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# Recreating Solar Panels: An Integrated Approach

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**ABSTRACT**

***As solar power becomes increasingly popular as a clean and renewable energy source, there is a need to better understand the technology used to convert sunlight into electricity. Bell Labs first used the photovoltaic effect to harness the striking of photons on a solar panel to create an electrical charge. In my paper, I propose two novel methods to increase the efficiency of solar panels. The first method utilizes solar tracking and computer science to tilt solar panels to face directly toward the sun throughout the day to maximize photon strikes. The second method concentrates photons through a magnifying glass to maximize the surface area of light being focused onto the panel. Developing better approaches such as those suggested in my paper have the potential to make solar panels more efficient and affordable, thereby increasing the scope of the solar power market.***

***Keywords***— *Solar Energy, Solar Schemes, History of Solar Panels, Working, Method to Calculate Tilt Angle, Solar Tracking, Concave Lens, Survey, Future Utilisation*

## 1. INTRODUCTION

Extracting usable solar energy and directly converting it to electricity, Daryl Chapin, Calvin Fuller, and Gerald Pearson made the first solar cell capable of converting enough of the sun's energy into power to run everyday electrical equipment at the Bell Lab. Becoming increasingly popular for being a renewable source, solar panels are now gaining wide popularity. The pathway of this process is based on a simple effect: photovoltaic effect. The particles of light called photons first strike the solar panel which knocks some electrons. A circuit is formed since it has conductors attached to the positive and negative side of the cell. When electrons flow through such a circuit, they generate electricity.

The government of India is also making a conscious effort to promote the usage of the same. One such scheme is the 'Jawaharlal Nehru National Solar Mission' also called National Solar Mission. The objective of this solar scheme is to establish India as a global leader in the solar sector by deploying 1,00,000 MW of grid-connected solar power by 2022. Another scheme called the 'Central Financial Assistance/Subsidy' has been initiated by the government. The scheme aims to develop solar parks and ultra mega solar power projects. To install grid-connected solar rooftop power projects, The Ministry of New and Renewable Energy (MNRE) will provide central finance assistance (CFA) at the rate of Rs.22.50 (~$0.3371)/W. This will amount to a subsidy of 30 percent on the benchmark cost of Rs.75 (~$1.10)/W. And further result in the installation of 100MW of grid-connected solar rooftop projects in Tamil Nadu with regard to the MNRE's "Grid-Connected Rooftop and Small Solar Power Projects Program."

## 2. HISTORY OF SOLAR PANELS

It all started when Edmond Becquerel - a physician working in France - observed the photovoltaic effect in 1839. Many years later, Augustin Mouchot, inspired by the works of Edmond Becquerel, began registering patents for solar-powered engines in 1860s.

Then in 1873, Willoughby Smith found out that selenium could be used as a photoconductor. As early as 3 years later, in 1876, William Grylls Adams and Richard Evans Day applied the photovoltaic principle discovered by Becquerel to selenium. This showed unexpected results. They noticed that this system could generate electricity when exposed to light.

Finally in 1883, 50 years after the discovery of the photovoltaic effect, American inventor Charles Fritts created the first ever proper working model of solar cell by coating selenium with a thin layer of gold. Fritts said that the model produced current "that is continuous, constant, and of considerable force." The sincere effort and handwork of many scientists and physicians led to the invention of a solar cell.

 

## 3. WORKING OF SOLAR PANELS

THe working of the solar panels can be described in the following steps:

1. The photovoltaic cells absorb the sun's energy and convert it into direct current(DC) electricity.
2. But direct current(DC) isn't usable. So the solar inverter converts the direct current(DC) to alternating current(AC), which is then used by most appliances in our home.
3. The electricity flows through our home, powering appliances and the excess electricity is fed to the electric grid.

***But how do these solar panels generate electricity?***

Solar panels consist of silicon cells, a metal frame, a glass casing, and various wiring that allows the current to flow from the silicon cells. Using silicon offers many benefits, since it is a nonmetal with conductive properties that allow it to absorb and convert sunlight into electricity. When light falls on a silicon cell, photovoltaic effect takes place, which is basically the motion of electrons that initiates the flow of electric current. The photovoltaic effect is how solar panels generate electricity. The photovoltaic effect can be generally thought of as a characteristic of certain materials (known as semiconductors).

