Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2019
(ICMERE2019) 11 – 13 December, 2019, Chittagong, Bangladesh

ICMERE2019-PI-070

CURRENT STATUS OF RENEWABLE ENERGY IN BANGLADESH: OPPORTUNITIES AND CHALLENGES

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Abstract: Energy is indispensable in modern world and is one of the most important elements of socio-economic development. Renew ability of energy and harnessing these renewable sources can be considered as key factors to this development. Bangladesh as an economy is now in its "ignition phase" and energy has been reported as a critical concern for the nation. The country's current average production hovers between 6,500MW to 11,500MW while the power-generation capacity stands at 20,420MW. The government, according to the Renewable Energy Policy 2008, had a plan to achieve 5% power generation from renewable sources by 2015, and the amount was supposed as twice by 2020. Unfortunately, it is currently generating around 560 MW of electricity from renewables, which is just 2.95% of total power generation. Itwillbechallenging producing 2000 MW of power which is almost 10% of the total power within two years. This also implies there is a huge lag between where we want to be in just 2 or 3 more years, and where we are now. To ameliorate the present situation in a rapid pace within the shortest possible time, we are badly in need of some new ways of implementing and improving renewable energy technologies to make things positive. This paper presents a precis of renewable energy resources of Bangladesh and the current status of various renewable energy technologies (RETs) such as hydro energy, solar power, wind energy, bioenergy etc. It highlights the opportunities and challenges for the development of RETs in Bangladesh. This paper also delineates some recommendations for the promotion, development and implementation of RETs in the country.

Key words: Renewability, renewable energy, hydro energy, solar power.

INTRODUCTION

The status of living and quality of life of a country depend on its per capita energy consumption. Bangladesh is one of the poorest developing countries (139 out of 188 in the IDH rank established by the PNUD with a per capita gross national income of $1,909) [1, 2]. Here per capita energy consumption in 2014 stands at 222.22 kgOE (kilograms of oil equivalent), which is much below the world average of 1778 kgOE. Bangladesh has become one of the developing nations recently by making a remarkable progress in access to electricity as its electrification coverage reached 95 percent at the end of 2018 [3]. The government of Bangladesh has undertaken a master plan under the Vision-2021 to reach electricity facilities to every village of the country. As of 2015, the country's 67 per cent villages have come under power coverage and it is now at around 72 percent. The government is expected to ensure 100 per cent electrification to all villages in the country by December this year. The power sector in Bangladesh depends highly on fossil fuels, as natural gas and coal are the dominating sources for electricity generation in the country. About 62.9% of Bangladeshi generated electricity comes from natural gas, while 10% is from diesel, 5% comes from coal, 3% of heavy oil, and 3.3% is of renewable sources [4]. The cumulative efforts of exploration for oil and gas resources in Bangladesh has resulted in the discovery of 26 gas fields of various sizes reserving 35 billion cft of natural gas. Bangladesh produces 2.71 billion cft natural gas a day against a demand of 3.4 billion. A little over 58 percent of the gas goes to the power plants, 17 percent in factories, 11 percent for household, 7 percent in fertilizer manufacturing units and another 6 percent for automobiles. To meet the increasing demand, Bangladesh has decided to import liquefied natural gas or LNG and has already started construction of terminals [5]. The scope of hydropower generation is very narrow 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 [6].

2. CURRENT ENERGY SCENARIO

2.1 SOLAR ENERGY

Amongst various sources of renewable energy, solar energy is one of the most viable options for Bangladesh as it has high daily average solar radiation levels ranging from 4-6.5 kWh/m^2 [6]. The Government of Bangladesh has made some progress in tapping solar energy by successfully disseminating solar home systems (SHS) throughout the country, providing electricity to people in remote off-grid areas. However, the contribution of SHS to the total amount of power generated in the country is

extremely low. Moreover, the on-grid solar power generation capacity, currently at almost 47.5 MW has been growing at a very slow pace due to certain challenges like land availability, high initial investment required etc [7].

Table 1: Progress of electricity coverage in Bangladesh due to the increase in the use of renewable energy

Item	2014	2016	2018
Power Generation Capacity (MW)	10,213	15,755	17,060
Access to Electricity	62%	77%	79%
Distribution Line (ckt. Km)	9,322	10,436	15,665
Transmission Line (km)	288,787	341,000	341,000
Per Capita Power Generation (kWh)	321	371	460
No. of Consumers	1,420,000	2,526,594	3,126,594
Average System Loss	10%	14%	15%

The Government of Bangladesh has outlined a target to install 1.7 GW of solar capacity by 2021 through the solar home systems (SHS) program and on-grid solar power plants [8]. Bangladesh has been successful in developing off-grid rooftop solar power (solar home systems), however, it needs to ramp up the development of on-grid large scale solar power plants in order to achieve the target. Presently, the country's solar power capacity is largely dominated by off-grid projects accounting for nearly 86% of the total installed solar capacity [9]. We can take a look on the table 1 to find out the increase in electricity coverage for the last few years in Bangladesh.

