A Novel Solar Tree Approach for Energy Conversation in Western Rajasthan

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Abstract- **Energy is required to perform any of the operation in the world ranges from involving the small to large momentum. As the sources of energy are limited so depending upon the solar energy is the future. In our paper we have research the efficiency of the A-300 cells usage in the solar tree, saving both the energy and save required for the installation. In this paper we have mentioned better efficiency performance of the**

Index Terms- **Solar Energy, Solar Tree, A-300 Cell.**

INTRODUCTION

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic's, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.[1][2]

It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

The large magnitude of solar energy available makes it a highly appealing source of electricity. The United Nations Development Programmed 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.[3][4]

In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating global warming, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared".[1]

Solar energy refers to energy from the sun. The sun has produced energy for billions of years. It is the most important source of energy for life forms. It is a renewable source of energy unlike non- renewable sources such as fossil fuels. Solar energy technologies use the sun's energy to light homes, produce hot water, heat homes as shown in solar tank less water heater reviews and electricity.

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 silico n 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 neighbors except that in this case, each atom has four hands joined to four neighbors. 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.

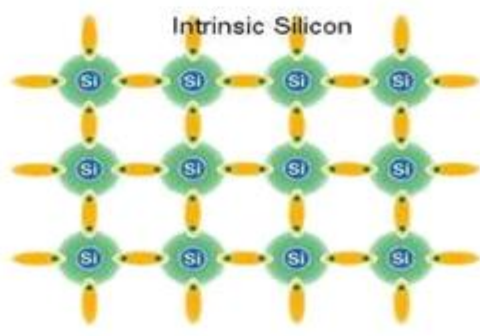

Figure1. Impurity Silicon (Extrinsic): P-type and N-type Semiconductors

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 valence of 4, but in a sense, the phosphorous has one electronthat 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.

II. SOLAR TREE

Now days with the growing population and energy demand we should take a renewable option of energy source and also we should keep in mind that energy should not cause pollution and other natural hazards. In this case the solar energy is the best option for us.

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 . We can also use the technique called “SPIRALLING PHYLLATAXY” to improve the efficiency of the plant.

Solar trees are intended to bring visibility to solar technology and to enhance the landscape and architecture they complement, usually in a commercial or public context. An objective of many solar tree installations is to promote awareness, understanding, and adoption of renewable energy. They are not typically used as a primary source of energy for a property—that role is accomplished by rooftop solar systems. Solar trees are complementary to rooftop solar systems, or other green building measures, symbolizing these larger investments and their environmental benefit.

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.

Components of Solar Tree

The solar tree consists of mainly five parts to design.

- Solar panels
- Long tower
- LDEs
- Batteries

Figure 2. Solar Tree

Solar Tree in India

India being a developing country and highly populated requires a power plant where maximum energy can be generated by using minimum land.

We must try to produce energy from sun by using solar tree in our country to increase our per capita land and fulfill the growing energy demand.

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

III. LITERATURE SURVEY

M. Tabaa, A. Dandache and K. Alami [1] amid the most recent couple of years, sustainable power source and supportable development were at the center of enthusiasm of numerous African countries particularly Morocco through its Moroccan Agency for solar energy (MASEN). A la mode, the last has been dealing with all energy ventures including the most imperative one: `The Moroccan undertaking of Solar Energy'. Its fundamental objective is creating an aggregate limit of 2000 MW of power absolutely issued from solar energy by 2020.

A. de Villiers and H. J. Vermeulen [2] This paper displays the consequences of an exploratory examination to research the capability of Data Envelopment Analysis for assessing the energy change execution of an utility size photovoltaic plant. The outcomes acquired with Date Envelopment Analysis are translated with regards to comes about got with customary techniques and with reference to the impacts of nearby climate conditions on plant execution. Plant execution is analyzed both after some time and as far as its individual parts. DEA is found to have potential as an execution and condition checking instrument.

R. Oprea, M. Istrate and D. Machidon [3] The photovoltaic transformation of the solar energy is of awesome intrigue and this division saw a critical development in the most recent decade. Therefore, a 4.32 kW photovoltaic power plant was produced at the Electrical Engineering Faculty of Iasi, Romania, for both research and pedantic exercises and furthermore to supply a few burdens. Alongside this paper the photovoltaic power plant's effectiveness is broke down, deciding the energy yield all through a few time interims.

