Design of a Hybrid Model of BPL electricity Module and Solar Photovoltaic Cell

Dr. Md. Kamrul Alam Khan, Shuva Paul, Saniat Rahman Zishan ,Md. Adibullah, Sohel Mahmud

***Abstract*—**Energy is the most demanding and most valuable thing from the very beginning of the human civilization. The consumption of energy is increasing day by day because of the rapid growth of the human population. And to keep cope with the increasing population meeting the demand of energy has become a challenge for the scientists of the century. Moreover the energy source or fuel source are limited in stock or reserve. So in future we must have to think of alternative energy sources. Here comes the revolution of renewable energy. In this paper a new pattern of renewable energy in the form of biomass energy is introduced and a new approach of Hybrid energy system is introduced for the betterment of the energy received by the renewable energy sources. This paper will discuss about the proposed "Hybrid BPL and Solar Electricity Module". The energy generation process and their feature are also discussed here.

***Index Terms*-**BPL,Photovoltaic etc

1.INTRODUCTION

DESIGN of such kind of hybrid energy system provides some unique features of feasibility, inexpensive installation and easy conversion of energy. This hybrid BPL and Solar Power/ Electricity module or power system provides with some unique features. Here Solar Photovoltaic Cells are used for solar electricity generation from the solar energy source.BPL electricity module and Solar PV(Photovoltaic Module) provide such a meaningful energy system to have green energy in return of cheap installation cost.

2.THE TWO SOURCES AND THEIR INTRODUCTION

Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides and geothermal heats, which are renewable (naturally replenished).Biomass as a renewable energy source, is biological material from living, or recently living organisms. As an energy source, biomass can either be used directly, or converted into other energy products such as biofuel. The first component we are using for biomass energy is BPL malt or juice. The full form of BPL is Bryophyllum Leaf. The malt or juice of the leaf of Bryophyllum Kalanchoe (Genus: Kalanchoe) [1] is used for generation of electricity. The malt or juice of the leaf has chemical properties to behave like an electrolytic material which can be used for generating electricity [2]. For solar energy conversion we are using solar photovoltaic cells. Now let us know about Photovoltaic Cells and how they work.

2.1 BPL Electricity Module

BPL electricity module is a module containing BPL malt or juice as electrolyte. The generated electricity is passed through an inverter. For more power and energy we can use BPL electric panel and electric array. BPL electric panel is combination of some BPL Electricity modules and BPL Electric array is combination of some BPL Electricity panels. Here the picture of a BPL electricity Panel.

Figure: A model of BPL Electricity Array.

2.2 Solar Photovoltaic Cell

Solar photovoltaic power is a universal term that is used for generated electric power from sunlight. The main theme is to convert solar sunlight into electricity. The main component or the fundamental building block of solar PV power is the solar cell or photovoltaic cell. A solar cell is made of semiconductor materials and it can be considered as electricity producing device [3]. Photovoltaic is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are

captured, an electric current result that can be used as electricity.

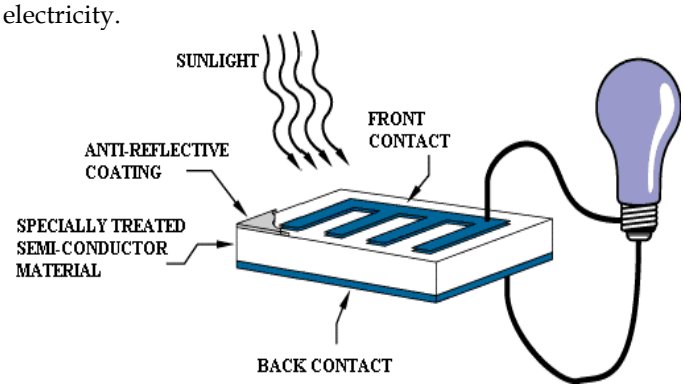

Figure: Solar Photovoltaic Cell

The diagram above illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the same kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load, such as a light or a tool.[4]

2.3 Electricity Generation from BPL module

BPL electricity module is constructed based on the Bryophyllum Leaves malt as the main fuel source. The malt has some chemical properties which generate electricity. In this sense if the malt or juice can be used as a electrolytic material it is possible to generate electricity. BPL malt has P^H of 4.6(without water) and with water the value of P^H is 4.8. For the generation purpose of BPL electricity a few experiments have been done. The experimental data of one of the experiments has been given as sample.[2]

Table I: Variation of current without load with time.

