity Silicon (Extrinsic): P-type and N-type Semiconductors

Extrinsic silicon in a solar cell has added impurity atoms purposefully mixed in with the silicon atoms, maybe one for every million silicon atoms. Phosphorous has five electrons in its outer shell. It bonds with its silicon neighbor atoms having valency of 4, but in a sense, the phosphorous has one electron that doesn't have anyone to bond with. It doesn't form part of a bond, but there is a positive proton in the phosphorous nucleus holding it in place. When energy is added to pure silicon, in the form of heat, it causes a few electrons to break free of their bonds and leave their atoms. A hole is left behind in each case. These electrons, called free carriers, then wander randomly around the crystalline lattice looking for another hole to fall into and carry

an electrical current. In Phosphorous-doped Silicon, it takes a lot less energy to knock loose one of "extra" phosphorous electrons because they aren't tied up in a bond with any neighboring atoms. As a result, most of these electrons break free, and release a lot more free carriers than in pure silicon. The process of adding impurities on purpose is called doping, and when doped with phosphorous, the resulting silicon is called N-type ("n" for negative) because of the prevalence of free electrons. N-type doped silicon is a much better conductor than pure silicon. The other part of a typical solar cell is doped with the element boron, which has only three electrons in its outer shell instead of four, to become P-type silicon. Instead of having free electrons, P-type ("p" for positive) has free openings and carries the opposite positive charge

Formation of Potential Barrier and Photoelectric Effect

The electric field is formed when the N-type and P-type silicon come into contact. Suddenly, the free electrons on the N side combine the openings on the P side. Right at the junction, they combine and form something of a barrier, making it harder and harder for electrons on the N side to cross over to the P side (called POTENTIAL BARRIER). Eventually, equilibrium is reached, and an electric field separating the two sides is set up. This electric field acts as a diode, allowing (and even pushing) electrons to flow from the P side to the N side, but not the other way around. It's like a hill -- electrons can easily go down the hill (to the N side), but can't climb it (to the P side).

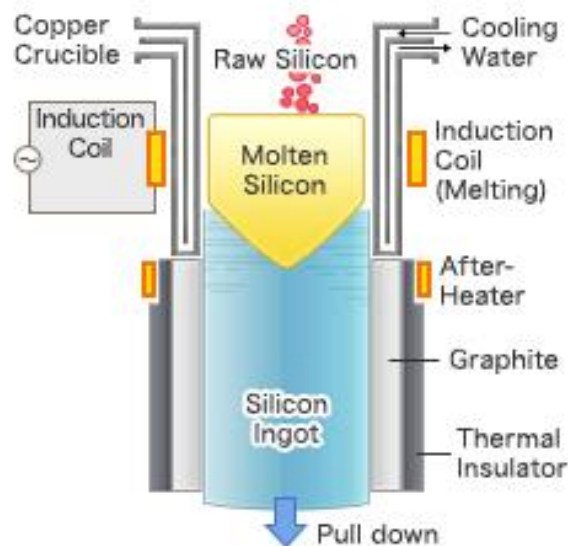


When light, in the form of photons, hits solar cell, its energy breaks apart electron-hole pairs (Photoelectric effect). Each photon with enough energy will normally free exactly one electron, resulting in a free hole as well. If this happens close enough to the electric field, or if free electron and free hole happen to wander into its range of influence, the field will send the electron to the N side and the hole to the P side. This causes further disruption of electrical neutrality, and if an external current path is provided, electrons will flow through the path to the P side to unite with holes that the electric field sent there, doing work for us along the way. The electron flow provides the current, and the cell's electric field causes a voltage.

The final step is to install something that will protect the cell from the external elements- often a glass cover plate. PV modules are generally made by connecting several individual cells together to achieve useful levels of voltage and current, and putting them in a sturdy frame complete with positive and negative terminals.