S. S. Rangarajan, E. R. Collins, J. C. Fox and D. P. Kothari [4] Photovoltaic energy (PV) is one of the cleanest types of sustainable power source. The fame of this innovation has been broadly perceived with the motivations gave by the legislatures of different countries over the globe. Step by step, the development rate of PV is consistently expanding. Sustainable power source assets like PV are interfaced with control electronic inverters to empower its interconnection to the power system arrange.

IV. PROPOSED WORK

Sun Power A-300 Cells

SunPower is equipping its first factory to produce A-300 solar cells. The A-300 is a rear-contact solar cell with efficiency greater than 20% and a grid-free front surface. Its structure, virtues, superiority and fabrication have been presented elsewhere.

Light trapping makes the "optical thickness" of a solar cell greater than its actual thickness. This is achieved by

(1) Coercing light rays to pass obliquely through the cell; and

(2) Instituting a non-zero internal reflectance at the front and rear surfaces to prevent rays from escaping.

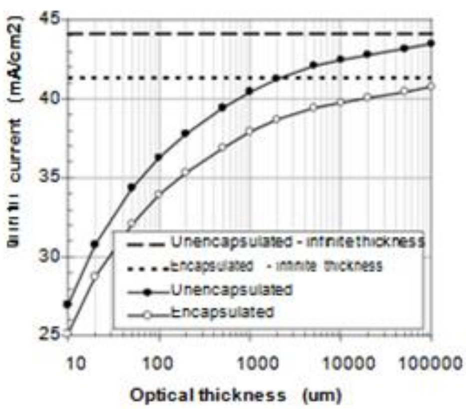

Figure 3. Generation current vs optical thickness for SunPower's A-300 solar cell under one-sun illumination; other assumptions are listed in the text.

Figure 3 illustrates the large improvement in J_G that can be gained by increasing the optical thickness. For instance, if the cell were 250 μ m thick with no light trapping, an unencapsulated cell would forgo almost 6 mA/cm^2 (13%) of the available generation current. If the same cell incorporated light trapping such that the optical thickness was 1500 μ m (i.e., $Z = 6$), the loss in generation current would be halved to 3 mA/cm^2.

Light trapping is typically quantified by the path length enhancement factor Z, where Z is defined to be the optical thickness W_O divided by the cell thickness W:

$Z = W_O / W$.

The purpose of this work is to determine Z for SunPower's A-300 solar cell, and to explore economically viable ways to increase Z.

Light Trapping In the A-300

Figure 4.2 depicts the relevant features of the solar cells investigated in this study. The front surface is textured with random pyramids (54.75°) and coated with a passivating SiO_2 film and an anti-reflective film; the texture refracts the incident light so that it travels obliquely to the plane of the cell, thereby increasing the optical path length.

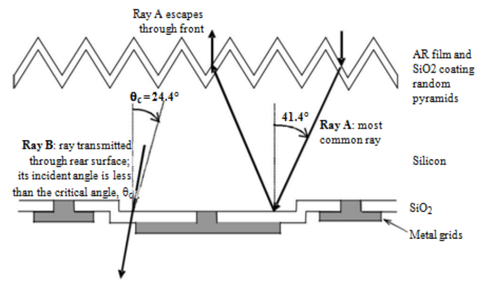

Figure 4 Schematic diagram of A-300 solar cell

The rear surface is planar and coated with SiO_2 except where the metal makes contact to silicon. The metal constitutes the positive and negative electrodes, and it forms a pattern of interdigitated fingers over the most of the cell.

TABLE 1 SUNPOWER'S HIGH EFFICIENCY ADVANTAGE - UP TO TWICE THE POWER

	Thin Film	Conventional	Sun Power
Peak Watts / Panel	65	215	300
Efficiency	9.0%	12.8%	18.4%
Peak Watts / m2	90	128	184

Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C

TABLE 2 ELECTRICAL DATA

Nominal Power (+5/-3%)	P_{nom}	300 W	
Rated Voltage	V_{mpp}	54.7	V
Rated Current	I_{mpp}	5.49	A
Open Current	V_{oc}	64.0	V
Short Circuit Current	I_{sc}	5.87	A
Maximum System	IEC	1000 V	

Voltage			
Temperature Coefficients			
	Power	-0.38% / K	
	Voltage (V_{oc})	-176.6mV / K	
	Current (I_{sc})	3.5mA / K	
NOCT		45° C +/-2° C	
Series Fuse Rating		15 A	
Limiting Reverse Current (3-strings)	I_R	14.7	A

