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Applications of non conventional energy sources

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Abstract— ***This paper reviews the potentialities of available renewable strength resources in conjunction with numerous private and authorities future mission plans to include renewable power assets and its potentials in angle of Bangladesh. In an arising u . s . Like Bangladesh call for energy might be burgeoning. Modern, in Bangladesh dearth of power is ubiquitous and close to about 70% of its populace is excluded from access to power and bulk of the people are dwelling in rural areas. Among several renewable power resources, the utility of sun photo Voltaic (PV) is renowned despite the fact that the largest plant based on renewable energy goes into hydroelectricity. Additionally, wind, biogas, mini hydro and tidal are also well known. A plan has been initiated by the authorities of Bangladesh (GOB) to generate five% of the total strength from renewable strength assets inside 2015 and 20% with the aid of the yr of 2020. through the authorized renewable strength coverage, the GOB is dedicated to facilitate funding in both public and private sectors in renewable energy initiatives to substitute contemporaneous non-renewable strength assets and increase the contributions of renewable electricity primarily based electricity technology. With this context, evaluate of latest activities on concurrent renewable electricity assets is imperative in addition to to discover potentials of the resources. but, no longer all renewable energy sources are suitable to install indiscriminately in all areas, as a substitute there are sure parameters to select a source of RER for efficacy. After analyzing this paper, an investor gets large statistics about modern-day situation and guidance for destiny involvement of renewable electricity resources in Bangladesh. moreover, this paper could be instrumental to pick greatest efficacious renewable electricity assets for a particular place.***

Keywords— solar PV, biogas, renewable energy, rice husk.

I. INTRODUCTION

Geographically Bangladesh is situated in the north-eastern part of South Asia between 20.840 & 26.8380 North Latitude and 88.8010 & 92.8410 East Longitude. The total population is about 160 million with an average population density near about 1050 per sq. km (among the highest in the world) [1]. 70% of the population live in the rural areas of Bangladesh is seriously deprived of the access to electricity. As because the expansion of grid is inordinately expensive in the rural areas; already initiatives have been taken to popularize the use of renewable energy sources. The prospect, trend, utilization and its technology as well as reviews of the policy, institutions and opportunities based on renewable energy technology towards sustainable development and climate change mitigation has been investigated in paper [3]. A contemporary scenario of the renewable energy associated activities in Bangladesh is presented in this paper [4].Furthermore comparing with other countries of Asia, energy consumption level is lower in Bangladesh although crisis is intense. Due to perpetual failure of power, development and welfare of the citizens have been inhibited, so the government is compelled to move into contractual agreements at high cost and adopt expedient solutions of purchasing rental power and small IPP on an emergency basis based on diesel or liquid fuel. In Bangladesh the per capita energy consumption is one of the lowest in the region. On an average in Bangladesh per capita energy consumption is 160 kg oe (Kilogram oil equivalent) compared to

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530 kg oe in India, 510 kg oe in Pakistan, 340 kg oe in Nepal and 470 kg oe in Sri Lanka [5]. The average energy consumption in Asia is 640 Kg oe. It has therefore, evinced clearly that per capita average consumption of energy in Bangladesh is lower than any other country of Asia. Long term strategy has been devised by the government for the melioration of existing debilitated energy situation in order to extenuate the financial problems. The strategy has created equilibrium approach regarding both supply increase and demand management aspects of the energy market. Energy options from the domestic sources need to be complimented with possible options for energy trade. Specifically the strategy would try to determine what can be done by the government about gas and power and to explore for various options to diversify the fuels for power generation.

II. ENERGY DEMAND AND GENERATION CAPACITY SCENARIO AND FUTURE PROJECTS In Bangladesh, installed generation capability (June 2014) has reached to 10416 MW [2] and the maximum generation is 7500MW where the maximum demand is 8500MW. Nearly 77% of the total generation is obtained from natural gas [2] besides the only renewable part of the generation which comes from hydro and which is around 2.45%. In contrast, around 3 million [6] IDCOLs SHS programme has installed solar home systems. Their goal is to finance 6 million SHSs by the end of year 2016. Moreover, IDCOL financed a 250 kW Biomass based power plant at Kapasia, Gazipur, 100kWp Solar PV and diesel based hybrid power plant in Sandwip, Chittagong and 400-kW rice husk gasification based power generation facility along with a precipitated silica plant at Chilarong, Thakurgaon sadar, Thakurgaon. It has been anticipated that in future the

biogas technology would be the driving force as because of the ascending poultry industry in Bangladesh.