Time Variation	Current,I (without load)(Amp)
Each data has been taken having 5 minute interval.	1.35
	1.34
	1.34
	1.35
	1.32
	1.31
	1.34
	1.33
	1.33
	1.32

Table 2: Data Tabulation of Open Circuit voltage, Short circuit voltage etc

Time Interval	V_{OC}	I_{SC}	Volt (V)	Amp (I)	Watt (P)	Temp	Juice Temp
5 Min Interval during each Obser-vation	6.67 Volt	1.35 Amp	4.06	0.45	1.827	28	26
			4.06	0.45	1.827	28	26
			3.91	0.44	1.7204	27	26
			3.73	0.43	1.6039	28	25
			3.51	0.43	1.5093	28	26
			3.31	0.42	1.3902	27	26
			2.99	0.41	1.2259	27	26
			2.77	0.40	1.108	28	26
			2.65	0.39	1.0335	28	26
			2.51	0.37	0.9287	27	25
			2.38	0.36	0.8568	28	25
			2.22	0.34	0.7548	28	25
			2.09	0.33	0.6897	28	26
			2.08	0.33	0.6864	28	26
			1.96	0.32	0.6272	28	26
			1.89	0.30	0.567	27	25
			1.69	0.29	0.4901	27	25
			1.60	0.28	0.448	27	25

2.4 Hybridization of Solar Photovoltaic Cell and BPL electricity Module

This is just a simple concept to utilize two of the available sources for producing electricity to feed the feeders as well as the storage device. Now the first concern is to hybridize both of the sources in such a manner so that it is possible to get the maximum power output from both of the cells. The structural block of the proposed hybrid is drawn below:

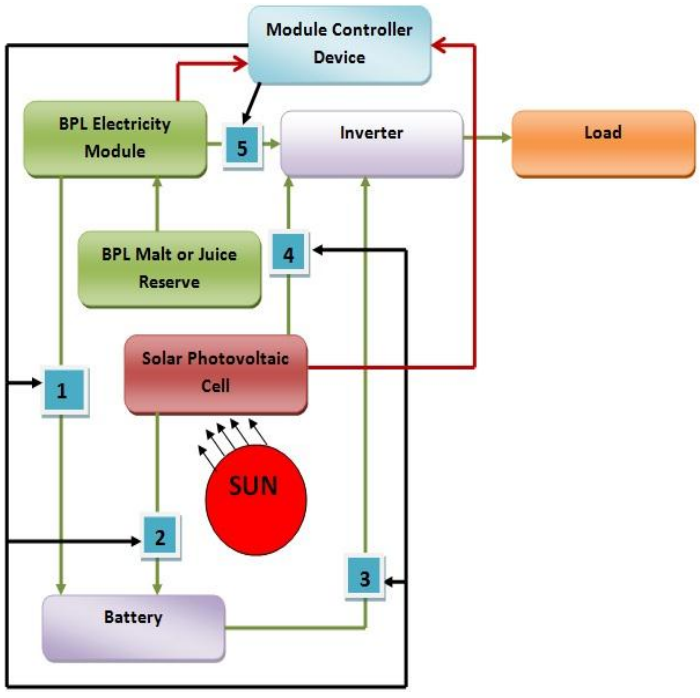

Fig 2: Building block of the Hybrid BPL and Solar Electricity Module

This is the simplest block diagram of the structural unit of the proposed hybrid module. The boxes containing

number 1, 2, 3, 4 and 5 are representative block of Switches which are controlled by controller. There are two types of Data bus connected to the module controller device. The black colored bus is sender bus and the red colored bus is receiver bus connected to the module controller device. The green colored contacts are normally connecting wire.