2.1.1 SOLAR COOKING

A solar cooker is a device that uses sunlight to produce heat in order to cook food. Solar cooking is the cleanest and safest mode of cooking. It utilizes solar energy which is abundantly available in nature to cook food. There are several advantages of implementing a countrywide solar cooking practice:

- Reduction of Deforestation: In Bangladesh, 40 million tons of firewood is burnt for cooking causing air pollution. Solar cooking neither produces smoke nor involves cutting down of trees.
- Reduction of GHG emission: By burning 1000kg of firewood, 1900g of carbon dioxide gas is released into the atmosphere. Burning of 1000 cubic feet of natural gas produces 55,622.38 g of carbon dioxide. As previously mentioned, solar cooking does not emit any greenhouse gas.

Despite the many advantages that solar cooking can bring about in the lives of Bangladeshi people, there are several obstacles to successful deployment of solar cookers over a countrywide range. The obstacles are discussed below:

- Lack of flexibility: Solar cooking can be done only in the presence of sun and with necessary solar insolation Moreover; solar cooing takes longer to cook food than conventional methods.
- Limited Access to Sunlight: Although rural people in Bangladesh may still get plenty of sunlight for cooking, very few residents of the city area have access to sunlight for solar cooking purpose [10].

2.1.2 SOLAR IRRIGATION PUMPS

In the remote off-grid areas of Bangladesh, the amount of irrigation pumps powered by diesel is excessively high. The price volatility and difficult transportation method of diesel undoubtedly make it taxing for the farmers. The Government of Bangladesh has been trying to address the issue recently by showing sincere inclination towards sustainable agriculture via promoting the use of solar powered irrigation pumps. IDCOL has already started implementing solar irrigation pump projects in many areas and aims to install 50,000 such systems by 2025. However, solar irrigation pump systems tend to remain under-utilized over a significant portion of a year, especially during lengthy monsoon season. If arrangements can be made to supply electricity from these systems into the national grid during off-season, path will open up to exploit the untapped potential. Simultaneously, the Government envisions providing access to clean, affordable and grid-quality electricity to all its citizens by 2021, which is manifested by the effort invested in expanding the national grid. Thus it is very likely that both technical and financial challenges of integrating this huge number of off-grid solar irrigation pump systems will emerge in recent future.

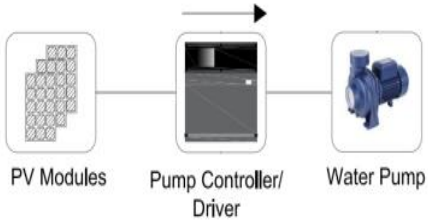

Fig. 1: Schematic diagram of existing SIP systems installed by IDCOL

Even though IDCOL has the largest share of SIP installation throughout the country, there are other government organizations that are acting as implementing agencies; e.g., BREB, BADC, BMDA etc. REB has implemented 2 solar irrigation pump projects. The details are presented in Table 2.

Table 2: REB implemented SIP project summary

2.1.3 SOLAR POWER DRINKING WATER

Three out of 10 people worldwide do not have access to potable water - according to the UN World Water Development Report 2019. The solar-powered water system is one of eight new networks jointly completed by UNHCR, the UN Refugee Agency, OXFAM, Médecins Sans Frontières and Bangladeshi non-governmental agency BRAC, which have been installed in the last half year, supplying a total of 40,000 people across the site. There are plans to install another 10 networks in the coming year, which will benefit 80,000 more refugees.

Project Title/ Parameter	Solar Power Irrigation Pump as well as Power Management and Distribution System to mitigate Energy Crisis and Climate Change	Solar Powered Irrigation Pump and Solar Home System
Funding Source	Climate Change Trust Fund (GoB) 100% as grant	KOICA and GoB
Project Period	April 2010 to June 2012	July 2011 to June 2013
Target	20 SIP and 300 connections	20 SIP and 1250 SHS
Pump Capacity (HP)	5	5
Type of Pump	Submersible DC	Submersible,3 phase AC
PV module capacity (kWp)	6.72 or 7.2	5.16
Water discharge capacity (Lac L/d)	1-1.5	1-1.5

The systems run entirely on electricity generated through solar panels. Motorized pumps draw water from deep boreholes to newly-installed 70,000-litre tanks where chlorine kills bacteria and other harmful microbes. It is then piped to collective water points strategically installed throughout the site. More than 900,000 Rohingya refugees are living across 34 different locations in Cox's Bazar, Bangladesh. Additionally, UNHCR and Oxfam earlier this year put into service the biggest human waste treatment facility ever built in a refugee settlement. The plant is able to process the waste of 150,000 people. In most locations, water is scarce. In the dry season, often the only solution is water trucking, which is very costly. It has been challenging to secure adequate water sources for the whole refugee population. UNHCR and its partners aim to provide 20 litres of chlorinated water per day to every individual refugee – ensuring safe water for all. Chlorinating water helps in maintaining safe water and eliminates any risk of spread of disease which can be considered as one of the fundamental steps to delivery service to the refugees [11].

