A Study on Performance of Ideal and Non-ideal Solar Cells Under the Climatic Situation of Bangladesh

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Abstract

In this paper, it has been studied the I-V characteristics between ideal and non-ideal solar cells. The ideal curve was for before using the solar cell for irrigation and for vegetative & fruits field. It has been observed several parameters of solar cells for before and after use of irrigation and vegetative & fruits field like conversion efficiency and Fill Factor (FF). It was found that the value of the conversion efficiency and the Fill Factor (FF) decreases after use the solar cell. The I-V characteristics totally different between ideal and non-ideal solar cell.

Keywords: *I-V characteristics, Ideal cell, Non-ideal cell, Fill Factor (FF), Conversion Efficiency.*

Introduction

World energy consumption is doubling every 16 years. The rate of increase is even higher in America, where 6 percent of world population consumes one third of the world's energy. As technology advances, new demands for energy emerge[]1-21].The World Trade Centre Petronus towers in Malaysia consume an amount of electricity equal to that of the city of Syracuse. The insatiable demand of energy cannot be meet indefinitely. Sooner or later the depletion of energy resources will force us to change the energy consumption behavior. Throughout history the demand on natural resources had been small compared to natural reserves. In recent years the demand has increased" drastically because of the advance of industrialization [22-35].The increased rate of consumption depletes the natural reserves rapidly. Starting in the late 1972, shortage of fuel began to hit various part of our society and suddenly an energy crisis appeared.

The solution for the energy crisis in the future is partly dependent on the use of nuclear energy. The safety of reactors has already become an issue. It is argued that the emergency core-cooling system of the reactors has not been tested and thus there is no guarantee that it will work as expected in an actual emergency. In fact, suit has been filed by environmentalist to close down all existing reactors because of this. Besides the possibility of accidental malfunctioning, one may also consider the possibility of sabotage and natural catastrophe that might destroy a reactor and disperse the radioactive material[36-40]. In time of war, the possibility of bombing is so real that it would be very difficult to keep reactors operating safely[41-45].

II. Methods and Materials

A solar water pump was used for irrigation and vegetative & fruits field. The change of the solar cell has been occurred before and after the use of solar cell.

II A Practical application of solar cell for irrigation and Vegetable field:

Fig.1 Experimentally measurement of I-V characteristics of solar cells under Bangladeshi Climate.

A device to estimate the I-V characteristics under Bangladeshi Climate by a computer for an ideal and non-ideal solar cell.

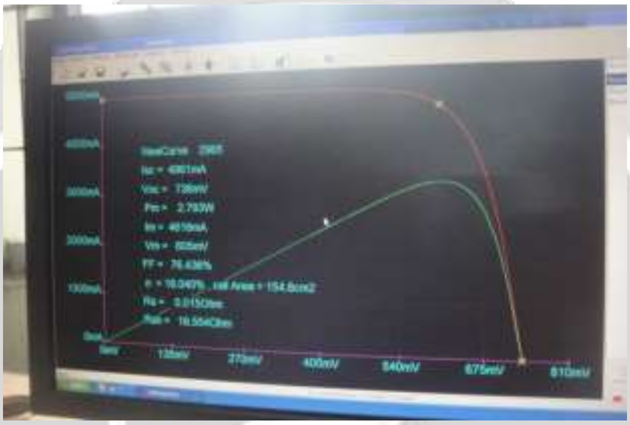

Fig.2: I-V characteristics of a solar cell before using for an ideal solar cell.

Fig.2 shows the I-V characteristics of a solar cell. It is shown that the efficiency = 18.04% and the Fill Factor = 76.434% for a specific solar beam radiation[46-50].

Fig.3: I-V characteristics of a solar cell before using for an ideal solar cell

Fig.3 shows the I-V characteristics of a solar cell. It is shown that the efficiency = 18.04% and the Fill Factor = 76.436% for a specific another solar beam radiation for the same solar cell. It is mentioned that the ideal FF = 0.71 i.e., FF indicates the quality of the solar cell. So that under Bangladeshi climatic condition the quality of the solar cell was good.