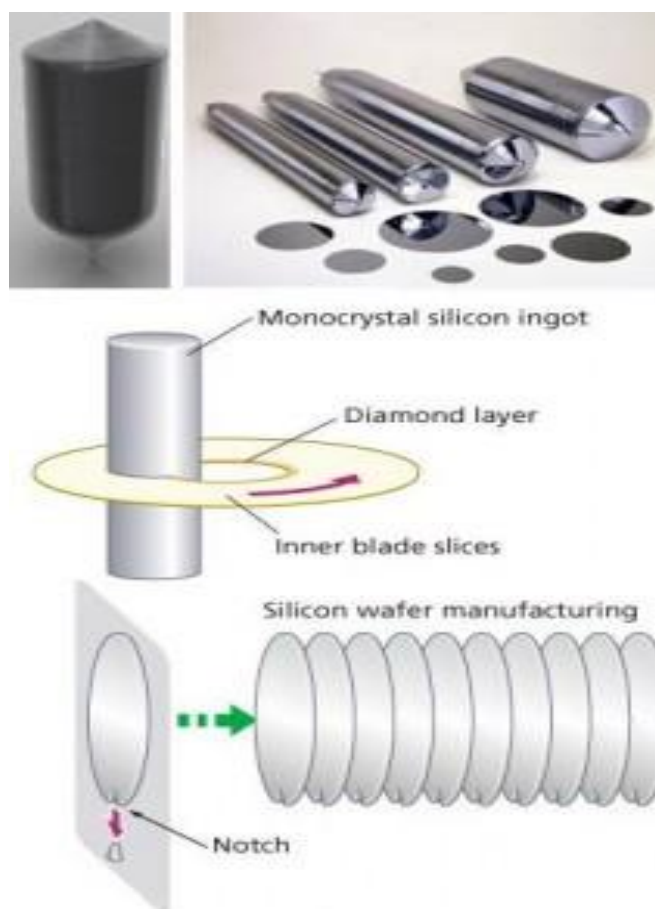
Manufacturing Technology and process of Solar Cell

STEP 1 - PURIFICATION OF SILICON:



The basic component of a solar cell is intrinsic silicon, which is not pure in its natural state. To make solar cells, the raw materials—silicon dioxide of either quartzite gravel or crushed quartz—are first placed into an electric arc furnace, where a carbon arc is applied to release the oxygen. A Graphite and Thermal insulator trap the heat and maintain the furnace at required temperature for gangue (impurity) to form a slag. The products are carbon dioxide and molten silicon. Silicon ingot is pulled down from the molten silicon using seed silicon crystallization and floating zone technique. Passing impure silicon in same direction several times that separates impurities- and impure end is later removed. This process yields silicon with one percent impurity, useful in many industries but not the solar cell industry. At this point, the silicon is still not pure enough to be used for solar cells and requires further purification. Pure silicon is derived from such silicon dioxides as quartzite gravel (the purest silica) or crushed quartz.

STEP 2- INGOT AND WAFER PREPARATION:



Solar cells are made from silicon boules, polycrystalline structures that have the atomic structure of a single crystal. The most commonly used process for creating the boule is called the Czochralski method. In this process, a seed crystal of silicon is dipped into melted polycrystalline silicon. As the seed crystal is withdrawn and rotated, a cylindrical ingot or "boule" of silicon is formed. The ingot withdrawn is unusually pure, because impurities tend to remain in the liquid. From the boule, silicon wafers are sliced one at a time using a circular saw whose inner diameter cuts into the rod, or many at once with a multi wire saw. (A diamond saw

produces cuts that are as wide as the wafer—. 5 millimeter thick.) Only about one-half of the silicon is lost from the boule to the finished circular wafer—more if the wafer is then cut to be rectangular or hexagonal. Rectangular or hexagonal wafers are sometimes used in solar cells because they can be fitted together perfectly, thereby utilizing all available space on the front surface of the solar cell. The wafers are then polished to remove saw marks.