III. REVIEW OF VARIOUS RENEWABLE ENERGY ACTIVITIES

A. Solar PV Application The application of solar PV is mainly found in remote areas of Bangladesh. In 2003 IDCOL started the SHS program to ensure access to clean electricity for the energy starved off-grid rural areas of Bangladesh. The program bolsters the Governments vision of ensuring Access to Electricity for All by the year of 2021. Additionally, hybrid microgird (with solar PV), solar PV based irrigation system, grid-tied solar PV systems are also in operation. These are described below.

***1) Solar Home System*:** In Bangladesh, access to energy for services like cooking and lighting in off-grid villages is slender. Most rural households have to rely on kerosene lamps for lighting and traditional stoves for cooking. The Government has initiated various programs and has given enormous efforts to introduce flexibility in rural economy. Solar power, especially SHS technology, has been welcomed by the rural people as a reasonable way to fulfill the requirement of lighting. In the off-grid rural areas of Bangladesh more than 3 million SHSs have already been installed under the supervision of the program [5]. As a result, 13 million of people are receiving solar electricity that is around 10% of the total population of Bangladesh. IDCOL has a goal to provide financial support to 6 million SHSs by 2017, with an estimated electricity generation capacity of 220 MW. Currently 47 Partner Organizations (POs) are implementing this program. IDCOL provides refinancing and grant support and at the same time essential technical assistance to the POs. The POs install the SHSs, expand credit to the end users and assistance with after sales services. IDCOL received credit and grant support from the World Bank, JICA and other financial supporting organizations [5]. More than 65,000 SHSs are now being installed every month under the supervision of the program with an average year to year installation growth rate of 58%. The program has superseded 180,000 tons of kerosene which have an estimated value of USD 225 million per year. Furthermore, near about 70,000 people are indirectly or directly engaged with the program. The program has been heralded as one of the biggest and the quickest growing off-grid renewable energy programs in the world [5]. Excessive cost of fuel and regular maintenance forced the telecom operators to cogitate of an alternative energy source by which the remote and off-grid BTSs can be functioned. Many operators have decided to run off-grid BTSs with solardiesel hybrid power systems for an uninterrupted voice and data services. As the primary power source these systems use solar PV and as backup diesel generator. In the

telecom sector so far IDCOL has financed 138 such solar-diesel hybrid power solutions [3].

2) Solar PV based irrigation system: Bangladesh has 14.76 million hectors of total land in which 8.3 million hectors are net cultivable and 7.56 million hectors are irrigable. It is an agro-based country whose irrigation is traditionally dependent on monsoon rain water. Besides this, irrigation pump has been considered as a major invention to ensure food security. According to a recent survey conducted by Bangladesh Agriculture Development Corporation (BADC), there are about 1.42 million diesel based irrigation pumps are operating in the country, consequently requiring about 1 million ton of diesel per year [7]. Solar powered irrigation system is an innovative, economic and environment friendly solution for the agro-based economy of Bangladesh. This particular system fundamentally consists of solar panels and solar power operated pumps. Primarily, diesel operated shallow and low lift pumps, preferably using in triple crops areas, were targeted to be superseded by the solar irrigation pumps. Average capacity of each solar pump will be 8kWp with a head of 12-15 meters. Area coverage will be on an average 13 hector of paddy fields by a single pump. It is estimated that 18,700 diesel-based irrigation pumps will be replaced by solar powered pumps under this program. Total solar power capacity in this case will be 150 MW, which will reduce 95,000 liters of diesel and significant amount of CO2 emission per day [7]. Till to date, around 46 pumps have been installed [7].