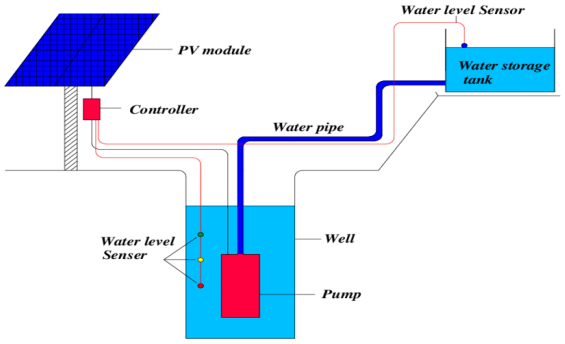

Fig. 3: Schematic diagram of Solar powered water pumping system

2.1.4 LIMITATIONS AND FURTHER ASPECTS IN SOLAR FIELD

The initial cost of purchasing a solar system is high enough as it includes solar panel, battery, inverter, wiring for the installation. Besides, a solar system requires a huge space to be installed and an empty space without the access solar radiation wouldn't be preferred. During the manufacturing process, some hazardous and toxic substances can be emitted which is admonishing for the people of that area. Moreover, One of the primary limitations of solar cell is it's not having any suitable storage. So, people must use the energy at day time and it certainly depends on weather conditions also. The following initiatives may accelerate the future solar benefits.

- Research on increase in its efficiency would help a lot in amplifying the use of renewable energy.
- Several tariff methods should be launched and different agencies should provide some facilities in case of the high initial payment for a solar cell.
- Introduction of thin film solar cell and 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.
- Though observations show the viability of solar thermal devices, it is not thoroughly used in private or public sphere.
- If the solar power can be stored for a certain period, then dependence on non-renewable energy will sharply decline, in some cases, it may be zero.

2.2 Wind Energy

Wind energy is a renewable which can be harnessed by the means of a turbine or a fan which converts winds velocity to mechanical energy which is eventually then converted into electric energy. Since Bangladesh occupies hilly areas in the north eastern and south western part and the bay of bengal is situated in the southern part of the country, Bangladesh has a lot of potential to harness the wind energy and ameliorate the energy crisis it faces right now.

2.2.1 Bangladesh Wind Potential Scenario

Bangladesh consists of 724 km coastal line and several islands which is visited by monsoon winds form Indian Ocean [12]. At a height of 30m the annual average wind speed is more than 5m/s [13]. In the month June-July the

winds speed is greater and is comparatively low in the month October-February. Wind speed is found more than 4.5m/s in the north-eastern zone and around 3.5m/s in rest of the country [13, 14].

Windmills with capacity of 2 MW are already in operation in the coastal areas of Bangladesh and a project has been taken by the government to increase the capacity to 20 MW [15]. The feasibility of wind condition in some area of Bangladesh is shown in table 3.

Table 3: Feasibility of Wind Conditions at Different Places [17].

Site	Reference height (m)	Annual average wind speed(m/s)
Teknaf	5	2.16
Cox's Bazar	10	2.42
Patenga	5	2.45
Kutubdia Island	6	2.09
Sandip Island	5	2.16
Hatia Island	6	2.08
Bhola Island	7	2.44
Khepupara	10	2.36
Comilla Airport	6	2.21

Table 4: Wind turbine (all are in Functioning) installations in Bangladesh by different organizations [18].

Organization Name	Installed Capacity (watt)	Location
Grameen Shakti	4500 7500	Grameen offices in coastal region Cyclone shelter in the coastal region
BRAC	5220	Coastal region
Bangladesh Army	400	Chittagong Hill Tracts
IFDR	1100 600	Teknaf Meghnaghat
LGED	400	Kuakata
Total	19720	

Muhuri Dam area of Sonagazi in Feni produced 900 KW and WIND Battery Hybridy Power Plant at Kutubdia Island produced 1000 KW; a total of 19.2 KW was installed by Grameen Shakti, Bangladesh Center for Advanced Studies (BCAS), BRAC, Bangladesh Army, IFRD [19]. Bangladesh has the world's longest coastal belt of around 724 km in the line of Bay of Bengal and it's been noted that electrification from wind turbines in Bangladesh requires more techno-economic assessment [20]. 22 sites for wind power generation and onshore Wind Power Plants along the coastline of coastal regions of Bangladesh was identified by BPDB recently, moreover, a 15 MW Wind Power Plant in Muhuri Dam Area of Feni, Mognamaghat of Cox's Bazar, Parky Beach of Anwara in Chittagong, Kepupara of Borguna and Kuakata of Patuakhali, a 50-200 MW wind generations plants Anawara in Chittagong area has been planned by BPDB [19].