STEP 3 - DOPING:

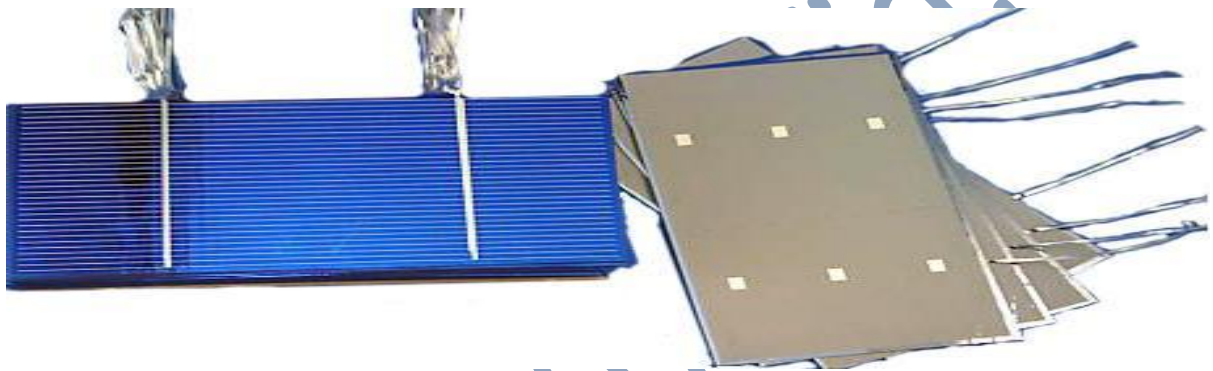
The traditional way of doping silicon wafers with boron and phosphorous is to introduce a small amount of boron during the Czochralski process. The wafers are then sealed back to back and placed in a furnace to be heated to slightly below the melting point of silicon (2,570 degrees Fahrenheit or 1,410 degrees Celsius) in the presence of phosphorous gas. The phosphorous atoms "burrow" into the silicon, which is more porous because it is close to becoming a liquid. The temperature and time given to the process is carefully controlled to ensure a uniform junction of proper depth. These diffusion processes are usually performed through the use of a batch tube furnace or an in-line continuous furnace. The basic furnace construction and process are very similar to the process steps used by packaging engineers.

STEP 4 - SCREEN PRINTING:



Electrical contacts are formed through squeezing a metal paste through mesh screens to create a metal grid. This metal paste (usually Ag or Al) needs to be dried so that subsequent layers can be screen-printed using the same method. As a last step, the wafer is heated in a continuous firing furnace at temperatures ranging from 780 to 900°C. These grid-pattern metal screens act as collector electrodes that carry electrons and complete the electrical continuity in the circuit.

STEP 5 - STRINGING AND TABBING:

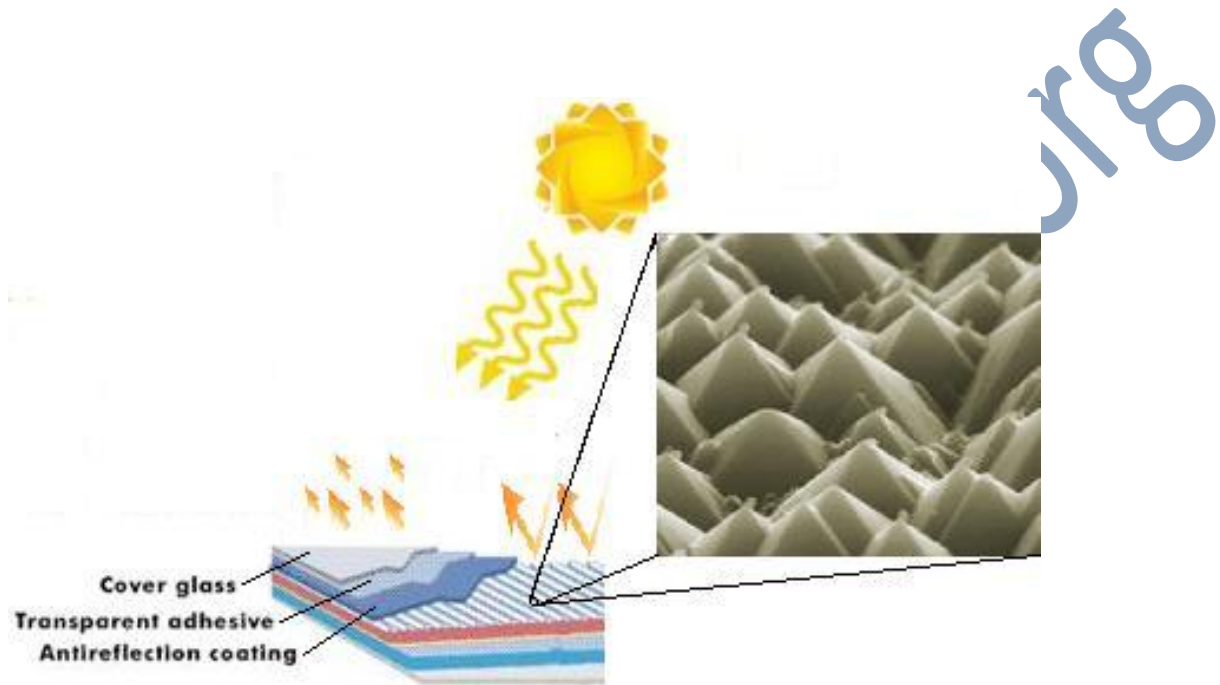


Electrical contacts connect each solar cell to another and to the receiver of produced current. The contacts must be very thin (at least in the front) so as not to block sunlight to the cell. Metals such as palladium/silver, nickel, or copper are vacuum-evaporated. After the contacts are in place, thin strips ("fingers") are placed between cells. The most commonly used strips are tin-coated copper.

STEP 6 - ANTIREFLECTIVE COATING:

Because pure silicon is shiny, it can reflect up to 35 percent of the sunlight. To reduce the amount of sunlight lost, an anti-reflective coating is put on the silicon wafer- mostly titanium dioxide, silicon oxide and some others are used. The material used for coating is either heated until its molecules boil off and travel to the silicon and condense, or the material undergoes sputtering. In this process, a high voltage knocks molecules off the material and deposits them onto the silicon at the opposite electrode. Yet another method is to allow the silicon itself to react

with oxygen- or nitrogen-containing gases to form silicon dioxide or silicon nitride. Commercial solar cell manufacturers use silicon nitride. Another method to make silicon absorb more light is to make its top surface grained, i.e. pyramid shaped nanostructures that yield 70% absorption that reaches the cell surface after passing through anti-reflective coating.



STEP 7 - MODULE MANUFACTURING

The finished solar cells are then encapsulated; that is, sealed into silicon rubber or ethylene vinyl acetate. Solar module assembly usually involves soldering cells together to produce a 36-cell string (or longer) and laminating it between toughened glass on the top and a polymeric backing sheet on the bottom. The encapsulated solar cells are then placed into an aluminum frame that has a Mylar or tedlar back sheet and a glass or plastic cover. Frames are usually applied to allow for mounting in the field, or the laminates may be separately integrated into a mounting system for a specific application such as integration into a building.

Advantages of Solar Panels

Private home owners are discovering the benefits to our environment and a way to live happily off the grid or are considering installing a grid-tied solar power system to offset their electric bill or due to a belief in reducing their carbon emissions. These are great reasons to "go solar"...