3) Solar PV based microgrid: Many regions in Bangladesh which are deprived of consuming electricity from national grid depend on microgrid to fulfill their electricity demand. Microgrid based on small diesel based generation is being used in Bangladesh. Government has plan to install several microgrid based on solar PV. From this context, initially, 30 remote areas have been identified under this program where grid expansion is not planned for next 15-20 years. Additional new areas will be identified to develop solar mini grid system on the basis of successful implementation. Total solar power capacity in addition from this constituent will be 25 MW. Solar mini grid will ensure quality electricity in remote villages and help the villagers to have an improved income which will in turn mitigate their poverty to some extent [3]. Besides these, BPDB, REB has installed larger size of solar PV systems in various locations of Bangladesh. IDCOL has installed 100-kW solar photovoltaic (PV) based microgrid by PUROBI Green Energy Limited (PGEL) at Sandwip island in Chittagong. To alleviate the problem of low solar radiation a 40-kW diesel generator has been incorporated into the suggested power plant in order to ensure adequate power supply [8]. IDCOL aims to finance 50 solar mini-grid projects by 2017. The World Bank, KfW, JICA, GPOBA, USAID, ADB and DFID are allocating financial support in these projects.

B. Other Renewable Energy Sources

Other than the solar PV, there are some other renewable energy sources available in Bangladesh.

1) Biogas: An agro-based country like Bangladesh has huge potential for utilizing biogas technologies. According to IFRD, Bangladesh has plenty of resources to establish four million biogas power plants. Grameen Shakti has completed installing 13,500 biogas plants. Lately Seed Bangla Foundation has propounded a 25 KW power plant based on biogas in Rajshahi. IDCOL has been implementing domestic biogas programs in Bangladesh since 2006 with support from SNV Netherlands and KfW. IDCOL has financed establishment of over 33,000 biogas plants covering a wide range of regions all over the country with the help of its 24 partner organizations till April 2014. The program saves 80 thousand tons of firewood every year worth $2 million and also reduces the use of 28,000 tons of chemical fertilizer worth $20 million by producing 200,000 tons of organic fertilizer. The program also reduces the use of 1,000 tons of kerosene every year. IDCOL has a plan to install 100,000 biogas plants in Bangladesh by 2018. Some organizations in addition with the partnership with IDCOL have constructed private biogas plants with their own funds. Moreover, since May 2011, IDCOL along with its partner organizations has installed 18,713 biogas plants in different parts of Bangladesh [3]. Besides these, biomass production from rice husk energy (similar process to biogas) is steady over decade and day by day it is showing an increasing trend [10].

2) Hydro energy: The sole hydropower plant in Bangladesh is the Karnafuli Hydro Power station situated at kaptai about 50 km apart from Chittagong. Currently it has the capacity of 230 MW by 5 units. BPDB is appraising the operation and planning to increase its generation up to 330 MW. The Water Development Board (BWDB) and BPDB carried out a joint study on micro-hydro power potential in the country [4]. With a view to install other two hydro power plants at the Sangu and Matamuhuri rivers two sites have been selected. The projects will be named as The Sangu Project and The Matamuhuri Project comprising the generation capability of 140 MW and 75 MW respectively. At Barkal Upazila of Rangamati district, a 50 kW micro-hydro plant was installed in 2005. The ongoing projects are: 50-70 kW Mohamaya Irrigation-cumHydro Power Project at Mirersorai, Chittagong. Rehabilation of 50 kW micro-hydro power plant at Barkal Upazila of Rangamati district is underway [9].

3) Wind: The potential of wind energy is limited to offshore islands, coastal areas, rivers sides and other inland open areas with robust wind regime. BPDB installed 4 units of 225 KW which is accumulated to 900 KW capacity grid connected wind plant at Muhuri dam area of Sonagazi in Feni with a hope to generate electricity from wind energy. In 2008, another project of 1000 KW wind-battery hybrid power plant at Kutubdia Island was accomplished, which comprises of 50 wind turbines of 20 kW capacity each. Refurbishment of the existing Kutubdia 1000 kW windbattery hybrid power project is in progress. Steps have been taken to install 15 MW wind power plant across the coastal regions of Bangladesh after a year of wind resources assessment in Mognamaghat of Coxsbazar, Mu

huri dam area of Feni, Parky beach of Anwara in Chittagong, Kuakata of Patuakhali and Kepupara of Borguna. Wind mapping is going on at Muhuri dam area of Feni and at Mognamaghat of Coxs bazar by Regen Powertech Ltd. of India. Under the supervision of USAID TA project, installation of wind monitoring stations at Inani beach of Cox'sbazar, Parky Beach of Anwara, Sitakundu of Chittagong and at Chandpur is also underway [4].

