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Source Management of A Hybrid DC Micro Grid in Rural Area of Bangladesh

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***Abstract*—This paper explores the idea and analysis of a DC micro grid which have several types of renewable energy resources as well as traditional fuel based resources for remote area of Bangladesh. Most of the remote areas of Bangladesh is deprive from the benefit of using electricity due to lack of enough transmission and distribution line. Moreover the Generation of electricity is not enough to serve its demand. For various factors, national and international concern has been raised to develop alternative renewable sources of primary energy such as solar, biomass, wind, hydro and other green power technologies are being used to provide sustainable and affordable sources of energy. Government is trying to solve this problem by means of several renewable energy activities. Microgrid is one of them. Analysis of DC microgrid is important as an AC microgrid. The grid may have multiple types of energy resources. This paper also aimed to mention how to manage the resources used in a DC micro grid system.**

***Index Terms*—Source management technique, dc micro grid, renewable energy, hybrid system.**

I. INTRODUCTION

Renewable energy may be one of the best choices in meeting the shortage between generation and demand in the country if proper technologies and policies are applied. Bangladesh has already made noticeable development in this sector to provide electricity. Many rural people live in remote places where Rural Electrification Board in Bangladesh (REB) delivers electricity. Bangladesh is one of the sunniest parts of the world. It receives plenty of sunlight. This energy is converted into electrical energy by means of solar photovoltaic (PV) panels. For small isolated area, DC grid to provide electricity to the population may be better than that of AC grid. A grid normally connects the loads with the power sources.

II. PRESENT ELECTRICITY SITUATION IN BANGLADESH

Electrical energy is one of the most congenial terms of energy and a key point of economic condition for any country in the world [1]. According to worldwide calculation of electric consumption at present, approximately 1.4 billion people (more than 20 percent population) all over the world are not got electric connection. All of those people live in remote areas in Asia and Africa [2]. Currently almost 52 percent [3] of Bangladeshi people are connected with the power grid and 9 percent of the population have stand alone Solar Home System (SHS) [4]. The power supply is not adequate to meet the peak demand in Bangladesh. In the rural areas, only about 25 percent people have grid electricity connection that means almost 75 percent people have no grid electricity. At this time, the country is facing a dour electricity demand due to growth of almost each and every sector. According to the Rural Electrification Board in Bangladesh the present peak and off peak hour the shortage of electricity is almost 15-20 percent of generation [5]. Due to the limitations of use natural fuels and also the shortage of fossil fuels, the government already has focused on the renewable energy and about its technology - mainly solar energy.

III. RESEARCH BACKGROUND

An analysis was done in a remote area which village name is Vulbaria in the district of Natore (Fig.1). It is a small village with 4,000 to 4,500 inhabitants approximately, located in the community of Natore district and 25 miles far distance from Shingra Thana. Education rate of this village is approximately 67 percent. The village has one primary school with only 6 classrooms, one Alia Madrasha and one Mosque. There is no electricity connection in the village; people need to alternative solutions for energy, such as firewood, cow-dung and oil lamp. The nearest grid electricity line is around 5 kilometres far from this village. A local power supplier has been serving electricity to the 100 consumers almost with the help of diesel generator. But the location of the local power supplier is almost 3 kilometres away from this village, so the villagers are not get electricity connection from the local supplier also. More than 150 households are installed Solar Home System (SHS) out of 500 households. The total number of cows in this village is around 6 to 7 hundreds.

Biogas plants installed in this area is about zero. There are only two numbers of poultry firm in this village and totally 600-700 numbers of cow. The poultry waste and the cow dung can be used to generate biogas.

There is a small river named Nagar. It contains water only for few months around the rainy season so micro hydro is not possible at that area. The speed of wind is less than 0.5 ms^{-1} which is not possible to run the micro wind generator, finally it can't be installed at that area.

House to house average distance is about 2-2.5 meter. Currently total 150 numbers of households are using Solar Home system. Most of them are using 60 W_P solar packages. The survey reveals that the demand of present user increasing day by day. Most of them are lower income people. If a source management technique can be provided among the different energy sources it is possible to access electricity to the whole villagers easily. Therefore the source management system may be capable of meeting the electricity demand of any rural area specially that village.

