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SOLAR ENERGY- FINDING NEW WAYS

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ABSTARCT:
Different aspects of power generation using solar energy are described in this art paper. A brief history showing advancement in this field from ancient times till today is presented. Popular uses and method of collection of solar energy is briefly given. This article also includes some innovative ideas on which scientists are working to optimize the utilization of solar energy
Keywords: Solar Energy, Renewable energy.

1. INTRODUCTION

As conventional energy sources are limited and energy demand is increasing day by day need for development of renewable energy sources is increasing at alarming speed. We are here focusing on solar energy only. It could be a reliable energy source in the future. Solar energy can be used for drying, cooking, and heating purposes. It is used for outdoor lightning such as streets, gardens etc. [6]. It can also be used to warm buildings, water pipes [7]. So we see that it is eco-friendly and can be utilized for multiple purposes but still it is not applied on a large scale, let's take a look.

2. SOLAR ENERGY BACKGROUNG

In the last few years there has been a rapid development in solar technology but use of solar technology is not new. Its use has been started Before Christ (BC). During 3rd Century B.C. Greeks and Romans use burning mirrors to light torches for religious purposes. In 2nd Century B.C. the Greek scientist, Archimedes, used the reflective properties of bronze shields to focus sunlight and to set fire to wooden ships from the Roman Empire which were besieging Syracuse. (Although no proof of such a remarkable act exists, the Greek navy recreated the experiment in 1973 and successfully set fire to a wooden boat at a distance of 50 meters.)

During 1st to 4th Century A.D. the famous Roman bathhouses had large south facing windows to let in the sun's warmth. In 1767, Swiss scientist Horace de Saussure began developing a solar energy collector (also known as a "hot box"), a first in the entire world. Later in 1839, French scientist Edmond Becquerel discovers the photovoltaic effect while experimenting with an electrolytic cell. In 1860, French mathematician Auguste Mouchout developed the very first motor that runs on solar energy. He also invented the first solar-powered steam engine that he used to make ice by connecting it to a refrigeration device. After 16 years in 1876, William Grylls Adams along with Richard Day, discovered that when selenium was exposed to light, it produced electricity. The selenium cells were not efficient, but it was proved that light, without heat or moving parts, could be converted into electricity.

The first solar cell was invented by Charles Fritz in 1883. In 1891, Baltimore inventor Clarence Kemp patented the first commercial solar water heater. Calvin Fuller, Gerald Pearson, and Daryl Chapin, discovered the silicon solar cell in 1953. In 1956 the first solar cells were available commercially. The cost however was far from the reach of everyday people $300 for a 1 watt solar cell. Toys and radios were the first items to have solar cells available to consumers. This was efficient enough to run small electrical devices. In later 1960's Solar power was basically the standard for powering space bound satellites. In the early 1970's cost of solar cells brought down to around $20 per watt. This research was spearheaded by Exxon. [1]-[5]. In 1999, Cumulative worldwide installed photovoltaic capacity reaches 1000 megawatts.

3. USAGE OF SOLAR ENERGY

Its most popular use is to dry wet things from the laundry to crops. It is also used to power lighting systems from street lights to garden lamps. In some regions emergency phone systems on the side of roads, transportation signals, and speed cameras along roads rely on solar power during the day. At night, a photo-resistor detects the absence of light and a circuit board triggers the batteries to provide power. Many satellites use solar panels to generate power. Research centers in Antarctica use solar panels during the months when that part of the world receives constant sunlight throughout day and night [6].

