

Prospects of energy resources and analysis of hybrid energy at Bhola island, Bangladesh: A realistic way to alleviate energy demand

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Abstract— Power is one of the most important factors for a developing country like Bangladesh. Human lives are closely bonded with electrical power. Like the rest of the countries of the world, the demand for power is increasing day by day in our country. The rapid increase of gap between demand and power supply has created power crisis in Bangladesh. This paper focuses on the fact that how proper district based investigation on the resources and its proper utilization can help to give an easy realistic solution on the way of sustainable energy security of Bangladesh. To make the renewable power system more stable and reliable a Hybrid Power System is introduced by interconnecting both conventional power sources and non-conventional power sources to increase optimized source of energy.

Index Terms— Solar energy, Wind energy, Biogas energy, Tidal energy, Gas turbine energy, Hybrid energy.

1 INTRODUCTION

Bangladesh lacks a sufficient electricity generation capacity and grid networks to electrify the whole nation and never enjoyed 100% electrification. 80% of the total population in Bangladesh lives in rural areas. Only 10% of the rural households have electricity connection and there are some parts of Bangladesh which will not get the access of electricity connection from the national grid within next 30 years [1]. Renewable energy exists continuously and in plentiful quantity in the environment. In Bangladesh, the country receives an average daily solar radiation of 4 - 6.5 kWh/m² [2]. In Bhola island solar, wind, biogas and tidal energy can be a potential source of power to produce electricity. Currently, only one gas turbine power plant is working for the electricity demand of the Bhola island's population. Electricity can be generated by harnessing abundant energy obtainable in nature and lift up the life style of the people of a certain remote area by an isolated hybrid energy system [3]. Hybrid energy System is small or medium set of collaborating units which generates power with different types of renewable and non-renewable energy sources where a power electronics control system co-ordinates all the operation. If the generation is more than the power demand then the surplus power can be connected with national grid. This paper shows the renewable energy resources of Bhola island and proposes a hybrid energy system for proper utilization of power.

2 OVERVIEW OF BHOLA ISLAND

Bhola is a district to the South-Western side of the Bangladesh and it is a part of Barisal division. This district is bounded by the Lakshmipur and Barisal districts to the north, Bay of Bengal to the south, Lakshmipur and Noakhali districts, Meghna River and Shahbazpur Channel to the east. Patuakhali district and Tentulia River is to the west of this district. The position of Bhola island is 22.6903°N 90.6525°E [4]. Average maximum temperature 35.6°C, minimum 12.4°C; annual rainfall 2402 mm. Its area is 3737.21 Sq. Kilometers. Bhola island has more than 1758000 populations and 3,07,436 households. Upazilas of Bhola district are Bhola sadar, Burhanuddin, Char Fasson, Daulatkhan, Lalmohan, Manpura and Tazumuddin. This district is main crops like-paddy, potato, onion, chilli, garlic, mustard seed, nut, berel leaf, betel nut etc. There is main exports-paddy, betel nut chilli and fish. This district are many mills and factories such as-rice mill, ice factory, saw mill, flour mill, oil mil, bread and biscuit factory, welding, lathe machine etc [5].

3 PRESENT ENERGY SCENARIO

The present generation capability of Bangladesh in public sector is 4794MW (56%) only. Due to large difference between production and demand authority distribute less power than actual demand to all over the districts of Bangladesh. It is observed, total demand of Bhola is near 42MW. Like other districts of Bangladesh, Bhola have a plenty of renewable energy source. Presently a small amount of these resources are used to meet energy demand.

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3.1 Solar Energy

Bangladesh is situated between 20.30 and 26.38 degrees north latitude and 88.04 and 92.44 degrees east which is an ideal location for solar energy utilization [6]. According to IDCOL, the total capacity of solar energy based installations in Bangladesh appears to be 20.75 MW [7]. In Fig.1 the monthly average solar radiation pattern is shown [8].