2.3 Hydro Energy

Hydroelectricity is a natural renewable source of power and water is utilized for the production of electricity by converting water head into kinetic energy in which the turbine propeller is rotated using water flow [21]. Many developed and developing country use hydro power as a good energy source. Some countries like Bhutan, Norway and Paraguay produce all their commercial electricity from hydro power. It has little or no environmental hazard. More electricity can be produced using turbine and generator if a water source has more velocity [22].

Hydropower plants can be classified into two categories [17].

(a) Large hydropower plants (0.10 MW)
(b) Micro hydropower plants (10 MW)

2.3.1 Hydro Energy Scenario in Bangladesh

During rainy monsoons, most of the rivers in Bangladesh flows with a high capacity of water. With a combination of 5 units, Kaptai, Karnaphuli in Rangamati district is the only running hydropower plants running in Bangladesh with a capacity of generate 230 MW electricity [18]. This plant is one of the large hydropower plants operated by Bangladesh Power Development Board (BPDB) which established in 1960s [12,24]. Besides two large hydropower plants are underway:

(i) Sangu Power Plant: It will be in Sangu river and its capacity will be 140 MW with annual energy is about 300 GWh per year [27].
(ii) (ii) Matamuhuri Power plant: This project will be in Matamuhuri river and its capacity will be 75 MW with average annual energy 200 GWh per year [22].

The power generation can be calculated by the following formula [25].

$p = n\rho QgH$ (in KW)

Where, P = net power generated in KW
H = Gross Water head in meter
Q = water flow rate in m^3/sec
g = gravitational force, 9.803 ms^{-2}

Moreover, Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazar regions has a tidal rise and fall remain between 2m to 5m and can use this tidal force to produce electricity [26].

Table 6: Proposed future hydro-energy projects in Bangladesh

Name of the river	Potential of Electrical Energy (MW)
Kaptai	100
Shangu	100
Matamuhuri	100
Mohamaya	23-65
Lohajari	4.5

Compared to world hydroelectricity production rate Bangladesh is lagging way behind and at the end of 2014 were 879.0 MTOE which is 2.0% increment and lower than the last two years; below the 10 years average of

3.3% [21]. Total consumption of hydroelectricity around the world in 2014 was 406.83% and China was the highest (27.4% of global share) [23]. Whereas in Bangladesh the production capacity of hydroelectricity in 2014 was 230MW and global sharing is very negligible. Table 6 represents the proposed hydroelectricity project [23].

3. BENEFITS OF RENEWABLE ENERGY TECHNOLOGIES

Renewable energy technologies (RETs) have already made a large impact on the life of rural people of Bangladesh. It is now playing a great role behind the widespread use of solar, wind, hydro and other renewable energy resources. The remote areas of the country are under electricity coverage due to these technologies. It has been a blessing for the poor people of the country as they can be an user of some modern technologies by the help of some volunteering agencies. It can be considered as a great solution to the drinking water problem in remote islands or villages. The Saintmartin Island may be a good example of these RETs application as the people from this area are using solar panel for many important tasks including cooking, providing electricity etc. RETs provide facilities to rural health centers as well as develop the quality of living of the rural people. Though there produces some toxic elements while manufacturing of these technologies, it can be called "clean energy" as the amount of those toxic elements are not appreciable enough. In summer days with the shiny sun in the sky, solar energy is a very dominant one.

4. ISSUES AND BARRIERS

RETs would have been more popular if it has faced no odds in its dissemination among the users. There occurs several issues in case of its widespread use. Some are technical while some are authoritative. Regulations of using these technologies are not very clear to many people, therefore, this lack of knowledge makes a greater impact behind the decline in the use of RETs. Then, there comes the financial issues which can be regarded as the most prominent right now in our country as initial cost of this RETs and installation expenses are not affordable enough for all classes of people. The organizations working on this issue are not being so honest here as they first think about their own profit, rather than the users. So governmental organizations should come forward as the savior and makes the rural people confident about these RETs. 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 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. 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. [16]

5. CONCLUSION

Dissemination of renewable energy technologies throughout the country should be first priority in solving our energy crisis. Net metering policy can be a good technique to enable consumers to sell their additional solar electricity to the government. Foreign investors must be allowed to transfer investment, income and profit to other countries. Avoidance of double taxation on the basis of bilateral agreements can be one of the remarkable steps to expand the use of renewable energy technologies.

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