2.4.1. Description of the Module Connection

The BPL malt or juice reservoir is connected to the BPL electricity module. From the reservoir the BPL malt or juice is delivered to the BPL electricity module. The Solar PV cell and the BPL electricity module are connected to the battery and inverter through green wire. Inverter is connected to load through green wire. The battery is connected to load through green wire. The switches are connected to the module controller device through which receives command from the controller module and performs on/off operation.

2.4.2. Operation

The operation procedure of the hybrid solar PV and BPL electricity module is dependent on the availability of the sources and obviously it can supply electricity even if the sources (sunlight for Solar PV and BPL malt or juice for BPL electricity module) are unavailable. First of all there may be three case or three types of operational condition for the hybrid module of the Solar PV and BPL hybrid module.

Operational Condition 1:

In the day light, the sunlight is available as well as the BPL juice is also available. This is case 1. Both the solar electricity generated from solar photovoltaic cell and electricity generated from BPL electricity module is supplied to the inverter and battery at the same time. To the battery it is charged for the condition when the battery is not fully charged. The power is feed to the load from the inverter and to the battery for charging purpose at the same time. When charging is complete the battery stops receiving dc supply from the both of the modules. These types of operations are controlled by the module controller. When the controller receives data about the availability of the both of the source, it sends command to keep the switch number 1, 2, 4 and 5 close and 3 open. As a result the battery does not need to feed the inverter to supply to the load. When the battery is fully charged the switch number 1 and 2 are open and others remain closed.

Operational Condition 2:

In the availability of one source, assuming only sunlight is available; the controller sends data to the switch number 1, 3 and 5 open and 2 and 4 closed. As a result the battery is charged by the Solar PV and inverter and loads are fed by the Solar PV generated electricity. Likewise the previous condition, when the battery is fully charged the switch number 2 is opened. In case of the availability of the BPL juice or malt only as fuel switch number 2, 3 and 4 are opened and 1 and 3 are closed.

Operational Condition 3:

When both of the sources are unavailable, the battery fed the inverter as well as loads. Especially at night, there is no sunlight. May be in some extreme case the BPL module is damaged or needed to be repaired. In that case operational condition 3 starts operating. In this condition switch number 1, 2, 4 and 5 are open and switch number 3 is closed in order to feed the inverter.

2.4.3. Module Controller Device Algorithm

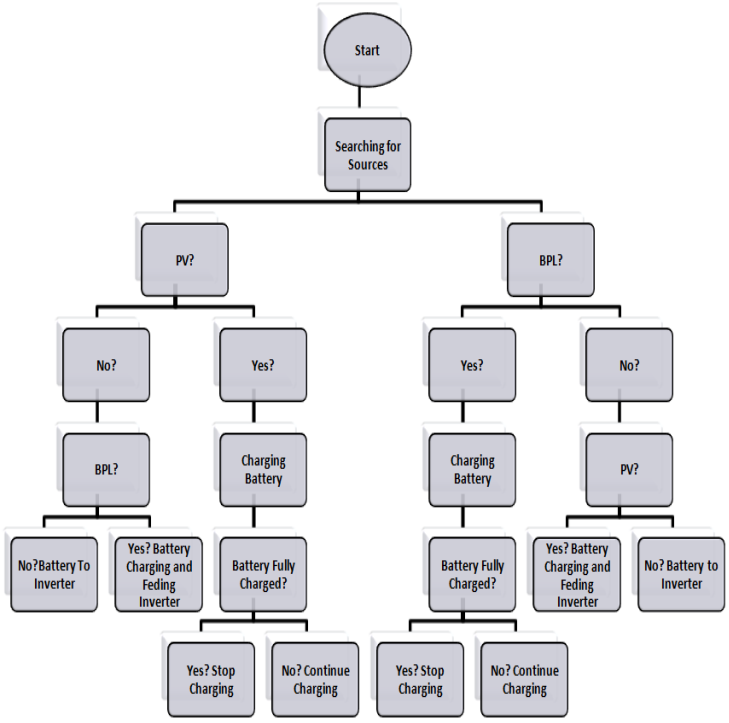

Fig 3. Developed algorithm for module controller device.

2.5. Operating Parameters and Limitations

2.5.1. Polarization of BPL Electricity Module

As the BPL electricity module is just like a cell and it contains anode and cathodes. It faces the problems of polarization of the electrodes. So, as much as possible it is efficient to reduce the polarization.