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Fig.1. Area map of the proposal

IV. Block Diagram of DC Micro Grid

Study of harnessing energy from renewable energy resources by means of several types of microgrid has been offered by different ways [9]-[12]. The following block diagram has been established for the Noble Design of a DC Micro Grid and it implies the basic principles of the Grid. This system also includes collection of solar energy by solar PV system. By using this types of project user can get electric power by overcome some steps. The process can be described with the help of Fig.2.

Firstly, solar module collects the sun power and converts it into DC power which is transmitted into the Central Control Unit (CCU).

Secondly, central control unit deliver DC power to the User Control Unit (UCU) as per demand and the meter is provided for measuring consumed energy.

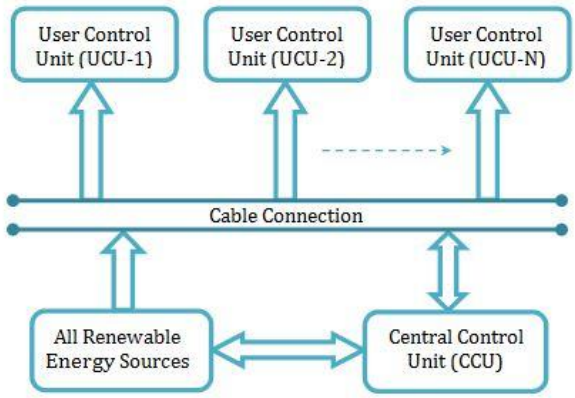

Fig.2. Block diagram of dc micro grid

This system includes three operational subsystems like are battery, biogas plant and diesel generator. The source management system may be cleared as a load management system that means the load is managed (run) by supplying electricity from the sources as well as the power grid. The source management system is a very important parameter. Traditional source management is completed by load shading in many country of the world such as Bangladesh. A new technique for source management method is discussed here. The system can able to identify how much load can be operated by the produced electricity. If load become more than the accumulated generated power then it automatically disconnect the specific overed load, so this is an intellectual operational system.

V. Micro Power Grid for AC and DC

A micro power grid is emerging as one of the amazing solutions to the integrating of various sorts of imparted renewable power sources with the grid of utility. Although the underlying power grids are AC grids, nowadays the loads of electricity comprises of power and electronic based equipments and also the distribution of the renewable energy formation make the DC micro power grids more attractive. However, individually AC micro power grid and DC micro power grid requires the multiple altercations of energy at the user for the DC and AC loads respectively, the resulting forms are less efficient systems [6].

VI. Control Strategy of the Grid

Any source that is not available always for due to some causes is known as intermittent source. An intermittent source is quite predictable. To exemplify, wave and tidal energy, solar photovoltaic system, biogas power plant etc. In the solar PV system electricity production is depended on the amount of sunlight and it does not produce electricity at night. Due to intermittency, the power system may have some fluctuation on frequency, voltage and other important parameters. To obtain constant power, the effect of intermittency must be overcome. Using battery is a simple way to overcome this. Moreover other renewable energy sources may be interconnected to the system. Besides this standby sources are biogas, diesel or other fuel based

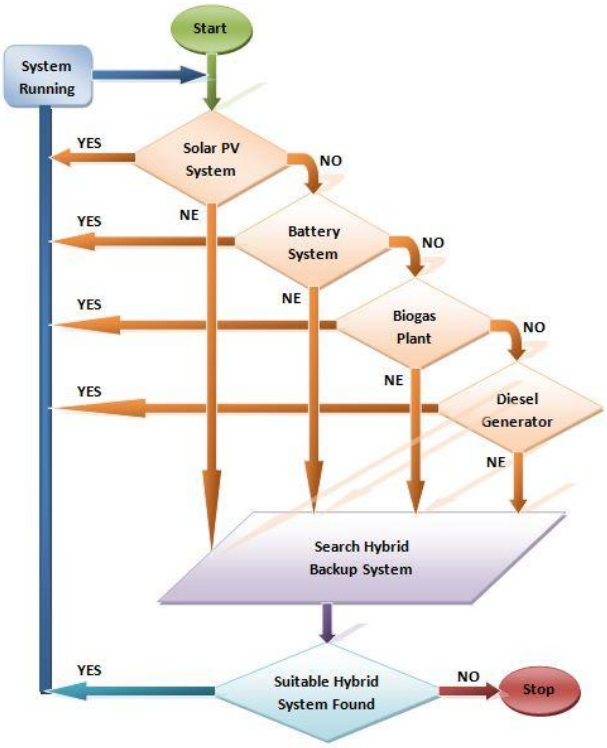

Fig.3. Flow chart of the dc micro grid

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generator is also necessary for long term unavailability of intermittence sources.