***4) Ocean wave energy*:** Ocean wave energy is another special type of renewable energy, which is generated directly from the waves of the oceans and thus helps decrease the harmful emissions of greenhouse gases associated with the generation of power. As Bay of Bengal is situated with Bangladesh so ocean wave energy can be potentially a remarkable source of generating electricity for Bangladesh. Though the main purpose of ocean wave energy is electricity generation, it can also be used for pumping of water and desalination of water as well. The Oscillating Water Column method is technically feasible and proving very attractive for this purpose. This type of wave energy harnessing device is being commissioned by several countries such as the United Kingdom (500 kW), Norway (100 kW), Ireland (3.5 MW), and India (150 kW). Bangladesh has a good potential for harnessing ocean wave energy from the Bay of Bengal [10].

5) Tidal energy: The energy which is attained from the tides of seas and oceans as a form of hydropower and converted into electrical power is called tidal energy. As tides are more predictable than wind and sunlight, tidal energy can easily be generated from the changing sea levels. The coastal area of Bangladesh has a tidal rise and fall of between 2 to 5 meters. Among these coastal areas, Sandwip has the best prospect (more than 5 meter tidal rise fall) to generate tidal energy [10]. By applying low and medium head tidal movements of height within 2-5 m from coastal tidal resources, Bangladesh can achieve adequate amount of tidal energy. Low head tidal movements are suitable in areas like Satkhira, Barisal, Khulna, Bagerhat and Cox's Bazar regions. In Sandwip, high tidal movements more than 5 meter of tidal wave is utilized to produce tidal energy. Therefore, we can say that Bangladesh is blessed with appropriate tidal height. Availability of such tides can be a great source of electrical energy for Bangladesh.

6) Geothermal energy: Bangladesh shows the prospect to explore the geothermal resources in the northern districts. Countrys first geothermal power plant close to Saland in Thakurgaon district is incipient with a capacity to produce 200 MW of electricity [13]. Dhaka-based private company, namely, Anglo MGH Energy has taken this initiative to enhance the geothermal resource opportunity in this country. They have planned to set up 28 deep tube wells to lift hot steam and the lifted steam will be used to run a turbine and the turbine is connected to

the generator to generate electricity. From the above discussion, it is clear that geothermal energy can also be a potential source of harnessing electrical energy in Bangladesh.

IV. DEPENDENT FACTOR FOR CHOOSING A RENEWABLE ENERGY RESOURCE

There are some factors which should be considered for choosing a renewable energy resource in different region. Among them, geographical location plays a significant role in selecting proper renewable energy resources. Different areas of the Earth receive different amounts of sunlight based on the location, the time of year, and the time of day. A suitable location for installing solar panels has specific characteristics and requirements. Identification of those locations requires that desirable characteristics be defined first. With an ideally suitable site, a solar panel should be placed south faced and a 23.5 0 tilt angle (in average) with the horizontal plane in Bangladesh. The site should be chosen such that it may receive adequate amount of sun light. The coastal area of Bangladesh is mostly protected by the trees. However, sometimes we may have to cut the trees of the coastal area to ensure exposure of adequate sunlight on the installed panel. As rivers are considered as open space so boats consisting solar panels can receive plenty of solar radiation. However, orientation is important for the installation if that is on a boat or anything movable. It is better to install the panel on any boat or roof-top of an electric car horizontally. In hilly regions, special care should be taken to install interconnection of solar panels/power sources. Population is another parameter which determines the effectiveness of utilizing a renewable energy resource.