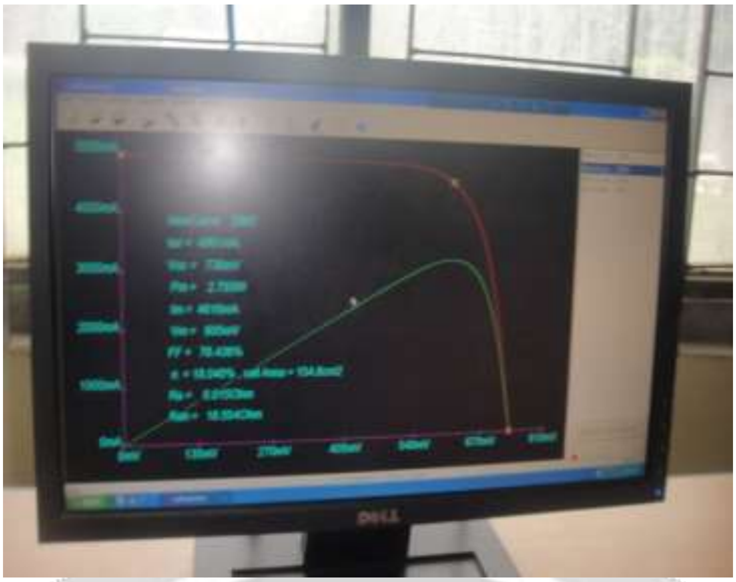

Fig.4: I-V characteristics of a solar cell before using for an ideal solar cell.

Fig.4 shows the I-V characteristics of a solar cell. It is shown that the efficiency = 18.04% and the Fill Factor = 76.436% for a specific another solar beam radiation for the same solar cell.

II. B. Define different Parameters:
i) Open circuit voltage : The voltage without load is called Open circuit Voltage. Generally, it is denoted by V_{oc}.
ii) Short circuit current: The current without load is called short circuit current. Generally, it is denoted by I_{sc}.
iii) Fill Factor (FF):
It **is** defined as**,** FF **=** $(V_m I_m) / (V_{oc} I_{sc})$, where, V_m = Useful voltage, I_m = Useful current, V_{oc} = Open circuit Voltage, I_{sc} = short circuit current[51-62].
iv) Convesion efficiency (η_c):
It is defined as, Conversion efficiency, $\eta_c = (V_m I_m) / A_c I_b$,where, V_m = Useful voltage, I_m = Useful current, Ac = Collector area(m^2), I_b = Beam radiation (w/m^2).

II.C Description of solar cell, module, panel, array:
Solar Cell: It is the building block of a solar cell. In a solar cell some rectifier diodes are in parallel connection. The standard open circuit voltage of the solar cell is 0.5 volt. The short circuit current of a solar cell = 0.5 A. The standard temperature of a solar cell= 25^0C. The standard pressure = 1 atm pressure= 760 mm Hg pressure [66-70].
Solar module: One or more than two cells make a solar module. It can be connected in series or parallel by solar cells.
Solar Panel: One or more than two modules make a solar panel. In a panel solar module can be connected by the series or parallel combination.
Solar Array: One or more than two panels make a solar array. A SPV Array is made up of PV modules, which are environmentally-sealed collections of SPV Cells - the devices that convert sunlight to electricity. The most common SPV module that is 5-to-25 square feet in size and weighs about 3-4 lbs./ft^2. Often sets of four or more smaller modules are framed or attached together by struts in what is called a panel. This panel is typically around 20-35 square feet in area for ease of handling on a roof. This allows some assembly and wiring functions to be done on the ground if called for by the installation instructions[71].
Balance of system equipment (BOS): BOS includes mounting systems and wiring systems
used to integrate the solar modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and over current protection for the solar modules[72]. Most systems include a combiner board of some kind since most modules require fusing for each module source circuit. Some inverters include this fusing and combining function within the inverter enclosure.
Dc-ac inverter: This is the device that takes the dc power from the PV array and converts it into standard ac power used by the house appliances.
Metering: This includes meters to provide indication of system performance. Some meters can indicate home energy usage.
Other components: Utility switch (depending on local utility).

II D SPV Electrical System Types:
There are two general types of electrical designs for PV power systems for homes; systems that interact with the utility power grid and have no battery backup capability; and systems that interact and include battery backup as well [73].