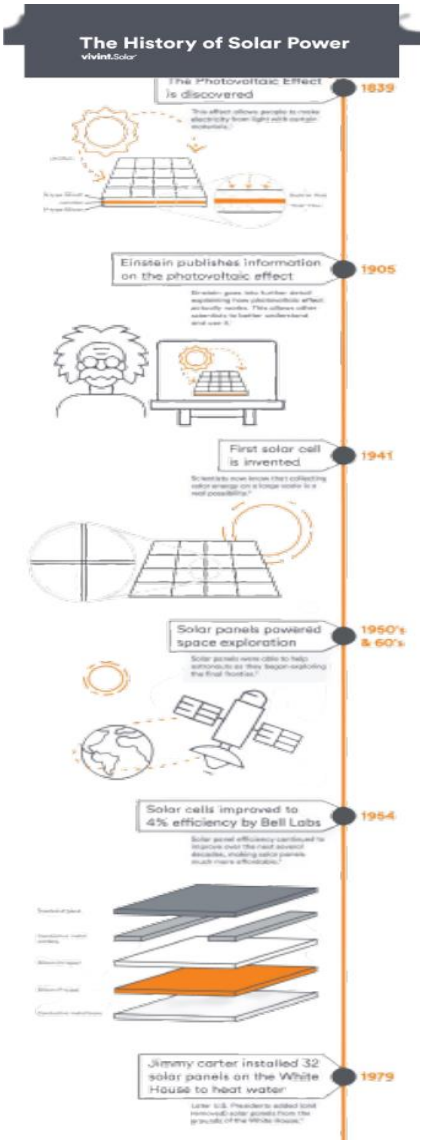


Fig. 1: A diagram illustrating the timeline of the History of solar pane.

**Method one (Integrating Computer Science and Solar tracking):**

Solar tracking system has been in the market for a long time now. Even solar trees work on that phenomenon. While solar trees exist in market, their cost of panel is very high. Each solar tree can cost upto ₹750,000 (~$9,595). Apart from this, it can cause harm to human eye and even cause hazards to birds. However, integrating computer science and solar tracking system can be a better approach. Every year we get the coordinates of the sun. Based on which we can write a programme that tracks the sun's movements and increases the electricity output.

**How to calculate solar panel tilt angle:**

The sun movement is never fixed. It depends on the time of the day and the season. To maximise the output, you need to determine what direction the panels should face and calculate an optimal tilt angle. This will depend on:

1. Where you live
2. What time of the year you need the most solar energy

 

To calculate this during winters, we use the simple formula of multiplying the latitude by 0.9 and then adding 29°. For the month of January in 2021, the latitude of Delhi was 28.7041° N.

28.7041° * 0.9=25.83369°

25.83369 + 29=54.83369°

For summers, the tilt angle is calculated by multiplying the latitude by 0.9 and subtracting 23.5°.

```
for i in range(16,23):
  print(i,"°",i+22,"'")
print(23,"°",46,"'")
for j in range(24,29):
  print(j,"°",j+23,"'")
print(29,"°",53,"'")
```

```
16 ° 38 '
17 ° 39 '
18 ° 40 '
19 ° 41 '
20 ° 42 '
21 ° 43 '
22 ° 44 '
23 ° 46 '
24 ° 47 '
25 ° 48 '
26 ° 49 '
27 ° 50 '
28 ° 51 '
29 ° 53 '
```

**Fig. 2: The code I wrote using the Sun's coordinates. This provides the degree and minute values for the month of January 2021.**

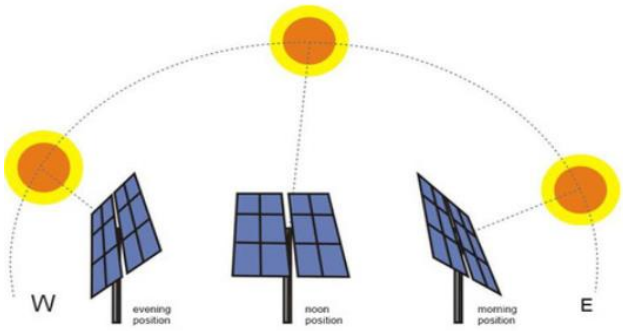


**Fig. 3: This figure shows how solar panels will move according to the coordinates of the Sun.**

**Advantages of this over solar tracking:**

The price of solar panels is approximately $3 per watt. On the flip side, a solar tracker for a 5 kW solar panel system can be around $500 or more for a single photovoltaic module. And for the entire solar panel system, the cost could be above $5,000. This cost disparity can be enough to persuade customers to not buy solar panels with solar tracking.