Buildings are specially designed to utilize solar energy which keeps it warm. Black painted pipes are laid in the greenhouse which keeps water flowing through pipes warm [7]. The device used to cook food - Solar Cooker only needs healthy sunshine. The three most common types are the parabolic cooker, box cooker, and panel cooker. The parabolic cooker looks like a satellite dish. Because of its wide, reflective surface, parabolic cookers could get seriously hot. Solar box cooker has several parts: an insulated box with black base, reflective lid, and clear cover**.** Solar box cookers are more difficult to heat up, but keep the food warm for long durations**.** Panel cookers are constructed of flat reflective a panel that directs the sun's rays into a cooking pot. Panel cookers are more affordable but they can be unstable against strong winds. Solar cooker can also be used to purify water, sanitize kitchen utensils, sterilize health instruments and pasteurize milk. [8]

4. METHODS FOR COLLECTING SOLAR ENERGY FROM INCIDENT RADIATION – SOLAR COLLECTORS

4.1. Glazed falt-plate collectors

These collectors are suitable for moderate temperature applications where the required temperature is 30-70°C and also for the applications that require heat during the winter months. These collectors are used for heating buildings, ventilating air and crop-drying. To minimize heat loss, the plate is located between a glazing (transparent material) and an insulating panel.

4.2. Unglazed flat-plate solar collectors

Unglazed flat-plate collectors are normally made of black plastic that can withstand ultraviolet light. Since these collectors have no glazing a large portion of the heat absorbed is lost and hence these can only be used for low temperature applications where the required temperature is below 30°C.

4.3. Parabolic dish systems

A parabolic dish collector is similar in appearance to a large satellite dish. This system uses a computer to track the sun and concentrate the sun's rays onto a receiver which is located at the focal point in front of the dish. The temperature at receiver can reach 1000 °C.

4.4. Parabolic trough system

Shapes of Parabolic troughs are like the letter “u”. The troughs concentrate sunlight onto a receiver tube that is positioned along the focal line of the trough. The temperature at the receiver can reach 400 °C and produce steam for generating electricity**.**

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4.5. Power tower system

A power tower has a field of large mirrors that follow the sun's path across the sky. The mirrors focus sunlight onto a receiver on top of a high tower where temperatures well above 1000°C can be achieved.

4.6. Vacuum tube solar collectors

Vacuum tube solar collectors are amongst the most efficient and most costly types of solar collectors. These collectors are best suited for moderate temperature applications where the required temperature is 50-95°C and for very cold climates. They deliver high temperature efficiently so they can also be used for the cooling of buildings by regenerating refrigeration cycles [9].

5. INNOVATIONS IN SOLAR ENERGY

5.1. Solar thin film technology

Thin solar films can be ‘printed’ in rolls giving more opportunities for placement of these solar power producers for example these can be integrated into the roofing materials of buildings.

5.2. Solar Windows

Windows are treated with a special coating which gives them the ability to convert sunshine to energy. This coating produces the world’s smallest functional solar cells, size less than ¼ the size of a grain of rice.

5.3. Hairy Solar Panels

These solar panels are designed with nanotechnology, using light-absorbing nanowires on carbon-nanotube fabric. These nanowires can absorb more energy from the sun than silicon.

5.4. Infrared Spectrum Solar Panels

Today’s solar panels capture sun light from visible spectrum only but in future it could be possible that materials like vanadium, titanium harvest sun light from infrared spectrum.[10]

5.5. Polymer film stickers

Genie Lens Technologies has developed these large transparent stickers imprinted with a special kind of microstructures. When these stickers are applied to the front of the panels output power is increased by nearly 10%. [11]

5.6. Solar Powered Artificial Plant

The National Institute of Advanced Industrial Science and Technology, Japan developed an artificial houseplant with high-efficiency organic thin-film solar cells as leaves of plants having about 9 square inches of power-generating area. Each flexible leaf has a complex structure protected by a thin plastic layer. In the future these generators could be embedded into buildings, clothes, and toys [12].

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Figure 1 Solar powered Artificial plant

5.7. Solar Powered Plane

The Solar Impulse plane, composed of 12,000 solar panels. It is designed to fly day and night. It is currently undergoing test flights. It has 10748 monocrystalline Si solar cells on wing and 880 on stabilizer. With 200m² of photovoltaic cells and a 12% total efficiency of the propulsion chain, the plane's motors achieve an average power of 6kW [13].

5.8. Solar Paint

Using technology developed at the Argonne National Laboratory, next generation's plans to create a solar paint that entails a nanoscale mixture of photovoltaic components that can be painted or sprayed on to any number of surfaces. Research on this technology is still in its infancy. A Nano-solar cell has ability to capture energy from a broader spectrum of light [14].

