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RENEWABLE ENERGY SNAPSHOT AND PROSPECT IN BANGLADESH

Mohammad Uzzal Hossain Joardder[1], Md. Shazib Uddin[2], Barun Kumar Das[3], Omar Faroque[4]

[1,2,3]Department of Mechanical Engineering
Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh
[4]Department of Business Administration
Northern University, Rajshahi, Bangladesh
muhjoardder@gmail.com*, shazib0397@gmail.com, barun_ruet@yahoo.com, omar_ntcu@yahoo.com

Abstract*- This paper addresses the snap of renewable energy and the need for effective progress strategies linked with sustainable energy development along with prospect of renewable energy in Bangladesh. Our country is gifted with vast renewable energy resources such as biomass and solar. Approximately 73% of total energy demand of the country is supplied by local biomass based fuels. Bangladesh is endowed with abundant supplies of solar energy. Annually about 1.9 MWh energy is received per square meter of horizontal area in Bangladesh. Besides, hydro and wind as well as geothermal power can be considered as potential renewable energy resources. Karnafuli Hydro Station is the merely hydro energy power generation plant of the country that generates 230 MW. The annual wind speed at a height of 25m at some coastal locations is above 5 m/s and much higher in the pre-monsoon and monsoon periods.*

Keywords: Bangladesh, Renewable energy, Solar, Biomass, Prospect

1. INTRODUCTION

The standard of living and quality of life of a nation depend on its per capita energy consumption. Bangladesh is one of the poorest developing countries (147 out of 179 in the IDH rank established by the PNUD and 83% of the population living with less than $2 per day). Here per capita energy consumption in 2005 stands at 227 kgOE (kilograms of oil equivalent), which is much below the world average of 1778 kgOE. The energy consumption mix was estimated as: indigenous biomass 60%, indigenous natural gas 27.45%, and imported oil 11.89%, imported coal 0.44% and hydro 0.23% [1]. Bangladesh has one of the lowest per capita power generations (only 236 kWh) in the region and about 51% of its 155 million populations have no access to power. The government of Bangladesh has undertaken a master plan under the Vision-2021 to reach electricity facilities to every village of the country. Approximately 48,754 villages out of 87,372 villages have been brought under electricity facilities till April 2011[2]. Even then, the national power generation capacity is only 4500-4750 MW against a peak demand of 6000 MW. At the current rate of increase in consumption 10% annually [3]. The generation is predominantly depends on the indigenous natural gas accounting for about 88.39% of the generated power. Rest of the power is produced by Diesel, Hydro, Coal and so on. Primarily biomass and kerosene are used by majority of the households. Natural gas, LPG, electricity, kerosene and biomass fuels are used for cooking. In areas without natural gas and electricity, biomass is used to meet the household cooking needs. The cumulative efforts of exploration for oil and gas resources in Bangladesh has resulted in the discovery of 23 gas fields of various sizes producing 2000 mncft of natural gas . Currently, from our 5 discovered mines only Barapukuria Coal Mine is producing at this stage. In 2008 it produced about 0.8 million tones. The estimated reserves of coal are close to 3300 million tons, while the proven reserve is about 884 million tones [4]. The scope of hydropower generation is very limited in Bangladesh because of its plain lands, except in some hilly region in the northeast and southeast parts of the country. At present only 230MW of hydropower is utilized in Karnafuli hydro station through 5 units of Kaplan turbine [5]. Traditional energy sources, i.e., those that produce a substantial amount of the power currently used, include coal, oil, natural gas, hydropower, and nuclear fission.

2. RENEWABLE ENERGY RESOURCES AND TECHNOLOGIES PRACTICE

As already noted the high and rising price of oil and gas as well as their derivative fuels is a principal accelerant to search for alternative fuels. Moreover, Bangladesh relies heavily on fossil fuels for its energy especially on gas resources. But the present proven reserve would be depleted by 15-20 years [6]. Another motivation for this search lies in concerns about global warming, produced by increasing emissions of carbon dioxide during transportation, power generation and during manufacturing processes attendant to production of steel and cement, for examples. Bangladesh is endowed with vast renewable energy resources such as

biomass and solar insolation. Besides, hydro and wind power can be considered as potential renewable energy resources. Summary of renewable energy technology installation in harnessing these resources appears to be a promising solution for improving the quality of life of rural villagers. The government has set a target to raise renewable energy resources to 10 percent of total electricity by 2020.The government and many non-governmental organizations (NGOs) have tried to comprehend and have strived to address the problem of energy. This paper reviews the renewable energy resources and renewable energy technologies (RETs) practicing in Bangladesh in terms of its implementation, research and development activities.