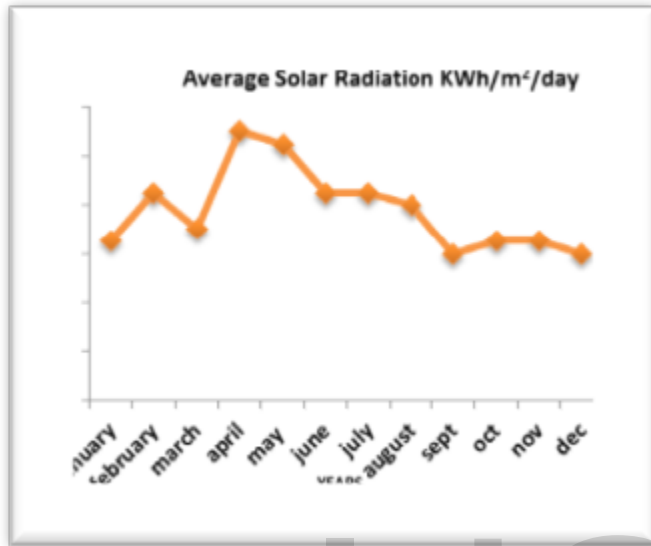


Fig.1 Average solar radiation of Bangladesh.

Daily average solar radiation varies between 4 to 6.5 KWh per square meter. Maximum amount of radiation are available in the month of March-April and minimum in December-January. Moreover, in the southern territories of Bangladesh where the solar intensity is very high, solar thermal power plant can be installed. In Bhola, average daily solar radiation of 5 - 6 kWh/m². So, for both photovoltaic technology and solar thermal technology, Bhola is at a suitable location. In fact, Bangladesh government has recently taken many steps to encourage people to use photovoltaic energy.

3.2 Wind Energy

There are many hilly and coastal areas in Bangladesh which have huge potential for wind energy generation. Along the coastal area of Bangladesh, the annual average wind speed at 30m height is more than 5 m/s [9]. Bhola have immense potential to produce electricity from wind energy. A survey of 15 days wind velocity in charfashion is shown on Fig.2 [10].

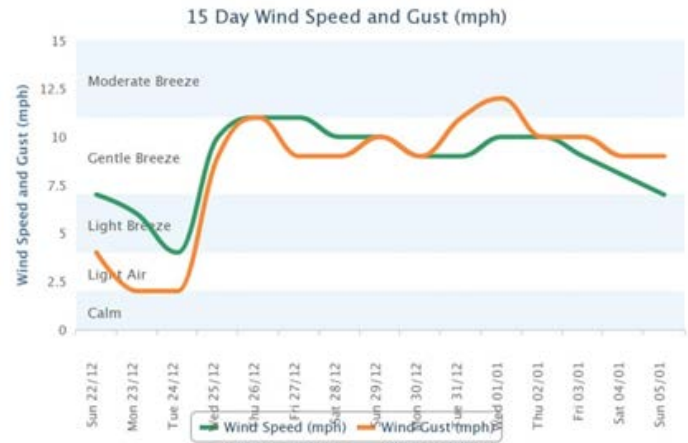


Fig.2 Wind speed of charfashion

In Bhola island the wind speed is quite high. The wind speed in this area is good enough for power generation and hence fulfillment of the demand of this particular area. The average wind speed of several area of Bhola island is shown on TABLE 1.

Name of area	Average wind speed (m/s) at 30m height
charfashion	6.17
Betua	6.28
Lordhadinge	5.39
Gozaria	5.12
Mirzakalu	4.78
Borhanuddin	4.34
Elisha	4.40
Mongol sikder	5.93
Dokkhin aicha	7.2

TABLE.1 Average wind speed of Bhola island.

3.3 Biogas Energy

Natural resources in the form of fossil fuels are the raw materials from which electrical energy is generated and the day to day life of the people of today's world is solely dependent on the electrical energy in this present world [11]. Waste materials produced from natural day to day life usage and also from animal wastes, can be good sources of energy in this purpose and can help to meet the electricity demand by generating electricity through biogas. In Bangladesh biogas is still a relatively new technology. In most of the places it is used to generate electricity to meet the household demands. Recently Seed Bangla Foundation has proposed a 25 KW Biogas based Power Plant in Rajshahi [12]. IDCOL, a Government owned Investment Company fixed a target to set up 37,669 biogas plants in Bangladesh by 2012, under its National Domestic Biogas and Manure programmers (NDBMP). In Bhola the temperature varies in between 12.4°C to 35.6°C throughout the year, thus the inside temperature of the bio-gas digester typically remains between 22°C-30°C which is quite close to the optimum temperature [13]. Which major materials of a biogas plant are richly available in Bhola district is shown on TABLE 2 [14].

Biogas material	Amount	Biogas production
Cattle Dung	11.5 million kg/day.	0.481 million m ³ (Mm ³)/day
Poultry Litter	0.48 million kg/day.	33520 m ³ /day.
Rice Husk	45000 kg/day.	Produces electricity by Steam Turbine Plant

TABLE.2 Available material of biogas plant in Bhola.

