

Improvement of Yield and Reduction in Water Evaporation in Farms by Using Solar Sharing and Principle of Refraction of Light

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ABSTRACT: Solar energy is the most convenient and environmental friendly form of energy available. In the coming future there shall be a great increment in the energy requirement and solar energy shall be put to more profound use. The current system faces a number of difficulties and few of them include the huge investment of space. What if the solar generation could assist our agriculture and also promote savings in water resource by shrinking the water loss due to evaporation. Also there are a number of conveniences that this system can serve like subsidizing the cost for space and also a potential livelihood to the farmers/land owners. The system involves solar sharing and placing of solar panels on the fields in a particular conformation so as to reinforce the benefits of one process to the other. This system can find its application in a majority of areas where water is scarce and energy demands are pounding hard. This also involves to set up a business model like a joint venture between private entrepreneurs and land owners to accomplish a better means of revenue.

KEYWORDS: solar, energy, plants, sharing, agriculture, power, electricity, revenue, joint venture, profit, water savings.

I. INTRODUCTION

Solar energy existed ever since the universe came into existence yet mankind was capable of harnessing it in the late 1800s. In 1839, Alexandre Edmond Becquerel discovered that certain materials produced small amounts of electric current when exposed to light, and this phenomenon agitation up the entire energy sector. Source of clean, cheap and convenient form of energy was now available. The solar energy being the prime source of energy to for the entire universe accounts for a great potential. The Earth receives 174,000 terawatts (TW) of incoming solar radiation (insolation) at the upper atmosphere. The United Nations Development Programme in its 2000 World Energy Assessment found that the annual potential of solar energy was 1,575–49,837 exajoules (EJ). This is several times larger than the total world energy consumption, which was 559.8 EJ in 2012. There is an abundant availability of resource but due to some factors there this energy isn't being harnessed to its peak. Plants require sunlight for photosynthesis and the available solar radiation is way too far than the plant requirement in many parts of the globe the plants wilt due to excess radiation to sunlight. In agricultural fields the as the land is exposed to sunlight there is evaporation of the water accounting to the loss in water. Solar/Photovoltaic energy is concept capable of sufficing the energy requirements as well as being of benefit to the agriculture in saving water. Also the land recruited for solar farms accounts for a large part of the financial investment and causes an obstruction to the entire set-up.

The objective of the paper is to offer solutions and policies that could be adapted to utilise the energy and the set-up for the energy in a better, precise and cost-efficient way. It is to be noted that by properly planning and placing the objects

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better efficiency and more benefits could be achieved, similarly setting up a solar farm could be of more benefit to the entire agricultural set-up and economy of the parties involved in the project.

II. RELATED WORK

Solar Sharing:

This concept of sharing solar energy intended for agriculture along with the active solar generation photovoltaic panels has found a great application. The concept basically developed in Japan could be used in the many parts of the world having shortage of water but are having abundance in sunlight and space for setting up the solar grid. The current concept of solar sharing claims it to be a new way of producing clean energy without compromising food production. And to a reality it does proves itself to play its part.

In this systems solar panels are installed on a frame/grid about 3 meters above the ground. Rows of panels are widely spaced so that about one third of sunlight hits the panels and two thirds reach the ground. In this way, the same area can be used simultaneously for both agriculture and power generation. Solar sharing is based on the fact that most plants don't need all sunshine they receive in an open field. Plants do need light for photosynthesis, but only to a certain point. Everything beyond this saturation point does not increase photosynthesis and can even be harmful (e.g. causing more evaporation and lack of moisture). In solar sharing, solar panels use the excessive sunlight for power generation while crops are cultivated below just as they would be anyway.

Solar sharing was invented in Japan by Mr. Akira Nagashima in 2003. Today there are many independent solar sharing projects all over Japan.



Fig. 1: Solar Sharing in Tsukuba, Japan

III. IMPROVING GEOMETRY AND CONFORMATION OF SOLAR PANELS

Optical phenomenon like (refraction) bending of light upon striking an obstruction could make light enter into the area of geometrical shadow. This could potentially erase/decrease the possibility of formation of a shadow or could supply light into the area of geometrical shadow. We conducted experiments in the dark room with an object of dimensions: 5.5 X 8.6 X 0.2 cm along with a light source. It was observed that when the object is elevated to a height of 17 cm the geometrical shadow, the dark space beneath the object converted to a single line with considerable intensity of light. This phenomenon of bending could be interpreted and implemented to suit the crop requirements and also prevent evaporation losses. Following is the schematic dia. describing the flow and concept benefits.