2.1 Solar Power

Bangladesh is situated between 20 ^{o}13 $^{'}$40 $^{''}$ to 26 ^{o}13 $^{'}$80 $^{''}$ degrees north latitude and 88 ^{o}10 $^{'}$10 $^{''}$ to 92 ^{o}14 $^{'}$10 $^{''}$ degrees east, which is an ideal location for solar energy utilization. Daily average solar radiation varies between 4 and 6.5kWh/m^2. Maximum amount of radiation is available on the month of March–April and minimum on December–January. Out of 365 days we have 340 to 345 days of sunshine; even if it is raining we have sunshine in between the rains [1].

2.1.1. Technologies Practice for Solar Energy

2.1.1.1 Solar Photovoltaic (PV)

Despite of large potential of solar system in Bangladesh, utilization of solar energy has been limited to traditional uses such as crop and fish drying in the open sun. Solar PV are gaining acceptance for providing electricity to households and small businesses in rural areas. In 1988, Bangladesh Atomic Energy Commission (BAEC) installed several pilot PV systems. Since 1996, penetration of SHSs (Solar home System) increased rapidly, mainly due to the efforts of Grameen Shakti, which sells PV systems on credit to rural households through its extensive network. Several other NGOs such as CMES and BRAC are also engaged in promoting PV technology [7]. It is noted that the cost of solar power has decreased about 60% from 1991 to 2003 and decrease about 47% from 2006 to 2010. It is very important to look at the success of Solar Home System based on micro-financing from IDCOL. Over 500000 Solar Home Systems have been installed in rural villages and demand is growing; and installing over 20000 Solar Home Systems per month and this will double and triple within next few years [8].

2.1.1.2 Solar Power Seen as Alternative Energy Source for Irrigation

Adequacy of sunshine in our country makes the solar power eligible for agriculture irrigation especially for the boro crop as it is harvested during dry season. Bangladesh presently has 1100000 shallow tube-wells, out of which 903000 is diesel driven while the rest 197000 electricity-run. In order to make the farmers independent of price increase of diesel, as well as to tide over the scarcity of diesel, there is a good opportunity to provide irrigation through solar powered system. On the other hand, the price of solar pump along with solar panel is about TK 4 to 0.6 million which has a life of 15 years. A farmer holding 16 acre of land spends Tk 75,000 per year for irrigation, therefore, simple payback period is roughly 6.3 years whereas the life of the solar pumps is 15 years Waste Concern, Rahimafrooz Bangladesh, install solar pump through non-government organization [9].

2.1.1.3 Mini –Grid Power Plant

Grid electrification is essential for economic development in Bangladesh. There are more than 87,000 villages in Bangladesh and most of them are not connected to the national grid PV grid electricity generation system could be effective to extend the grid connection and available power for all. A study examines the feasibility of PV grid system for 500 kW generation plant has found that the per unit electricity production cost from the studied system is cost-competitive with grid-connected diesel power generation which is around 15-18 BDT [10]. If clean development mechanisms, carbon tax, and oil price increase are considered, the unit cost would be lower than the grid connected diesel power generation. Nation's first solar mini grid is now fully operational in the remote island of Sandwip. This is the first solar mini grid of this technology and capacity in the region. The power plant constitutes of the 100 kW solar park connected to the inverter system that allows direct use of 220V AC power at day time from the three phase line of the mini grid [11]. A solar mini-grid of 25 kW capacity will generate electricity for 4.5 hours and produce 113 kWh electricity that finally reduce demand for 82 GWh (GigaWatt) of electricity from the national grid per year [8]. Besides, the government plans to implement a megaproject of setting up 500MW solar panel based power installations with financial support of the Asian Development Bank (ADB) [12].

2.1.1.4 Solar Thermal Technologies

The solar thermal technologies that are of interest in Asia is solar hot water systems, solar dryers and solar cookers. While solar water heaters for hotels and hospitals could bring down electrical loads, solar cookers should conserve biomass and solar dryers would be useful for drying timber, paddy, fruits and vegetables with benign environmental effects. Only BRAC has propagated this technology in the field by installing 260 Hot Box cookers. The NGO has a future plan to install more 5000 Hot Box cookers all over the country [12].

