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Non-conventional energy sources: practical applications

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Abstract— ***There are several commercial and government future mission plans to integrate renewable power assets and their potentials for use in Bangladesh, which are reviewed in this study. The need for energy in a developing country like Bangladesh may be on the rise. Nearly 70% of Bangladesh's population is unable to access electricity, with the majority of the population living in rural regions. Solar photovoltaic (PV) power is a well-known renewable energy resource, despite the fact that the world's biggest renewable energy plant uses hydroelectric power. Also widely recognised are wind, biogas, small hydro, and tidal. Bangladesh's government (GOB) has launched a plan to produce 5% of the country's total power from renewable resources by 2015, and 20% by 2020. The GOB is committed to facilitating public and private sector finance for renewable energy efforts to replace current non-renewable strength assets and boost contributions from renewable electricity principally based on technology via the allowed renewable strength coverage. In this context, a review of present renewable energy efforts is necessary, as well as an investigation of the resources' potentials. Some renewable energy sources can no longer be installed indiscriminately in every location because of certain characteristics to consider when selecting a source of RER. Investors who read this paper will get a wealth of information regarding the current state of Bangladesh's renewable energy sector, as well as a roadmap for the country's future engagement in these resources. Moreover, the information in this study might be helpful in identifying the most efficient sources of renewable power in a given location.***

renewable, biogas, rice husks, solar PV.

I. INTRODUCTION

Geographically, Bangladesh is between latitudes 20.840 and 26.8380 north and longitudes 88.8010 and 92.8410 east in northern South Asia. According to the United Nations, there are over 160 million people in the country, with an average population density of approximately 1050 people per square kilometre. Rural Bangladesh is home to 70% of the country's population, however they are severely limited in their access to power. Due to the high cost of grid extension in rural regions, efforts to promote the use of renewable energy sources have already begun. This study [3] examines the potential, trend, use, and technology of renewable energy, along with a discussion of the relevant policies, institutions, and prospects for sustainable development and climate change mitigation. This study [4] presents a current picture for renewable energy-related initiatives in Bangladesh.In addition, despite the severity of the crisis, Bangladesh's energy usage is lower than in other Asian nations. The government is forced to enter into long-term contracts at a significant expense and use short-term alternatives, such as acquiring rental power and tiny IPPs based on diesel or liquid fuel, in order to keep the residents' progress and welfare from being stifled. Bangladesh has one of the region's lowest per capita energy consumption rates. Compared to 530 kg oe in India, 510 kg oe in Pakistan, 340 kg oe in Nepal and 470 kg oe in Sri Lanka per capita energy consumption is 160 kg oe in Bangladesh [5]. In Asia, the typical household uses 640 kilowatt hours per year. As a result, it's become evident that Bangladesh boasts Asia's lowest per capita energy use. There is a long-term plan in place by the government to alleviate the financial difficulties caused by a crippled electricity supply. The plan has produced a balanced approach to the energy market's supply and demand dynamics. It is important to consider the possibility of energy trading with domestic possibilities. A key part of the approach would be to figure out what the government can do to diversify the sources of gas and electricity production and what other choices there are.

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II. **ENERGY DEMAND AND GENERATION CAPACITY SCENARIO AND FUTURE**

III. III. PROJECTS In Bangladesh, installed generating capacity (as of June 2014) was 10416 MW [2], with a maximum generation of 7500MW and an overall demand of 8500MW. Most of the energy comes from natural gas, with just 2.45 percent coming from hydropower, which is the sole renewable source [2]. IDCOL's SHS programme, on the other hand, has built solar home systems on the order of 3 million people. Their goal is to finance 6 million The SHS will be completed by year's end in 2016. Besides that, IDCOL has funded the construction of a 250-kilowatt biomass power plant in Gazipur, a 100-kilowatt photovoltaic (PV) and diesel-powered hybrid power plant in Sandwip, Chittagong, and a 400-kilowatt rice husk gasification power plant in Thakurgaon sadar, Thakurgaon, as well as a precipitated silica plant in Chilarong. Because of Bangladesh's rising poultry industry, it has been predicted that biogas technology would be the driving force in the future.

IV. III. REVIEW OF VARIOUS RENEWABLE ENERGY ACTIVITIES

A. Solar PV Application Solar photovoltaic (PV) systems are mostly used in Bangladesh's outlying regions. In 2003, IDCOL began the SHS initiative to provide off-grid rural Bangladesh with clean power. The government's goal of having universal access to electricity by 2021 is furthered by the implementation of this initiative. A hybrid microgird (with solar PV), a solar PV irrigation system, and grid-tied solar PV systems are also in use. These are outlined below..