3.4 Tidal Energy

Tidal power or tidal energy is a form of hydropower that converts the energy of tides into electrical power. The coastal of Bangladesh has a tidal rise and fall of between 2 to 5 meters. Among these coastal areas, with 3-5 meter tides experienced, Bhola has the better prospect to generate tidal energy. Bhola island is bounded by rivers and Bay of Bengal. According to the coastal zone policy (CZPo, 2005), Bangladesh has its 19 districts in the coastal zone in which 12 are in direct contact with the sea [15]. Projects for harnessing tidal power in Bhola island can lead the coastal regions to sustainable development as various employment opportunities will be generated and moreover tour-ism opportunities may be created.

3.5 Gas Energy

The best Mineral resource of the Bhola island is natural gas. There are about 400mmcf natural gas in Bhola. Bhola island has some gas field and Shahbazpur gas field is one of them. It is situated at Kachi union under Burhanuddin upazila. The quantity of gas of this field is 0.5938 TCF and 0.3340TCF gas is procurable. By using this gas, Venture Energy Resources Limited is producing electricity of 34.5 MW. This plant is using 10 million standard cubic feet gas per day [16].

The Government of Bangladesh has authorized the Bangladesh Power Development Board to develop a 150 - 225 MW gas fired combined cycle power plant in Bhola, Bangladesh. To fulfill part of this requirement, Lanco Power International was appointed to design; finance and build own and operate a 217.9 MW gas-fired combined cycle.

The project location is Kutba union of Borhanuddin in Bhola island of Bangladesh. The CCPP will have a 1+1+1 configuration (i.e., one gas turbine generator (GTG), one heat recovery steam generator (HRSG) and one steam turbine generator (STG)) and will have a multi shaft design for gas turbine and steam turbine generators. The plant will be constructed on 12.32 acres of land which will be leased to Lanco out of the 28.03 acres of total land owned by BPDB. Rest of the 15.71 acres of land will be used by BPDB for building its own power plant [17]. The government has decided to extend contract with a rental power producer by two years to buy electricity from its 33 megawatt plant in Bhola. The decision was taken as the government failed to implement a long-term power plant having 225MW capacity in Bhola before the contract with the rental power producer expired. A three-year power purchase agreement between the state-run Power Development Board

and Venture Energy Resources Ltd, owner of the 33MW power plant in Bhola, expired in July this year. The plant is still generating electricity to meet Bhola's own demand and feed the rest of electricity it produces to the national grid. Petro-bangla, the state-run Oil, Gas and Mineral Resources Corporation, failed to assure the PDB to supply adequate gas for 20 years for running the planned 225MW power plant, PDB officials alleged [18].

4 PROPOSED HYBRID ENERGY SYSTEM

The proposed hybrid system is designed for both on grid and off grid operation. Block diagram of the typical hybrid grid connected power system is shown on Fig.3. The system consists of gas turbine generator, PV generators, wind generator, biogas, tidal generator and controller. In this system the input from gas turbine generator is directly fed to the controller ; whereas the input from Solar, wind, biogas and tidal generator is fed by converting them from DC to AC. Then the output from controller is used to control loads and connection of national grid. When the demand power of the Bhola island is fulfill then controller connect the extra produced power on national grid.

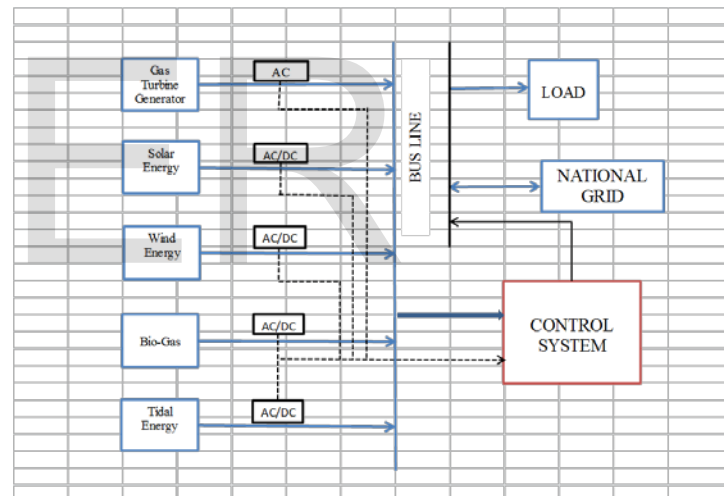


Fig.3 Block diagram of proposed hybrid system.