- **Ecologically Friendly** - For obvious reasons, the use of solar panels is Eco-friendly and considered one of the most "green" electricity resources. Because they operate by interacting with a renewable energy source, sunlight, there is no fear of depleting yet another natural resource.
- **Decreased Electrical Bill** - By switching to solar energy, you will save money on your electrical bills every month. Even if electricity bills continue raising in the next few months you will have the peace of mind knowing that your energy source is based on solar power.
- **Low Maintenance** - Solar panels have no moveable parts and are very simple to use. After being set up properly, they do not need to be tinkered with and will continue working for many years. In fact, many manufacturers have 25 year warranties on their panels.
- **Efficiency** - No matter where you live, the chances are that you can successfully use solar panels for your electrical needs. They are rugged and are very adaptable to climate conditions and the latest panel models are efficient enough to work well without facing directly south and some will even produce electricity under cloud cover.

Regardless of who you are or what type of home you have, solar power is one of the best ways to provide you and your family with electricity without causing more damage to our planet.

There are many ways to take advantage of the savings gained from solar panel systems. Not only does it help you save by cutting your energy requirement from the utility company, it may also allow you to lock in a lower solar power rate. By using the electricity produced by your unit

during the day, (when rates are at their highest), and using the utility company's power in the evening, (when the rates are at their lowest), you will lower your overall cost for all of your electrical use. There are also many rebates available to help you save 40-60% on the cost of acquiring your system. For more information on rebates and incentives for installing a solar power system on your home or business look up "Energy Incentives" on the IRS website or check with your local tax adviser for details.

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WHY WE CALLED IT AS SOLAR TREE

As we know trees are present in nature and they can produce their own food material by the process called PHOTOSYNTHESIS. It is the process by which the green plant collects energy from sun and the water present in soil at the day time and can produces their own food material. By this process they are indirectly providing food to the human society because we are depending on the green plants for our food directly or indirectly.

Here we are considering the example for understanding about the solar tree. This is a tree in which the stems connected acts as the branches of the tree and the solar panels are like the leaves. Green leaves are producing food materials for human beings likewise this leaves are producing energy for the society. So it is very appropriate to called it as a tree.



Natural Tree



Solar Tree

WHY IT IS NEEDED

Due to less land requirement:

It is the best option of energy generation because it requires very less land as compare to the traditional PV system. Now a day's land becomes the costliest commodity for the human society because of high population growth. Example – To generate 2 MW power from a PV module we requires 10 -12 acres of land for housing of panels only. But for the same amount of energy we require only 0.10-0.12 acres of land in case of solar tree. So we require such a plant which can generate maximum energy using minimum land.

Efficient energy generation:

It can generate energy very efficiently as compare to traditional system. Due to the technique called spiraling phyllataxy its efficiency further increase. We can also use the technique called “SPIRALLING PHYLLATAXY” to improve the efficiency of the plant. It can be applied in street lightening system , industrial power supply etc. It is much better than the traditional solar PV system in area point of view and also more efficient. Though it is somehow costly but as compare to all cost involve in traditional system it is more efficient.

It can collect energy from wind:

As the name suggest this is a device to generate energy from sun but it has some unique feature to generate energy from wind. The stem are flexible so that they can rotate in any direction and by shaking themselves they produce energy also from wind as in the case of a natural tree. The unique technique is that flexible panels connected to the stem which can be

rotated as our desire. So that flexibility avoidance of wind pressure can be possible. Flexibility offers manual rotating so that maximum power can be obtained.

CONSTRUCTION AND WORKING

The solar tree consists of some important parts in its design. They are as follows:

- Solar panels
- Long tower
- LDEs
- Batteries
- Stems for connecting the panels

WORKING:

- Batteries are charged during the day time.
- LEDs are automatically switched on
- These are used to indicate how much charge/energy remain left
- Batteries are also used to store the energy so that we can use it at night and in cloudy days when no sunlight is there.