***1) Solar Home System*:** The absence of energy in Bangladesh's off-grid locations makes it difficult to cook and light in these places. In rural regions, old-fashioned stoves and kerosene lighting are still widely used. The rural economy has grown more adaptable thanks to government interventions. As a low-cost option for illumination, solar power, especially SHS technology, has found favour with rural residents. The project has already led to the construction of more than 3 million SHSs in Bangladesh's rural off-grid districts [5]. As a result, almost 10 percent of Bangladesh's total population, or 13 million people, now have access to solar electricity. An estimated 220 MW of energy production capacity is expected to be generated by IDCOL's 6 million SHSs by 2017. 47 Partner Organizations are presently taking part in this effort (POs). IDCOL also provides essential technical assistance in the form of grants and money. SHS installation, credit expansion, and support with after-sales service are provided by POs. services. The IDCOL has received financial support from the World Bank, the Japan International Cooperation Agency, and other organisations [5]. SHSs have been installed at an average annual growth rate of 58 percent since the project was launched. The project has eliminated the need for 180,000 metric tonnes of kerosene per year, saving an estimated USD 225 million. More than 70,000 people are active in the programme in some capacity. In the field of off-grid renewable energy, one of the biggest and fastest-growing ventures [5] has received accolades for its plan. Companies have been forced to come up with innovative solutions to power their remote and off-grid BTSs because of the high fuel costs and the requirement for regular maintenance. It is becoming increasingly common for operators to use off-grid BTSs powered by solardiesel hybrid systems, which provides uninterrupted voice and data services. Renewable energy sources like solar PV and a diesel generator are used to power these systems. Up to now, IDCOL has financed 138 solar-diesel hybrid power systems in the telecom sector.

2) Solar PV based irrigation system: Total land area in Bangladesh is 14.76 million hectors, with 8.3 million hectors net cultivable and 7.56 million hectors irrigable. It is a nation that relies heavily on monsoon rain water for irrigation.

Another important technology for food security is the irrigation pump. Irrigation pumps that run on diesel need around 1 million tonnes of fuel each year, according to a recent analysis done by Bangladesh Agriculture Development Corporation (BADC). Bangladesh's agro-based economy relies heavily on the use of solar-powered irrigation systems. Solar panels and pumps powered by the sun are the foundation of this system. Pumps powered by diesel that were mostly used for irrigation in places where crops were grown three times a year were primarily replaced with solar pumps. Each solar pump will have an average capacity of 8 kWp and a head of 12-15 metres. A single pump will be able to cover an average of 13 hectors of paddy fields. According to this program's estimates, 18,700 irrigation pumps now powered by diesel will be swapped out for solar-powered alternatives. In this example, the total solar power capacity 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: Microgrids are used in several areas of Bangladesh when the national grid is not available to provide local electrical needs. Bangladesh is using a microgrid powered by a limited amount of diesel-based energy. There is a government initiative to develop many solar-powered microgrids. 30 distant locations have been selected for this program's first focus since they have no plans to expand their power grids in the next 15-20 years. On the basis of successful execution, additional locations will be selected for the development of solar micro grid systems. In addition to this component, a total of 25 MW of solar electricity will be generated. Quality power will be provided to isolated communities through a solar mini-grid, which will in turn assist the locals to earn more money, reducing poverty [3]. In addition to this, BPDB and REB have erected larger-sized solar PV installations around Bangladesh. Sandwip island in Chittagong now has a 100-kW solar photovoltaic (PV) microgrid constructed by PUROBI Green Energy Limited (PGEL). A 40-kW diesel generator has been added into the proposed power plant to ease the issue of low solar radiation [8]. Up to 50 solar mini-grid installations are planned by IDCOL by 2017. Projects supported by the World Bank (KfW), GPOBA (JICA), USAID, ADB, and DFID are receiving financial assistance.

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 energyKarnafuli Hydro Power Station is the only hydroelectric facility in Bangladesh, which is located around 50 kilometres from Chittagong. Currently, it can generate 230 MW of power using five separate units. BPDB is evaluating the operation and preparing to boost its output to as much as 330 MW in the near future. This country's micro-hydro power potential was examined by the Water Development Board (BWDB) and the BPDB jointly [4]. Two locations have been chosen for the construction of additional hydroelectric plants on the Sangu and Matamuhuri rivers. The Sangu Project and the Matamuhuri Project, each with a capacity of 140 MW and 75 MW, will be renamed. Micro-hydro power plant of 50 kW

has been been up at Barkal Upzila of Rangamati district in 2005. The Mohamaya Irrigation-cumHydro Power Project in Mirersorai, Chittagong, is one among the active projects. Rangamati district's Barkal Upazila is rehabilitating its 50 kW micro-hydro power plant.