II E Grid-Interactive Only (No Battery Backup):
This type of system only operates when the utility is available. Since utility outages are rare, this system will normally provide the greatest amount of bill savings to the customer per dollar of investment. However, in the event of an outage, the system is designed to shut down until utility power is restored[74-76].

II F Standard solar cell condition: The standard state condition of a solar cell is: The standard open circuit voltage of the solar cell is 0.5 volt. The short circuit current of a solar cell = 0.5 A. The standard temperature of a solar cell = 25^0C. The standard pressure = 1 atm pressure = 760 mm Hg pressure.

III. Results and Discussion with Graphical Analysis:

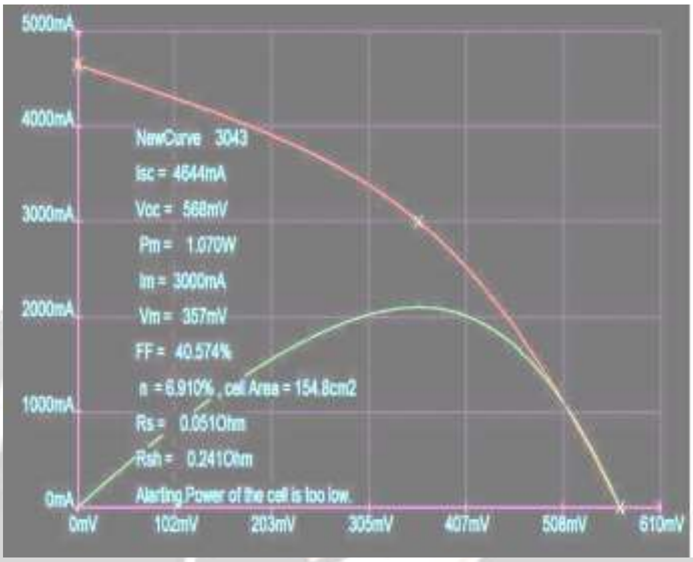

Fig.5 Ideal I-V curve for ideal solar cell-1

It is shown (Fig.5) the I-V curve after use of the solar cell it has been damaged by anyhow. The I-V curve (Fig.5) deviated the ideality due to damage of the solar cell. The conversion efficiency is around 6.91% whereas it was around18.04% and the FF is 40.574% whereas it was 76.436%.

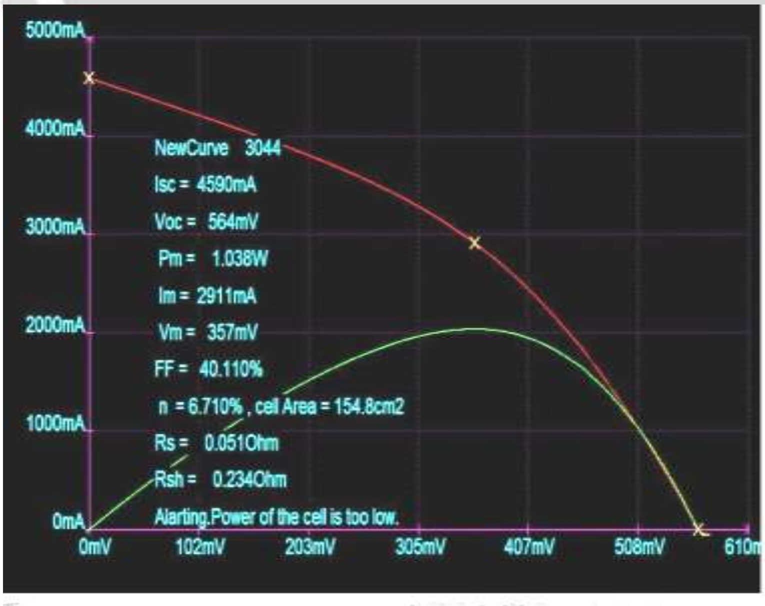

Fig.6 Ideal I-V curve for non-ideal solar cell-1

Fig.6 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown (Fig.6) the I-V curve after use of the solar cell it has been damaged by anyhow. The I-V curve (Fig.6) deviated the ideality due to damage of the solar cell. The conversion efficiency is around 6.71% whereas it was around18.04% and the FF is 40.11% whereas it was 76.436%.