2.1.2 R&D Activities and Further Initiatives have to Take in the Field of Solar Energy

There are seven public Technical Universities and three large research centers in Bangladesh, where feasibility studies and innovative research works in the field of RETs may be carried out for available renewable energy resources. They have technically sound human resource but lack of sufficient financial support. Some R&D activities in various fields of RETs have been carrying out in these Universities, research centers and in some NGOs. The following initiatives may accelerate the future solar benefits.

a. The technical durability of SHS in rural areas of Bangladesh requires further improvements of SHS quality and services
b. In regard of solar pumping system, the government can come forward with financial package for the farmers to transfer all shallow pumps into solar ones to save the electricity and consumption of fuel.
c. Due to the high initial investment cost of PV grid system, there should be favorable policies for this sector. These should first set a target for renewable energy deployment and use instruments to achieve such target. The instruments that can be applied to encourage renewable energy technologies promotion are incentives, consumer credit schemes, capacity building and to establish a renewable energy service company
d. Although R&D activities show viability of solar thermal devices, these have not found applications in the public or private sector.
e. Suitable incentives are essential to make such applications attractive. Suitable policies and mechanisms are yet to be developed for increasing efficiency of every use in different sectors.

2.2 Biomass

Renewable energy in the form of traditional biomass is the main source of primary energy in the country comprising some 35-60% percent of total primary energy use [13]. Approximately 40% of the world's population depended on biomass energy [14]. Biomass resources include various natural and derived materials mainly categorized as agricultural residues, wood and wood wastes, animal dung, municipal solid wastes. —that can be used as an energy source. Biomass is probably our oldest source of energy after the sun.

2.2.1 Biomass Energy Technologies

Traditional biomass energy is a local energy source, which is readily available to meet the energy needs of a significant proportion of the population – particularly the poor in rural areas of the developing world. Traditional biomass energy is low cost and it does not require processing before use [15]. Traditional biomass use, however, has significant drawbacks. The indoor air pollution from unvented bio-fuel cooking stoves is linked to respiratory diseases in many highland areas of developing countries [16]. Smaller-scale applications of modern biomass energy technologies still face numerous challenges particularly at the level of cost-competitiveness (although many argue that this is due to an absence of a level playing field [17].

2.2.1.1 Improved Cooking Stoves

Improved biomass technologies contribute to more efficient and environmentally sound use of biomass energy. Improved cook stoves, for instance, are designed to reduce heat loss, decrease indoor air pollution, increase combustion efficiency and attain a higher heat transfer [18]. which utensils rest. The efficiency of the traditional stoves for biomass fuel is between 5% and 10%, emitting greenhouse gases, have risk of firing, create health hazard in kitchen. Institute of Fuel Research and Development (IFRD) of Bangladesh Council of Science and Industrial Research (BCSIR) have been carrying out research on improved stoves for a long time. Their improved household stove is claimed to save 40–60% fuel compared to traditional ones. There are about 0.2 million improved stoves in operation, but they are not being regularly used [19]. Improved use of biomass in households, institutions and industries leads to reduced fuel consumption, faster processing, improved product quality and products with better shelf life [20].

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2.2.1.2 Biogas Plant

An agriculture-based country like Bangladesh has huge potentials for utilizing biogas technologies. The government and NGOs work together in this concern. LGED installed 4 KW Power Generation Plant at Faridpur Muslim Mission [21]. A 10 KW Project of Advance Animal Science Co. Ltd under German Technical Cooperation at Kashimpur (nearby Latifpur Village), Gazipur has been built. Another 50 KW ongoing Project of Infrastructure Development Company Limited (IDCOL) at Trishal, Mymensingh based on the Biogas produced from the Poultry Farm having 30,000 birds. Recently the Netherlands Development Corporation is starting a national program to set up 36,450 biogas plants. GTZ in collaboration with BCAS has recently completed a feasibility study to promote biogas plants in commercial poultry farms. The study findings are:

1. Over 25,000 fixed dome biogas plants have been installed in Bangladesh.
2. There are already more than 2000 poultry-based biogas plants.
3. Poultry farms are emitting bad smell, biogas technology is a solution.
4. Presently, litter is sun dried and sold at low price.
5. Slurry is a good fertilizer, it is sold at prices between 0.7–3 TK/kg.

It appears that poultry biogas plants of moderate and larger sizes are financially viable. For heat purposes moderate size farm is suitable. Larger size farms could also produce electricity. Such studies should be undertaken in commercial biogas plants based on livestock and other wastes. There is a huge potential for commercial biogas plant for other uses.

2.2.1.3 Biomass Briquetting

Biomass briquetting is now an established technology with local manufacturing capability in Bangladesh. In Bangladesh the activities on the subject started in early 1980s by importing two machines from abroad. In a robust calculation it is found that more than 15,000 briquette machines can run with the existing bio residues but at present only about 1000 machines are working in Bangladesh. Recently BRRI has made briquettes from rice husk and use them as fuel for heating purposes in their laboratory and got 20% better efficiency. They plan to use them in various rice mills for parboiling [22].