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, Muhuri 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*:** Using ocean waves to create electricity reduces the amount of damaging greenhouse gas emissions that would otherwise be produced in the process of producing electricity. For Bangladesh, the Bay of Bengal is a great source of ocean wave energy because of its proximity to the country. Although ocean wave energy is mostly utilised for generating power, it may also be used to pump water and desalinate water. Using the Oscillating Water Column approach is both technically viable and appealing for this application. More than a dozen nations, including the United Kingdom (500 kW), Norway (100 kW), Ireland (3.5 MW), and India, are planning to build wave energy harvesting devices of this sort (150 kW). [10] Bangladesh has a great deal of potential for using the Bay of Bengal's wave energy.

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's northern areas have the potential to use the country's geothermal resources. With a capacity of 200 MW, Thakurgaon district's first geothermal power station in Saland is under construction [13]. Anglo MGH Energy, a Dhaka-based private corporation, has spearheaded this effort to increase the country's geothermal resources. The concept is to employ 28 deep tube wells to raise hot steam, which will be used to power a turbine and a generator, which will provide energy. According to the foregoing explanation on geothermal energy, Bangladesh has the ability to harvest electricity from this source as well..

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. Panels should be used in densely populated metropolitan regions where high-rise structures are abundant. Interconnected solar systems with battery storage are desirable in these regions. There is a need for high-efficiency solar panels and hybrid systems in areas with a high demand for electricity. Because of the high cost of interconnection per person, a standalone system is preferable in sparsely populated regions. To safeguard the PV panels from cyclones and to avoid chopping down any trees, special care must be taken when installing them in coastal areas. As a result, PV cells should be positioned with care, taking into account all relevant factors. The removal of above trees for the installation of solar PV along the seaside may have a negative impact on the ecosystem. When it comes to wind power, it's not always reliable. The speed of the wind varies throughout the day, depending on the weather, time of day, and location. The strongest and most consistent winds are found near agriculture; narrow mountain passes; and even the ocean, which is why wind farms are built there. Because of the direction of the wind, coastal regions are ideal locations for wind turbines. Wind farms, on the other hand, are unsuitable for places with high densities of people [11] [12]. The Ganges, the Brahmaputra, and the Meghna all run across Bangladesh's plain delta, giving the country its name. Divided between east and west regions, the Jamuna-Padma-Meghna river system produces an annual average water flow of 1.3 trillion cubic metres. The tributaries of these rivers may be found across the nation. Most rivers' flow rates are high during the monsoon, but they drop dramatically throughout the winter. In Bangladesh, hydropower production is restricted to a few places, including the southeast and the northeastern hills. There are, however, several tributaries, canals, and small waterfalls that might be used to generate hydroelectric power. The fluid's hydropower is turned to mechanical power, which is then transformed into electrical energy at the hydropower plant. Depending on the required generating capacity, a wide variety of hydroelectric power plants may be constructed. Bangladesh's climate is ideal for the generation of biogas. Climate in Bangladesh ranges from 6 degrees Celsius to 400 degrees Celsius, which is perfect for the generation of biogas. As an agricultural nation, Bangladesh has a large amount of biomass to work with. Farm waste, water hyacinth seedheads, and rice husk are just few of the materials that may be used to make **compost. So biogas plants are increasingly prevalent.** 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

Paddy processing per metric tonne is computed, and the total amount of paddy processed in each cluster may be estimated from this data point

forward. Estimated annual husk output from this clustered paddy is 20% of the total volume. Conventional methods of parboiling rice husk are inefficient, resulting in a large variation in the amount of rice husk needed. This discrepancy suggests that a more efficient boiler might save money. For every tonne of parboiled paddy, most mills employ 100 to 150 kg of rice husk. Average rice parboiling needs around 135 kg (125 kg) rice husks. Roughly 80-115 kilogrammes of rice husk are used in rice mill mechanical dryers for every tonne of dried paddy We may estimate that 97 kg of husk is required for every tonne of rice. Most rice mills in Naogaon and Ishwardi, Bangladesh, use the sun to dry their grain. When compared to this, just 3% of rice mills in Bogra and Nawabganj use mechanical drying, while 54% of rice mills in Dinajpur do so. Amounts of excess rice are being sold. This table shows the husk after parboiling and drying. Finally, we can state that the site of a power plant is perhaps the most important issue, and it must meet certain standards. The availability of rice husks is the primary criterion for these power plants. The size of the power plant and the technique for generating electricity must be considered. Using rice husk as a fuel in the areas of Dinajpur, Naogaon, Bogra, Nawabganj, and Ishwardi would be both cost-effective and efficient. Because of the abundance of rice husk in these areas, compared to other areas.

For drying and parboling, rice husks are an excellent choice.

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

V. CONCLUSION

The wise and intelligent use of renewable resources is critical for a developing nation like Bangladesh. In order to provide a happy and comfortable living, it is important to provide all individuals with access to power. Renewable energy, particularly solar PV, is becoming more popular as a way to alleviate the current problem in the energy sector. In order to get electricity of the highest possible quality, dependability, and long-term viability, a combination of Mini Grid and SHS might be deemed much more effective.

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