Solar Cell Efficiency Calculation

```
function [FF, eta, Voc, Isc, Imp, Vmp] = efficiency(Volts,Curr,measInt,cellArea)
%% efficiency.m extract cell parameters from an illuminated IV curve
% Created by Jacob Mohin on 2011-01-13
% Last updated: 2011-10-3
%
% OUTPUT VARIABLES
% FF (Fill factor) - ratio of max power to theoretcial power
% eta - principle cell efficiency
% Voc - cell Open-Circuit Voltage
% Isc - cell Short-Circuit Current
% Imp - Current at the max power point
% Vmp - Voltage at the max power point
%
% INPUT VARIABLES
% Volts - array of voltages used to sweep the cell
% Curr - array of measured current at each voltage, in mA

%******PLEASE NOTE VOLTS AND CURR ARRAYS SHOULD BE THE SAME LENGTH*********

% measInt - the intensity of light used to illuminate the cell, in
% mW/cm^2
% cellArea - the cell area in M^2 (for now, until I change it to cm^2)
%
%
% See comments in code for explanations/justifications
% Data should be taken in from the kv200IVSweep.m file when possible
%
%

%%%%%Find size of fills - real and theoretical
%
% Find the two points immediately above and below zero
% %%%%%% tested to be more accurate AND faster than interpolation to
  %%%%%% find the zero-crossing for systems with >250 data points %%%%%
  zPhi=find(Curr>0,1,'first');
  zPlo=find(Curr<0,1,'last');
%
% Get the slope between these points
 slope=(Curr(zPhi)-Curr(zPlo))/(Volts(zPhi)-Volts(zPlo));
%
% Find zero crossing, by solving with slope - This is V open-circuit
 Voc = -Curr(zPlo)/slope + Volts(zPlo);

% short circuit is current at V=0 (converted to A)
 zind=find(Volts>0,1)-1;
 Isc = Curr(zind);
%
% make array of power from I*V, pick out the max
% %%% memory intensive but fast; don't give it >1000-point long vars tho %%%%
  fills = -(Curr).*Volts;
  [pmax,pind]=max(fills);
%
% theoretical power from the max we found
 Vmp = Volts(pind);
 Imp = Curr(pind);
 maxPow=abs(Imp*10^-3*Vmp);
%
% Must convert current to Amps
 theorPow=abs((Isc*10^-3)*Voc);
%
% Find the fill factor and principle cell efficiency
```

```
measIntCm = measInt*10;
FF = maxPow/theorPow;
eta = 100*maxPow  / (measIntCm * cellArea);
```

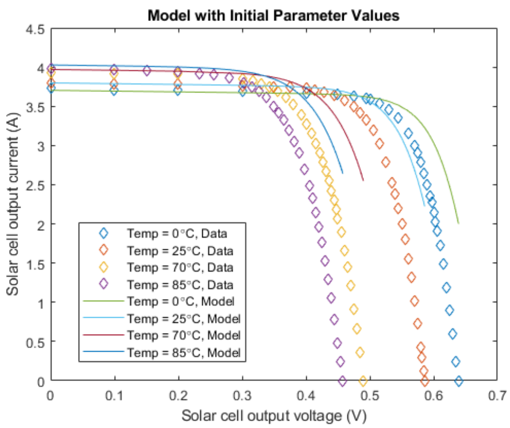

Figure 5 Solar Cell Output

V. CONCLUSION

Unprecedented growth in the demand for energy along with the awareness about environment and health hazards of fossil fuels have made scientists extensively investigates the alternative clean and renewable energy sources. Among various possible renewable sources 'solar energy' has tremendous potential to fulfil the energy demands of future generations in an environment friendly and sustainable manner. Importantly the solar energy can also power creation of other clean forms of energy such as hydrogen which is predicted to be 'the fuel of future' because of zero greenhouse gas emissions and high energy efficiency upon combustion. Current state of the art silicon-based photovoltaic (PV) technology is relatively expensive and therefore developing potentially cheaper PV technologies using solution process able earth abundant material systems is the need of the present time. With the advent of nanotechnology it has become increasingly possible to understand, control and manipulate the material properties in an unprecedented manner as a result of which several new concepts and designs of solar cells, hydrogen generation and optoelectronic devices have emerged.

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