For an AC micro grid, frequency control is important as well as voltage control, whereas, in a DC micro grid there is no option to control the frequency. The source and load management system are essential to get constant power and robust control system. The source management system is discussed below with Fig.3. The main source of energy in this system is solar PV system. This system contains three operational subsystems like battery, biogas plant and diesel generator. At the starting, to run this program, it find out the availability of solar energy. If solar energy is enough then it run's the system without the help of any subsystem. If solar energy is Not Enough (NE) then it can identify the battery subsystem and receive the amount of shortage power and keep in running the system. If the solar and battery subsystem are combinedly "Not Enough" (NE) then it will search for biogas and receive the amount of shortage power and keep in running the system.

If the solar, battery and biogas plant subsystem are combinedly "Not Enough (NE)" then it can search the diesel generator and receive the amount of shortage power and keep in running the system. If the solar, battery, biogas plant and diesel generator subsystems are combinedly "Not Enough (NE)" then it stop (End) the running system.

VII. Load Forecasting and Calculative Terms

In general, 5 pieces bulb is enough for each and every family at the village. An LED bulb of 5 Watt is sufficient to illuminate a space to study, gossip, kitchen work and other essential activities. The 5 Watt of LED bulb will provide around 550 lumen of light energy [8]. The bulbs run for 4 hours per day generally. Therefore, the daily consumption of lighting load for 100 families of the village is 10 KWh approximately.

Few of the natives of that village are also interested to run fan, television, computer and others loads whose are approximately 10 KW in total. If these loads will run for 4 hours per day then the daily consumption will be 40 KWh of the village. Therefore, the total daily consumption of the village is 50 KWh. The panel generation factor (PGF) is 3.5 for Bangladesh. So, the required panel rating will be 50 /3.5= 14.28 KW. It is recommended to use 15 KW_P panel.

Table 1 shows the monthly output of this panel for the area by using PVwatt software of National Renewable Energy Lab (RNEL), Canada, which is available at [13].

There are many households in this village use non-renewable energy like kerosene, diesel and other fuels whose have lesser luminance or brightness. The approximate cost of kerosene oil is 70 BDT per litre. If 5 pieces lamp are used for 4 hours per day for each households, then required kerosene almost 5 litters per month and the cost of kerosene will be 350 BDT.

Alternatively, if one household use 5 electric lamps of 5 Watt whose have greater luminance or brightness compared with any non-renewable energy sources for 4 hours per day by means of solar technology then monthly consumption will be 3 KWh (3 BTU). Although the cost of solar energy will be higher such as 40 BDT per KWh then the monthly consumption cost will be 120 BDT only.

Therefore, it is clearly realize that the solar energy is more efficient than any non-renewable energy sources.

TABLE I.
Specification of the PV System at Bogra Nearest to the Analysed Site

Station Identification		**Output**	
City:	**Bogra**	**Month**	**Energy (kWh)**
Country/Province:	BGD	January	1133
Latitude:	24.85° N	February	1068
Longitude:	89.37° E	March	1250
Elevation:	20 m	April	1218
Weather Data:	SWERA	May	1121
PV System Specifications		June	959
DC Rating:	10.0 kW	July	862
DC to AC Derate Factor:	0.77	August	905
AC Rating:	7.70 kW	September	911
Array Type:	Fixed Tilt	October	1067
Array Tilt:	24.9°	November	1064
Array Azimuth:	180.0°	December	1108

VIII. Conclusion

Although the resources has been analyzed for a specific area of Bangladesh, the method of analyzing the resources and the source management technique can be applicable to anywhere and any size of power sources. The performance of this model or the electricity generation system is released heavily. It should be considered about the ability of produce electric power with a negative emission of CO_2. The people of those villages basically in the remote areas and also the people of islands will be influenced to get the electric connection by under this model. The major pros and cons of a photovoltaic system is that it can be used expanded as our need and wide range of specific applications.

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