2.2.1.4 Gasification and Pyrolysis of Organic Solid Wastes.

Another established biomass energy technology is gasification. Presently there is no gasifier operating in Bangladesh. Whereas, there are several units of gasifier are running in the region viz. India, Thailand etc. Therefore, the experience from the region could be used for commissioning gasifier technology in Bangladesh [23]. Gasification could be better technology for the development of rice husk energy in to gaseous form [24]. Over four million tones rice husk produces from these rice mills and four million tonnes of rice husk could produce a little over about 400 MW of capacity of electricity. Besides, feasibility study of pyrolysis for production of alternative liquid fuel from organic solid wastes (scrape tyre, waste plastic, municipal solid wastes and lignocellulosic materials) may be carried out in Bangladesh. Some research work in the field has been continuing in Rajshahi University of Engineering and Technology (RUET) since 2000.A study proposes that the medium commercial scale plant using waste material is favorable, with better techno-economics. If the proposed plants would be established in the country, annual import bills will reduce for 29400 tons (205000 barrels) of oils, and 22400 tons of coal. Moreover, a big amount of hazardous waste (used tires) would be managed properly [25].

2.2.2 Further Steps in Biomass Arena

Research activities an in the field of biomass Improved Biomass Technology (ITB) has yet to be attained, there are a number of options that have been analyzed by leading biomass energy experts and that could provide an embryonic base for broad national, regional and global IBTs initiatives. Notable options that could be considered for implementation by policy makers in Bangladesh and respective partners, include:

- Setting targets, which include identifying and setting goals for the incremental contribution of improved biomass energy to total energy supply. The targets should preferably include financial commitments by governments and development partners.
- Introduction of new and innovative financing mechanisms, e.g. allocating a proportion of available energy subsidies (for example levies on electricity and petroleum) to the adaptation and wide scale dissemination of improved biomass energy technologies.
- Further research on the reasons for the relatively low dissemination of improved biomass technologies, with the aim of overcoming these barriers and speeding up uptake.

2.3 Hydropower

The scope of hydropower generation is very limited in Bangladesh because of its plain lands, except in some hilly region in the northeast and southeast parts of the country. Bangladesh is a reverie country with three main rivers: Padma, Brahmaputra and Meghna. 1.35 trillion m^3 of water flows through the country in an average water year. Numerous rivers flow across the country, which are mostly tributaries of these main rivers. Out of these, 57 rivers are Tran boundary, which originate from India and Myanmar. Apart from the south-eastern region, other parts of the country are mostly flat in nature. Major rivers of the country have high flow rate for about 5–6 months during monsoon season, which is substantially reduced during winter. More than 90% of Bangladesh's rivers originate outside the country, due to which proper planning of water resources is difficult without neighboring countries cooperation. At present only 230MW of hydropower is utilized in Karnafuli hydro station through 5 units of Kaplan turbine (3x50MW+2x40MW = 230MW), which the only hydroelectric power plant operated by Bangladesh Power Development Board (BPDP). BPDB is considering extension of Karnafuli hydro station to add another 100MW capacity (2x50MW = 100 MW). The additional energy will be generated during the rainy season when most of the year water is spilled. Apart from Kaptai, two other prospective sites for hydropower generation at Sangu and Matamuhuri River are identified by BPDB [26].

2.4 Wind Energy

Wind energy is the fastest growing renewable enrgy source in the world. It is the cheapest amongst all the renewable energy sources available in the global market, but in the Total wind power generation in Bangladesh is reported as 50kW [27]. It is almost 0.001% of total installed power plant of Bangladesh Studies show that some the coastal inlands and off-shore islands of Bangladesh should be fairly potential for small scale wind energy system [28].

2.4.1 Water Pumping Windmills

Local Government Engineering Department (LGED) has designed and manufactured low cost wind pumps with a rated capacity of 20,000 l of water per day at 4.0 m/s wind speed. Six such prototypes are already installed at different parts of the country. It has installed four water-pumping windmills in year of 1999. Two water-pumping windmills in year of 1999 and one wind–solar hybrid system in the year of 2000 have been installed under SRE project. BRAC has installed 10 wind turbines for water pumping. It has also installed 6 PV–wind hybrid systems. Bangladesh Army (BA) has also installed 1 windmill in Chittagong Hill Tracts.