The proposed system flow chart and algorithm is shown on Fig.4 .The proposed hybrid system has been designed in such a way that the maximum utilization of energy resources of Bhola island. This algorithm has been designed to operate on both on-grids as well as off-grid system especially for Bhola island as well as other rural areas. According to this flow chart at first we will measure the available power generated from gas turbine generator; if the power supply is greater than demand then the extra generating power is connected with national grid, if not then it will add the solar power. If the generated power is greater then the extra generating power is connected with national grid or else it will go to wind power. If the supply is more than demand then the extra generating power is connected with national grid or else it will go to the biogas scheme. In case of the failure of biogas scheme eventually it will go to tidal generator. If the generated power greater

than the demand then the extra generating power is connected with national grid or else the loads will take power directly from the grid if the grid power is available. However, in case of unavailability of the grid power, the system will again go to measure the wind speed and thus will repeat the entire process.

ronmental benefits. A contemporary scenario of Bhola island energy resources has been presented using data and illustrations, on the basis of careful fieldworks. This paper shows the energy resources of Bhola island and its proper utilization as well as perfect for high power stability and reliability which can be implemented in different countries of the world.

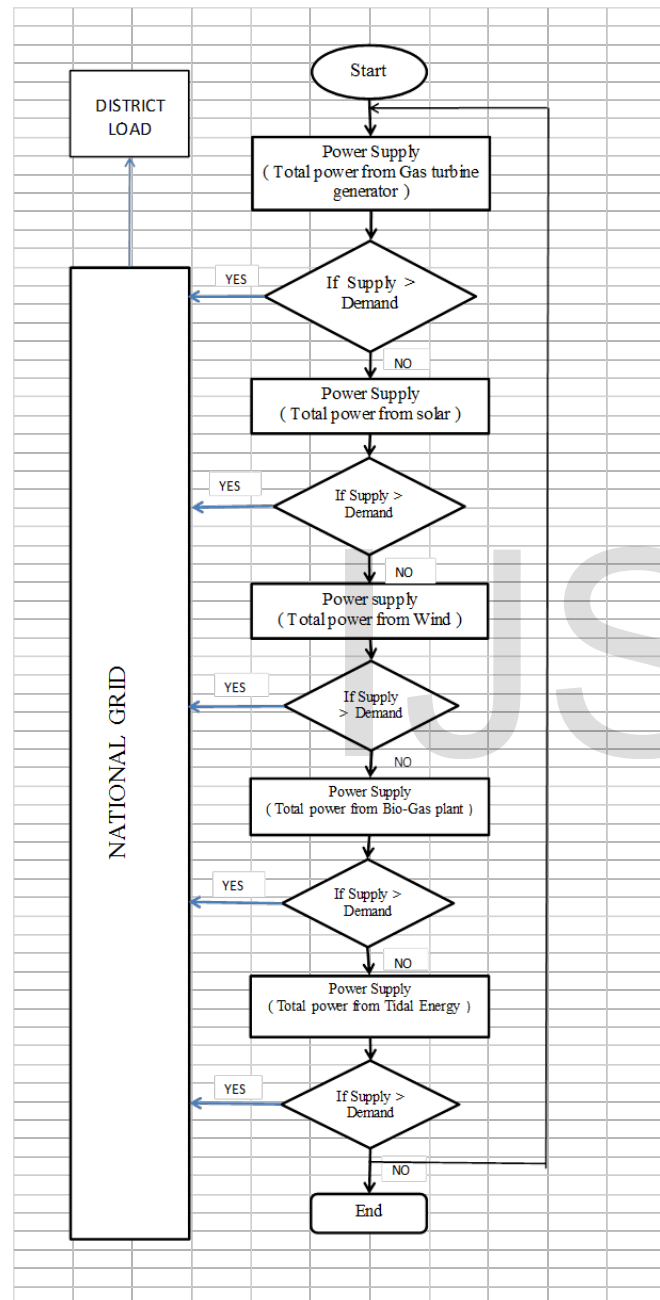


Fig.4 Flow chart of proposed hybrid system.

5 CONCLUSION

Hybrid systems have proved to be the best option to deliver high quality community energy services to rural areas at the lowest economic cost and with maximum social and envi-

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