Solar Water Pump for Vegetable field under the Climatic Condition in Bangladesh

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ABSTRACT
A solar water pump has been used for vegetable field under the Climatic Condition in Bangladesh. The solar cell which has been used for this water pump the I-V characteristics of those solar cell has been studied. The variation of Fill Factor (FF) and the conversion efficiency (\(\eta_c\)) have been observed in this research work. Furthermore, it has been found the different results for various solar cells under the Bangladeshi climatic conditions. The observable parameters were: \(\text{Short circuit current, Open circuit voltage, Maximum useful power, Maximum useful current, Maximum useful voltage, Fill Factor, Conversion efficiency, Cell Area, Diode Series resistance, Shunt resistance.}\)

Keywords: Short circuit current, open circuit voltage, Maximum useful power, Maximum useful current, Fill Factor, Conversion efficiency.

Introduction
Bangladesh is a agricultural dependent country. After completion the paddy cultivation, farmers are cultivating the vegetables to meet up the double crops systems in a year. To keep it in mind, a solar water pump has been set up at Saver area under Dhaka district of Bangladesh. A solar big solar panel has been set up to run the water pump connected to a cannel to bring water to the vegetable field. The effect of the solar panel has been studied for use in double crops in the almost whole month of the year.

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

Fig.1 Solar panel set-up for vegetable field cultivation after paddy cultivation.
Fig.1 shows an solar array made by some solar panels. It is under open sun condition. The beam radiation falls on the solar panel and the electricity is produced in the day time. An electric pump is operated using this produced electricity. There is a pump house where the pump is maintained during night time from the unsafe condition (Fig.1).

![Image](image1.png)

**Fig.2 A cannal is connected to the solar panel to water for vegetable field.**

A long circular long pipe is connected with the electric pump. The pump needs some specific power (watt) to turn the water pump. The one end of the pipe is inside the water and the other end is used as an output of the watering system.

![Image](image2.png)

**Fig.3 A control room for maintaining the liaison among solar panel, water pump and loads.**

It is the control room of the watering system (Fig.3). It does the function of the starting and closing the machine timely. It has an indicator giving the indication of the proper function.
Fig. 4 A water pump for use in solar system
Fig. 4 shows the solar water pump for irrigation and vegetative field. It indicates the flow of the water flow by a flow meter.

Fig. 5 Collected water from the cannel using solar water pump.
It is shown (Fig. 5) the outlet water collected from a cannel to provide a vegetative field. It operates from morning to evening nicely but it does not work at all at the night.

Fig. 6 Vegetable field where provided water by the solar system
Farmers and researchers are visiting the vegetative fields (Fig. 6) cultivated by the solar water pump. By the help of the solar system people can get double more crops by the help of solar photovoltaic electricity.
Fig. 7 Vegetables field where provided water by the solar photovoltaic system

Fig. 7 Vegetable field beside the solar panel
Visitors and researchers are waiting to see the vegetables field. It can be cultivated further any vegetative and fruits as per our necessity.

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,
$$FF = \frac{(V_m I_m)}{(V_{oc} I_{sc})}, \text{ where, } V_m = \text{Useful voltage}$$

$V_m$ = Useful voltage
$V_{oc}$ = Open circuit Voltage
$I_{sc}$ = short circuit current

iv) Conversion efficiency ($\eta_c$):
It is defined as,
$$\eta_c = \frac{(V_m I_m)}{A_c I_b}, \text{where,}$$
$V_m$ = Useful voltage
$I_m$ = Useful current
$A_c$ = 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°C. The standard pressure= 1 atm pressure= 760 mm Hg pressure

Solar module: One or more than two cells make a solar module.

Solar Panel: One or more than two modules make a solar panel

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.
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. 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.

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.

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°C. The standard pressure = 1 atm pressure = 760 mm Hg pressure.

III. Results and Discussion with Graphical Analysis:

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

Fig.7 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown the following experimental results:
Curve Number = 340
\[ I_{sc} = 5444 \text{mA}, \]
\[ V_{oc} = 705 \text{mV}, \]
\[ P_m = 2.957 \text{W}, \]
\[ I_m = 5106 \text{mA}, \]
\[ V_m = 579 \text{mV}, \]
Fill Factor, FF = 77.068%, 
Conversion efficiency, $\eta_c = 19.10\%$ ,
Cell Area = 154.8 cm$^2$,
Diode Series resistance, $R_s = 0.013$ ohm,
Diode Shunt resistance, $R_{sh} = 18.008$ ohm.

Finally, it is shown that where FF increases, the conversion efficiency also increases. Therefore it can be said that FF and conversion efficiency ($\eta_c$) is almost proportional.

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.

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