In highly dense urban areas where high-rise buildings are common, panel should be chosen for high shadow effect. In these areas interconnected solar system with storage is preferable. High efficiency solar panel with hybrid system is needed where energy demand is high. In low density areas, standalone system is better due to per capita inter-connection cost. Special care should be taken while installing PV panels at the coastal area for two reasons: firstly to protect them from cyclones and secondly without cutting any trees. Therefore, PV cells should be placed carefully considering all the parameters. Installation of solar PV at the coastal area may hamper the environment because of cutting the overhead trees. Wind is not always a steady source of energy. Wind speed changes constantly, depending on the time of day, weather, and geographic location. Wind farms can be found near farmland, in narrow mountain passes, and even in the ocean, where there are steadier and stronger winds. Wind turbines are suitable in the coastal areas considering the flow of wind. However, wind farms are not suitable in densely populated areas [11] [12]. Bangladesh is a plain delta having three of the major rivers of the world namely, the Ganges, the Brahmaputra and the Meghna flowing through it. The Jamuna-Padma,-Meghna river system divides it into east and west zones and creates an average water flow of 1.3 trillion m3 in a year throughout the country. Many other rivers flow throughout the country which are actually the tributaries of these rivers. During monsoon, the flow rates of most of the rivers are high but it reduces substantially during winter. There lies a stricture of hydropower generation in Bangladesh except some southeast part and some specific hilly areas of northeast. However, there are a lot of tributaries, canals, tiny waterfalls which have good potential for setting up hydro power plants. Hydro power plants convert the hydro power of the fluid into mechanical power which is further converted to electrical energy. Many types of hydro power plants can be setup according to the generation capacity. Bangladesh has a wonderful climate for biogas production. Bangladesh has a lukewarm temperature varying from 6 0C to 400C which is quite beneficial for biogas production as the ideal temperature is around 350C [13]. An agricultural country like Bangladesh has plenty of biomass. Cow dung, agricultural residue, poultry dropping, water hyacinth, rice husk etc are available in a huge proportion. Therefore, Biogas plants are more effective in densely populated areas. Small wind turbines can be installed in the coastal area and off-shore islands of the country. Also micro hydro power plants can be installed in the north-eastern hilly regions and in the existing irrigation canal system with sufficient head. There are scopes of installing integrated small tidal power plants in the coastal areas.It is advantageous to install wind power plants in a less density area or in an open area. To know the available quantity of rice husk in a cluster, it is important to know the cluster size as well as paddy processing capacity of rice mills in that cluster. Few major clusters, their size and

average capacity of the mills of different clusters are tabulated as follows.

Table1. Total amount of paddy processed(MT/year) different cluster

Cluster	Annual paddy processed (MT)	Number of rice mills (surveyed)	Average paddy processed (MT)	Total number of rice mills	Total amount of paddy MT/year
Dinajpur	464480	100	4644.8	300	1393440
Naogaon	241062	134	1799.0	775	1394225
Bogra	156611	100	1566.1	110	172271
Nawabganj	91426	16	5714.1	16	91426
Ishwardi	120764	50	2415.3	50	120764

From surveyed data, average paddy processed in metric ton by a mill is found and thus total amount of paddy processed in each cluster is estimated. Quantity of rice husk is assumed as 20% of the amount of paddy and so annual husk production of these clusters would be like this. Due to use of traditional parboiling system with low efficiency, amount of rice husk consumption during parboiling process shows a great variation. This variation indicates that there is a scope of saving husk if improved and efficient boiler could be used. Maximum mills consume from 100 150 kg of rice husk per ton of paddy parboiling. On average, we assume 125 kg of rice husk is used for per ton of paddy parboiling. Most of the mechanical dryer at rice mills use 80-115 kg husks per ton of paddy drying. On average we can assume 97 kg husk is required for per ton paddy drying. We found that almost all (100%) rice mills in Naogaon and Ishwardi use sun drying. On the other hand 54%, 3% and 99% rice mills use mechanical drying in Dinajpur, Bogra, and Nawabganj respectively. The amount of surplus rice husk after parboiling and drying are shown in the following table. Finally we can say that power plant location is probably the first consideration that should be made and it should fulfill some requirements. Rice husk availability is the main criteria for these types of power plant. Then size of power plant and process for power generation should be kept in mind. If the investor plans to invest to produce energy in the area of Dinajpur, Naogaon, Bogra, Nawabganj, Ishwardi, it will be effective and affordable to use rice husk as fuel. Because rice husk grows in abundant in these regions comparing to other districts.

Table2. Use of rice husk for parboling and drying

Cluster	Available rice husk (MT/year)	Total number of rice mills	Kg husk/ton paddy for parboiling	Kg husk/ ton paddy for drying	Rice mills use mechanical drying (%)
Dinajpur	278688	300	125	97	54
Naogaon	278845	775	125	97	0
Bogra	34454	110	125	97	3
Nawabganj	18285	16	125	97	99
Ishwardi	24152	50	125	97	0

V. CONCLUSION For an ascending country like Bangladesh, prudent and judicious use of renewable resources is paramount. Rendering electricity to all the classes of people can ensure a felicitous and more comfortable life. Renewable energy, especially solar PV is getting popular to mitigate energy crisis. Mini Grid along with SHS can be much more efficacious and considered as a better solution to have the power with prime quality, reliability and sustainability.

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