**Method two (Using a combination of magnifying glass and a concave lens):**

Attaching magnifying glasses on the solar panels can certainly increase heat intensity on a focussed area, but photovoltaic processes are based on light and not temperature. Concentrated rays of light will increase temperature not the spread of light. Also, solar panels work best when the their temperatures are low and not very high. To tackle this, if the magnifying glass on a solar panel is say accompanied by a diverging lens(concave lens) it'd spread the rays of light on the panel. Thereby, concentrating light as well as spreading it over a larger area.[The diagram below illustrates the same. Magnifying glasses contain convex lens in them.

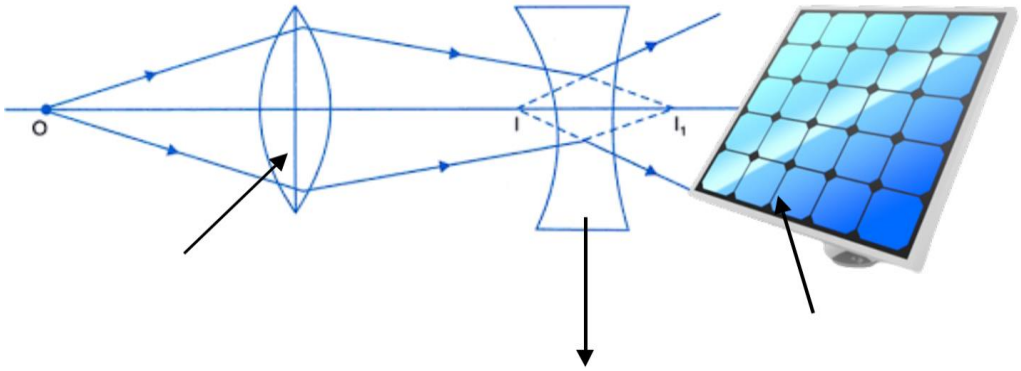


**Fig. 4: A diagram illustrating the proposal.**

## 4. THEORY

Convex lens is also known as Converging Lens. It converges the incident rays towards the principal axis. It has Positive Focal Length. The image formed is inverted, real and smaller than the object when the object is placed at focus. The image formed is the inverted, real, and the same size as the object when the object is placed at 2F. The image formed is inverted, real and larger than the object when the object is placed between 2F and F. No image is formed when the object is placed at focus (F). The image formed is upright, virtual, and larger than the object when the object is placed on the same side of the lens.

Concave lens is also known as Diverging Lens. It diverges the incident rays away from the principal axis. It has Negative Focal Length. The image formed is an upright, virtual, and smaller size than the object. The position of the image formed is in between the lens and the object regardless of the object's position

The convex lens in the magnifying glass concentrate the rays towards a point, while the concave lens diverges the rays because solar panels don't require concentrated rays rather rays that spread over the solar panel's surface thereby increasing the surface area.

## 5. SURVEY

I conducted a short survey regarding what improvement people would want from the solar panels. A total of 101 people attempted the survey and these were the conclusions drawn:

1. On asking whether the survey respondents have previously ever used solar panels, 62.4% replied no while the rest replied yes. 62.4% is a significant number. It just goes to show how much awareness about solar panels people in India have and how much more is needed. Textbooks and government should encourage the same.
2. 65.6% of the people never considered solar panels as a viable option. This again reiterates the same claim: awareness about solar panels is still necessary.
3. 76.23% people reported that if you somehow reduce the cost of the solar panels, they would be encouraged to buy it. Another major improvement suggested by a respondent was that if you make solar panels compulsory in new households, people would have no alternative but use them and thus contribute positively to the environment.

## 6. CONCLUSION

Solar panels are becoming increasingly popular and accessible nowadays. One of their disadvantages lies in the fact that their investment is high and return on the same takes a while. However, using better approaches mentioned above can certainly make solar panels more energy efficient and approachable which more sections of the society will consider as an option since the power output by employing the above-mentioned proposals is bound to increase by approximately 40%.

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