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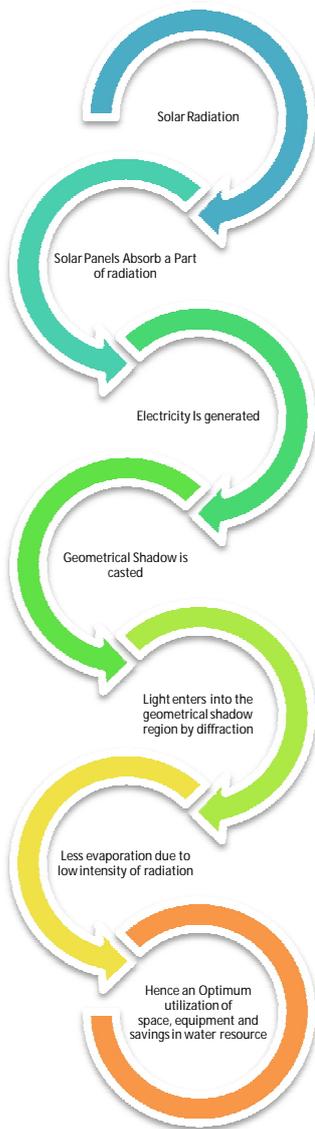


Fig. 2(a)
Flow Diagram

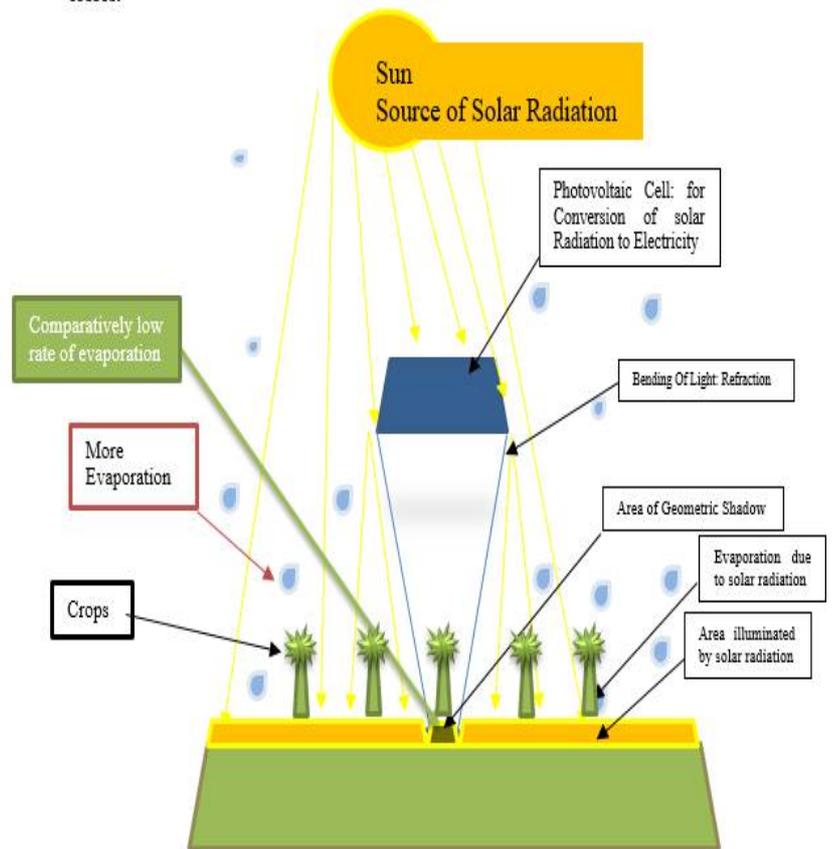


Fig. 2(b)
Geometric Operation

The above images are the schematic diagram of the entire procedure explaining the refraction of light from the edges of the obstruction into the area of geometric shadow. Fig. 2(b) shows how the shadow is casted and the difference in the rate of evaporation in the corresponding region.

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IV. EXPERIMENTAL RESULTS

Experiment in the dark room was conducted with a specimen of a like a card having dimensions 5.5 X 8.6 X 0.2 cm. Using bulb as a source of illumination ejecting spherical wavefronts and the specimen was place in the path of the light and the screen in the current context it was the paper on the desk. The observations are tabulated as follows:

Observations			Remarks
Elevation Of Specimen	Shadow Dimensions		
		Length	Width
+00(Original Dimensions)	8.6	5.5	
+1.7cm	8.8	5.5	
+9.5cm	9	5.4	
+17cm	8.5	1	Required Effect

Following is the image for the set-up and results (analytical)