2.5.2. Using of Solar Tracker

One of the important parts of this hybrid module is Solar Photovoltaic Cell. It depends on the availability of the solar ray or direct solar beam. As the position of the sun changes with the time changes in a day it is beneficial to use the solar tracker with the photovoltaic cell for the maximum solar power generation.

2.5.3. Cleaning of BPL module

It is true that the BPL electricity module becomes dirty when the Module containing the Juice is used for several days. So this must be going under maintenance once in a weak. In that case the user must keep the BPL module out of service.

2.5.4. Maximum Energy efficiency of PV cell

For high energy efficiency the PV should work at the maximum power point. In the PV system, we assume that a maximum power point tracker will be used. The maximum power output is presented by

$$p_s = \eta SI(1 - 0.005(t_o - 25))$$

Where η is the conversion efficiency of the solar cell array (%); S is the array area (m^2);I is the solar radiation (kW/m^2); and t_0 is the outside air temperature (^oC).

3. Maximum Conversion Efficiency

The maximum conversion efficiency of a Solar cell is given by the ration of the maximum useful power to the incident solar radiation. Thus

$$\eta_{max} = \frac{I_m V_m}{I_T A_C} = \frac{FFI_{SC}V_{OC}}{I_T A_C}$$

Where I_T is the incident solar flux and A_C is the area of the cell. FF is the fill factor. I_{SC} is the short circuit current; V_{OC} is the open circuit voltage. From an efficient cell, it is desired to have greater values of FF (Fill Factor), short circuit current and open circuit voltage. From solid state physics theory, the expressions can be derived for each of these quantities. The expression shows that high values of I_{SC} are obtained with low band gap materials, while high values of V_{OC} and FF are possible with high band gap materials. Thus if theoretical values of η_{max} are calculated for different values of E_g it is obvious that a maximum value would be obtained at some value of E_g

3. Future Plan

As the BPL electricity opens a new era of renewable energy in the form of biomass energy, obviously it can be a great choice for future energy demand meeting solution for future engineers. So, integrating this Hybrid module with the Micro Grid is the future plan and making it more efficient and effective.

4. Conclusion

Energy demand is the most promising demand in the recent world. To fed all the humans with their demand of energy requirement in household as well as in industry renewable energy selection cannot be avoided anyhow. So, hybrid Solar and BPL electricity module may be one of the best solution for household energy requirement.

References

[1] Information available at: http://en.wikipedia.org/wiki/Kalanchoe_sect._Bryophyllum
[2] Shuva Paul, Shuddha Chowdhury,Jennifar Aktar,Priyanka Paul,Nabilah Manzoor "Performance Testing of BPL electricity module" in proceeding of EIT-2012,IUPUI,United States
[3] S. X. Chen , H.B.Gooi and M. Q. Wang "Sizing of Energy Storage for Microgirds"IEEE Transaction On Smart Grid, Vol. 3. No. 1, March 2012
[4] Information available at: www.nasa.gov

Biographies

Dr. Md. Kamrul Alam Khan: Dr. Md. Kamrul Alam Khan is currently working as the Dean of the Department of Science, Jagannath University,Dhaka,Bangladesh. Email: kakhan01@yahoo.com

Shuva Paul: Shuva Paul is currently pursuing his BSc in Electrical & Electronic Engineering from American International University Bangladesh. Email: paulshuva66@gmail.com

Saniat Rahman Zishan: Saniat Rahman Zishan has completed his BSc in Electrical and Electronic Engineering and Masters of Engineering in Telecommunications from American International University Bangladesh. Currently he is working as a lecturer in the department of Electrical & Electronic Engineering at American International University Bangladesh. Email: saniat@aiub.edu

Md. Adibullah: Md. Adibullah is currently pursuing his BSc in Electrical & Electronic Engineering from American International University Bangladesh. Email: md.adibullah@gmail.com

Sohel Mahmud: Sohel Mahmud is currently pursuing his BSc in Electrical & Electronic Engineering from American International University Bangladesh. Email: sohelmahmud415@yahoo.com