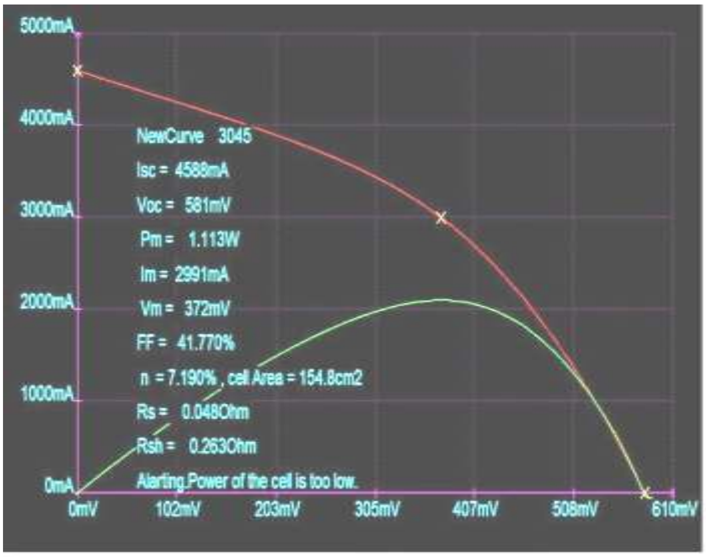

Fig.7 Ideal I-V curve for non-ideal solar cell-1

Fig.7 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown (Fig.7) the I-V curve after use of the solar cell it has been damaged by anyhow. The I-V curve (Fig.7) deviated the ideality due to damage of the solar cell. The conversion efficiency is around 7.11% whereas it was around18.04% and the FF is 41.77% whereas it was 76.436%.

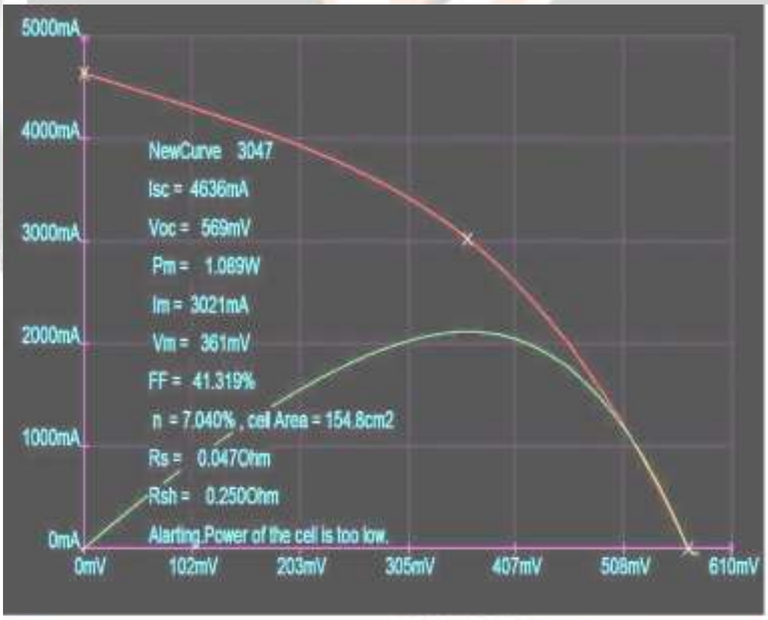

Fig.8 Ideal I-V curve for non-ideal solar cell-1

Fig.8 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown (Fig.8) the I-V curve after use of the solar cell it has been damaged by anyhow. The I-V curve (Fig.8) deviated the ideality due to damage of the solar cell. The conversion efficiency is around 7.00% whereas it was around18.04% and the FF is 41.31% whereas it was 76.436%.

Finally, it is shown that where FF was higher, then the conversion efficiency also higher. Therefore it can be said that there is a correlation between FF and conversion efficiency (η_c) of a solar cell.

IV. Conclusion

Solar photovoltaic electricity depends on solar radiation. Bangladesh is located in fine places where solar radiation falls nicely for solar Photovoltaic system. It is concluded that SPV system can be utilized for all months of the whole year. So that SPV system is feasible and viable for the agricultural activities under Bangladeshi climate. But sometimes it is shown that due to shadow effect sola cell became damage and as result the conversion efficiency and the FF became lower than the ideal value. So that finally, it is concluded that the solar cell should be set up in a proper places where shadow effect is totally absent for getting better performances.

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