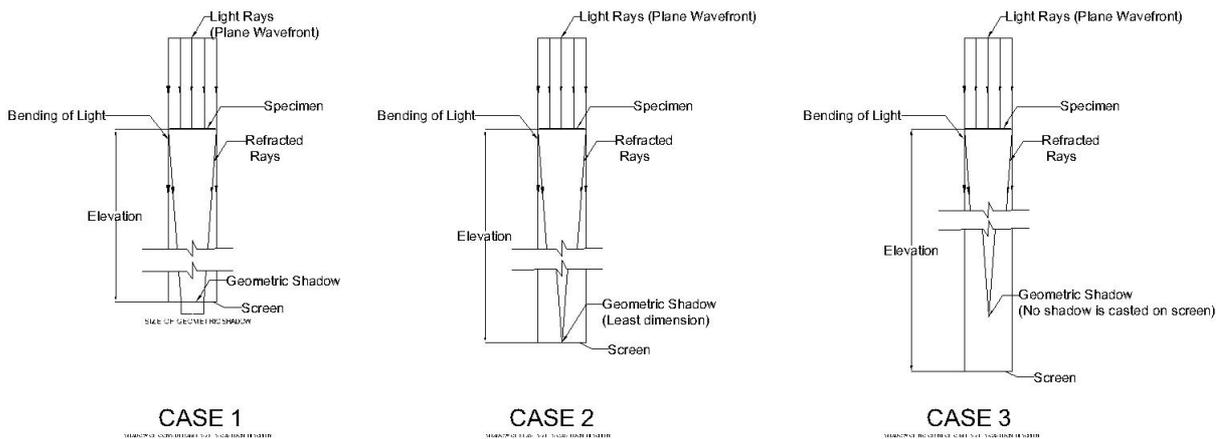


Fig. 3: Experimental Setup and Results 1

As per the images it is observed that as the object is elevated the light is refracted from its edges and this technique can be used to modify the intensity of light penetrating through the spaces in between the solar panel grids. Practical examples of this phenomenon are clouds and objects flying high in the sky. For example, aeroplanes are travelling on a height that their shadow doesn't reaches the ground and is illuminated due to refraction of light from the edges of the body of the plane. The height required to receive the CASE 3 result for a solar panel is quite high and may increase the installation cost. As the earth rotates around itself and due to this there is a constant change in the angle of inclination of solar radiation, so when the height of the solar panels is above 3 meters a shadow of lower size, reduced size of the panel geometry is observed. Due to the change in inclination periodically there the shadow also changes its dimension causing a shielding to the underlying crops from the direct solar radiation. This set-up imposes a slant sunlight to the groups which is beneficial and doesn't causes any damage to the crop.

V. ENERGY OUTPUT

A typical solar panel weighs approximately 4-5 lbs/sq.ft and they require very less maintenance. Also the output from

9 watts per sq-foot, or 200 sq-ft x 9 watts/sq-ft = 1,800 watts (1.8 kW) of electric power.

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VI. BUSINESS MODEL

Solar panels, hoisting equipment and land cost a lot. Funding for such projects become a difficult task as it involves a heavy initial investment and maintenance is also to be carried out to keep the grids functioning. For this project we suggest a joint venture policy for the land owner and the entrepreneur. Just as the government uses PPP (Public Private Partnership), a similar scheme could be developed which werefer to be OEP (Owner Entrepreneur Partnership). The OEP scheme shall facilitate the funding of a private entrepreneur to a land owned an individual, in certain context the farmer. Under this program the entrepreneur shall make the investment and install the set-up on the agriculture land and shall generate the electricity and sell it for revenue. Now as the farmer is allowing the entrepreneur to utilize his land the farmer may have access to a share of electricity and also some revenue but on the condition that the security of the set-up shall be under the land owners scope. Both the parties can benefit from this scheme as for the entrepreneur he's saving cost on land prices and property tax and for the farmer, he's getting the physical advantage of the set-up. Also in many areas farmers don't have a regular source of income so by installing the set-up on their land the land-owners could generate regular means of revenue.

VII. IMPLEMENTATION

The concept of *Irrolarea* has a number of benefits and these benefits also include better crop efficiency, water savings and optimum revenue generation from the available land. Due to the constant change in the direction of the sunlight the crops without this set-up are constantly exposed to the direct solar radiation, just as we'd mentioned earlier that the crops do not require too much sunlight and over-exposure could be hazardous to the crop life. So to cut the direct radiation, this set-up could be placed with a conformation of CASE 2 to enable s faint shadow that is created in the direction of the direct sunlight cutting down the intensity. This conformation could be implemented for agricultural activities in areas with open terrain or fields so that the fine shade could provide moisture detention required for a healthy agriculture produce.

VIII. CONCLUSION

This technique could bring a great revolution in how we currently deal with solar energy and agriculture. Also there is a great source of R & D in this sector as it has direct influence over the society. There are opportunities to study and develop geometry of panels that are able to deflect more light into the geometric shadow thereby decreasing the elevation required for the complete dispersal of shadow making it cost effective. The edges of the solar panels could be provided with optical coating like grating to refract more light into the shadow region.

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