2.4.2 A Glowing Prospect of Wind Energy

Wind energy utilization in Bangladesh is in the early stage of application. Recent study and analysis on wind energy assessment in Bangladesh show that some of the coastal areas are fairly potential for small scale wind electricity generation system. Wind speed varies from 4m/s to 5.5 m/s at the height between 25m to 50m. Maximum wind power density was in Kuakata (88kW/m2) at height 30m and minimum in Khagrachari (13kW/m2) at a height of 10m [29]. This wind speed is technically feasible, economically viable and socially acceptable in for the development of wind farms. Bangladesh has 740 km long (straight line) coastal belt facing the Bay of Bengal. If we use only 5% of the coastal areas (up to 10 km to the inland), and if we install

the 2.5 MW size wind turbines, the total gross potentials of wind power is more than 25000 MW. Wind energy is getting cheaper and competitive with the fossil fuels day by day. If we assume only 25% Plant Load Factor (PLF) of the wind power plants, then total energy generation potential is 54750 GWh per year. It is calculated by the financial/ economic analysis that 1 KWh of electricity can add value of TK. 30.00 to the GDP. So, the prospects of contribution of wind electricity to our national GDP may go up to TK 164250 crores per year [30].

2.5 Tidal Energy Resource Potential

A demonstration tidal power project is being planned in Sandwip, one of the coastal island of Bangladesh, by ISTP of Murdoch University, Australia. ISTP has developed a feasibility plan for rebuilding a recently damaged sluice gate with a trial paddle wheel [31]. If become successful, the tidal project of Sandwip can be replicated in the other coastal areas and which will usher new light in the region.

2.6. Geothermal Prospect

A private company has planned to set up Bangladesh's first geothermal power plant with a capacity to produce 200 MW.Anglo MGH Energy said it has sought government approval to establish the plant at Salandar village in the impoverished northern district of Thakurgain. The company has done primary feasibility studies on the plan and will conduct a final one shortly on a span of 3555 hectares of land to select the spot for the plant The company has secured favorable opinions from the Geological Survey of Bangladesh, the Ministry of Water Resources and the Ministry of Environment and Forest [32].

3. DISCUSSIONS

3.1. Benefits of RETs: Bangladesh Perspective

It is difficult to assess full impact of renewable energy in the country both socio-economically and environmentally. In the subsequent sections, different socio-economic benefits are described briefly.

1. Reduction in electricity transmission and distribution cost
2. Opportunity for saving foreign currency
3. Improved facilities for social activities
4. Creation of better environment for rural education
5. RETs are up to three times more employment-intensive than fossil fuel or nuclear power plants.
6. Improved facilities for rural health center
7. Solution of drinking water in remote islands
8. Development of rural women life style as well as safe environment

3.2. Issues and Barriers

It is evident that like many other countries in the South Asian Region Bangladesh has already initiated promotion of RETs systems. However the penetration levels and deployments differ from other countries, with India having extensive experience in almost all type of RETs and promotional models. The barriers, which are affecting full realization of the RETs potential, could be broadly categorized into:

1. Policy and Regulatory: The lack of clear, long-term and consistent policy is the major issue in Bangladesh. With lack of strong RETs policy, based on proper resource assessment and planning, various RETs initiatives seems adhoc and intermittent and thus fail to become part of overall mainstream energy planning at government level.

2. Financial: The high initial cost of RETs is a barrier especially in the developing countries where income levels are low. The issue of providing subsidies, to address the issue of high initial cost, have been discussed at various levels, including its impact on the market. Suitable/sufficient subsidies are essential in order to make RETs affordable to the users. However in the absence of mechanisms for effectively targeting them, these act as barriers. The high costs of these technologies result in lower rates of returns, though on lifecycle basis these technologies are viable.

3. Institutional: Renewable energy based provision of modern energy services is dealt with by various ministries, agencies and institutions, making good coordination between them a necessity to efficiently make use of limited human and financial resources in the country. There is provision lengthy and difficult process for permission. Dependency on the national budget for implementation of activities, which creates uncertainties in allocation of project financing as well as time delays associated with decision-making. Limited spatial distribution of suppliers limits access to RETs.

4. Technical: There is a lack of standards and quality control for renewable energy equipment. We have a great lacking of domestic manufacturing. Bulk procurement of RETs is limited due to the current small market for renewable energy based modern energy services.

5. Information: Lack of accurate resource, technical/economic information about RETs, equipment suppliers, and potential financiers is a barrier in Bangladesh. The absence of precise resource data limits the inclusion of RETs in the planning process and designing of specific promotional programs.

4. CONCLUSIONS

Dissemination of biomass and solar energy throughout the country should be first priority in solving our energy crisis. There is no way other than taking bio and solar energy for reducing environmental degradation. Scientists of the world are now seeking energy solution from the two resources, which are highly available in the country. By generating biomass and solar energy from our abundance sources we can solve a big portion of energy deficiency.

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