LEDs

8.1 Light Emitting Diode (LED)

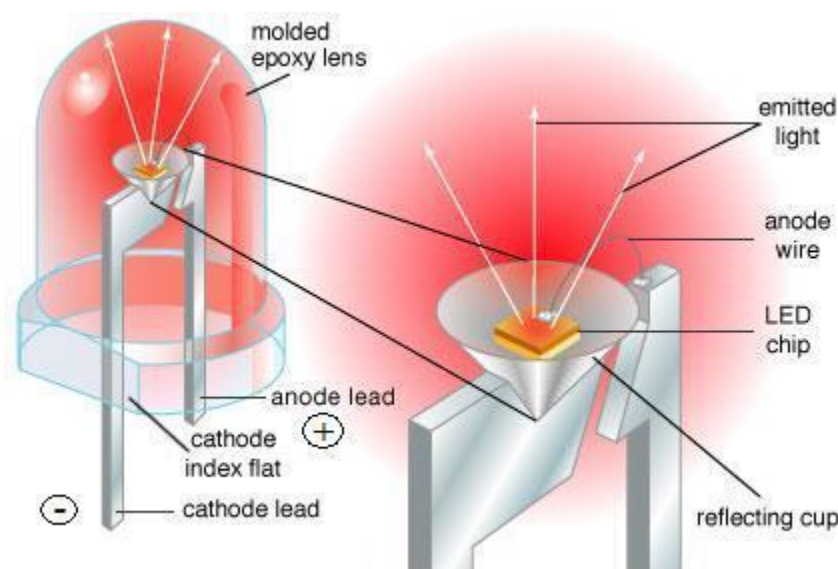


Light Emitting Diode

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Appearing as practical electronic components in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

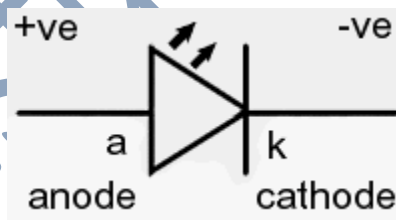
Internal Description of LED

When a light-emitting diode is forward-biased (switched on), electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is often small in area (less than 1 mm²), and integrated optical components may be used to shape its radiation pattern.



Internal description of LED

LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.



Electronic Symbol of LED

Light-emitting diodes are used in applications as diverse as aviation lighting, automotive lighting, advertising, general lighting, and traffic signals. LEDs have allowed new text, video displays, and sensors to be developed, while their high switching rates are also useful in really be advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other domestic appliances.

WHY IT IS BETTER THAN A TRADITIONAL SYSTEM

India is a highly populated country, so we should take the advantage of such an energy which requires a very less space to produce energy efficiently. In this case solar tree could be the best one for us. It is much better than the traditional solar PV system in area point of view and also more efficient. So this will be a very good option and should be implemented.

For the traditional system we require large size of land to generate a small amount of power. It requires about 1% land as compare to the traditional system. Solar energy is available in abundance and considered as the easiest and cleanest means of tapping the renewable energy. For direct conversion of solar radiation into usable form, the routes are: solar thermal, solar photovoltaic and solar architecture. However the main problem associated with tapping solar energy is the requirement to install large solar collectors requires a very big space. To avoid this problem we can install a solar tree in spite of a no of solar panels which require a very small space.

Example – To generate 2 MW power from a pv module we requires 10 -12 acres of land for housing of panels only but for the same amount of energy we require only 0.10-0.12 acres of land in case of solar tree.



APPLICATION

- Street light
- House supply
- Industrial power supply

ADVANTAGES

- No air pollution

- We wouldn't have to worry as much about future energy sources
- People in poor country would have access to electricity
- People can save money
- Land requirement is very less

DISADVANTAGES

- Cost is high
- May cause hazards to the birds and insects
- Hazards to eyesight from solar reflectors

CONCLUSION

- To fulfill the increasing energy demand the people and saving of land this project is very successful one. This can provide electricity without any power cut problem. The extra energy can be provided to the grid.

REFERENCES

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