5. GOING GREEN

- In New York City's Brooklyn Bridge Park, solar powered electric vehicle charging station has been set up.
- PowerMod is a portable solar tent to help in relief work to victims of disaster.
- Haidar Taleb, a 47 year old man from UAE, a person with polio since the age of 4, has built a wheelchair for himself which runs on solar power [11].
- Solar Powered Stadium - a dragon-shaped arena in Taiwan having 50,000 seats is designed by Toyo Ito. Electricity used by it is totally generated from photovoltaic technology through its 8,844 solar panels. The stadium's electric system takes 6 min to start. It can prevent the release of 660 tons of carbon dioxide into the atmosphere annually [15].
- The Lunar Cubit is a design proposal which consists of a series of solar panel pyramids forming a renewal energy plant. This astonishing series of pyramids will power homes in Abu Dhabi and will also serve as a stunning, illuminated public art installation by night [16].
- Solar Trash Cans are designed by installing solar-powered sensors and compactors that keep the trash compressed. These compactors allow the cans to store more trash [17].

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6. HORNET'S SKIN OR SOLAR CELL

The Orient Hornet has the ability to convert sunlight to electricity. In partnership with the late Prof. Jacob Ishay, Prof. Bergman of Tel Aviv University and his doctoral candidate Marian Plotkin engaged in a truly interdisciplinary research project to understand the process. Their research revealed that pigments in the hornet's yellow tissues trap light, while its brown tissues convert it into electricity. Exactly how the hornets use this electricity is still not completely understood. The team found that the brown shell of the hornet was made from grooves that split light into diverging beams. The yellow stripe on the abdomen is made from pinhole depressions, and contains a pigment called xanthopterin. The team isolated xanthopterin in a liquid solution, and then placed the solution inside a solid solar cell electrode, a type of conductor. When the scientists shed light on the electrode, the pigment in the solution generated electricity. While solar cells using human-made substances are usually 10 to 11 % efficient at generating electricity, the hornet's cells are only 0.335 % efficient. [18], [19].

6. RECREATING PHOTOSYNTHESIS

To perform photosynthesis artificially a system must do two tasks: harvest sunlight and split water molecules. In plants chlorophyll captures sunlight and a collection of proteins and enzymes use it to break down H_2O molecule into hydrogen, electrons and oxygen (protons).The electrons and hydrogen are then used to turn CO_2 into carbohydrates, and the oxygen is released. Artificial system must release hydrogen as well. To split water molecule energy input of nearly 2.5V is required. It also requires a catalyst which reacts with photons to initiate a chemical reaction.

6.1. Benefits

- Artificial photosynthesis can produce clean fuel efficiently without generating any harmful by-products.
- It produces liquid hydrogen which can be used as liquid fuel or channeled into fuel cell to generate electricity.
- It has the potential to produce more than one type of fuel. Methanol is another possible output. Some cars can even run on methanol alone.
- Photo-electrochemical reaction could even take out large amounts of harmful CO_2 from the atmosphere in the process of producing fuel. It's truly a win-win situation.

6.2. Challenges

- Replicating what happens naturally in plants is not a simple task. Designed process must be efficient.
- The manganese that acts as a catalyst in plants doesn't work well in man-made setup because it is somewhat unstable.
- Electrolyte solution that absorbs the protons from the split water molecules can erode other components in the system.

But the good news is that, advances in the last few years are beginning to address these issues. Cobalt oxide is a stable, fast and abundant metal oxide. Researchers have come up with a non-solvent-based solution to replace the corrosive stuff. [20]

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CONCLUSION

All of us are familiar with solar energy since ancient times and it is a vital resource which has been harnessed to produce electrical energy and various modern uses. Solar cells are eco-friendly and have low maintenance requirements however the widespread use of this technology is limited due to its high initial cost and low efficiency (solar cells are 10-11% efficient). But advances so far have created possibilities that one day majority energy demand would be met by solar energy.

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