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Research Article

New Energy Generation Technology in Bangladesh: A Progress Report on Current and Future Trends

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Abstract

Extreme weather events, such as storm surges and rising sea levels, will exacerbate floods in Bangladesh in the future. More severe weather is on the way, as shown by the recent heat waves and floods. The nation intends to reduce its greenhouse gas emissions by 15% from a Business as Usual (BAU) level by 2030 in an effort to fix the problem. However, there is still room for improvement in the shift to renewable energy. The recent global energy crisis has the potential to hasten the adoption of renewable energy sources, which now appear to be the sole viable option.

In Bangladesh, the amount of energy produced by renewable sources is rather low. In 1990, renewable energy accounted for 11.4% of power generation; in 2015, that number dropped to 1.2%, according to the World Bank research. Every year, a less and smaller percentage of the nation's electricity comes from renewable sources. In Bangladesh, renewable energy sources such as solar, biogas, wind and hydroelectric electricity are now the most common. Only one power plant in the nation, the Karnaphuli hydro power station, generates 230 MW of electricity.

The majority of wind power comes from areas close to or even offshore the coast, where the wind is always blowing. For example, there are two regions in the nation that have 2MW of operational wind turbines that generate electricity: Feni and Kutubdia. At Parky Beach, there are wind turbines that are being developed to produce an additional 50-200 MW. It is also possible to build 30 GW of wind power, both on land and at sea, within the country. As part of sustainable waste management, the nation has access to additional renewable energy sources, one of which is biogas, which is mostly produced from animal and municipal waste but shows promise. Another promising option is sunshine. Based on projections made by SREDA, the nation has the potential to generate 30 GW of solar power by the year 2041.

Consequently, the nation's renewable energy industry may represent an energy sector with promise. The World Bank ranks Bangladesh as one of the top 20 fastest-growing countries, which means that energy consumption will have to rise. Of the total energy supply, 55% comes from domestic natural gas, 27% from biomass and trash in pastoral regions and 15% from imported oil. In the year 2022, the nation's primary energy sources are biofuels, natural gas and other fossil fuels. Russia-Ukraine war has intensified the present shortage and inadequate supply of usable fossil fuel energy, leading to the hunt for new and improved energy sources.

Keywords: Extreme weather events, Storm surges, Rising sea levels, Renewable energy sources, Domestic natural gas

INTRODUCTION

Energy has come to represent progress; it is both the foundation and an important component of contemporary nation-building and it is crucial to human existence and the advancement of human civilization (Mondal, et al., 2010). A world devoid of electricity cannot progress technologically or sustainably (Ahmed et al., 2014). As a result of increasing urbanization and rapid technology advancement, its use is growing on a worldwide scale. The ever-increasing power consumption of electrical instruments is a direct result of technological advancements, rising demand and, on occasion, the inefficiency and wastefulness of some electrical and electronic equipment (Halder, et al., 2015). Because it controls economic, social, technical, environmental and sustainable development, energy and electricity are essential to every nation's survival (Akorede, et al., 2017). For fundamental electricity, industry and future advancement, among other things, energy is essential (Gulagi, et al., 2017). Electrical energy powers all of our modern electrical, electronic and information technology devices, including smartphone chargers, laptops, televisions and the internet (Yuksel, 2008). Electrical energy is essential to the medical industry and all diagnostic procedures (Ahiduzzaman, et al., 2011). Simply put, energy is fundamental to human well-being at all times and the development of our global community would be utterly unthinkable in its absence. In developing nations in particular, any disparity between energy demand and supply might put the country's capacity to function at risk. Many fossil fuels, including coal, natural gas and petroleum, are often included (Dogan, et al., 2016).

Almost every country gets all the energy it needs from traditional sources (Apergis, 2019). The Middle East, CIS, North America and Africa rely on natural gas as their primary fuel for electricity generation (Guney, 2019). Asia uses coal and South and Central America rely on hydropower, which accounts for more than half of the power generated (Majid, 2020). In contrast, only Europe uses a fuel diversification strategy, generating power from five diverse sources: Nuclear power, natural gas, coal, renewable energy and hydropower, all within a narrow range of 16-23%. Anthropogenic greenhouse gas emissions, including carbon, solid substances and other gases, increase in proportion to the amount of energy consumed (about three quarters or 75% of the world's total energy consumption) and lead to pollution, global warming and climatic change (Omer, 2009). An estimated one-third of the world's greenhouse gas emissions come from traditional power generating methods that rely on fossil fuels, posing serious risks to the health and safety of people and the planet both now and in the future (Zafar et al., 2018). With 141.7 EJ (energy joules), China surpassed all other countries as the world's largest energy user in 2019 (Shetol et al., 2019). Following the United States with 94.65 EJ were India with 34.06 EJ, Russia with 29.81 EJ, Japan with 18.67 EJ, Canada with 14.21 EJ, Germany with 13.14 EJ, Brazil with 12.4 EJ, South Korea with 12.37 EJ and Iran with 12.34 EJ (Ul-Haq, et al., 2020).

In addition, estimates show that the world's fossil fuel reserves will be depleted within a few decades and these resources are already expensive and getting scarcer at an alarming rate (Islam, et al., 2014). In an effort to guarantee energy stability, a number of countries are relying heavily on renewable energy sources to meet their power needs (Uddin et al., 2019). The REN21 reports that by the end of 2021, the total worldwide capacity for generating RE has reached 3146 GW (Rahman, et al., 2021).

MATERIALS AND METHODS

Electricity (power) generation in Bangladesh

As a result of population growth, improvements in social and economic conditions, technological advancements and Gross Domestic Product (GDP), the present yearly progress of energy consumption is around 10%, but this will rise in the future, as reported by BPDB (Sharif et al., 2018). Net electricity output increased by 12.61% to 80,423 GWh in fiscal year 2020–2021, from 71,419 GWh the previous year. In 2020–2021, the average annual household generated 560 KWh of power (Mozumder, et al., 2007). With an increase of 6.45% over the previous year's net output of 80,423 GWh, overall electricity production reached 85,607 GWh in fiscal year 2021-22. As shown in Figure 1 (a), the breakdown of electricity generation that year was as follows: 55.06% (47,136 GWh) came from natural gas, 26.71% (22,867 GWh) from furnace oil, 9.01% (7712 GWh) came from power imported from India and 9.22% (7892 GWh) came from various sources, including 1.73% (1483 GWh) from diesel, 6.24% (5342 GWh) from coal, 0.87% (744 GWh) from hydro and 0.38% (323 GWh) from other renewables. Figure 4 (b) shows that in the past year, the following sectors accounted for 57% of total power consumption: households (40708.83 GWh), businesses (19997.32 GWh), commercial enterprises (10%, 7141.9 GWh), agriculture (2%, 1428.38 GWh) and other sectors (3%, 2142.57 GWh).

The amended PSMP-2016 states that whilst the demand is 14,500 MW in 2020, 27,400 MW in 2021 and 51,000 MW in 2041, the necessary capacity to generate electricity is 21,000 MW, 31,000 MW and 57,000 MW, respectively. Figure 1 shows the country's overall power output throughout time (Figure 1).

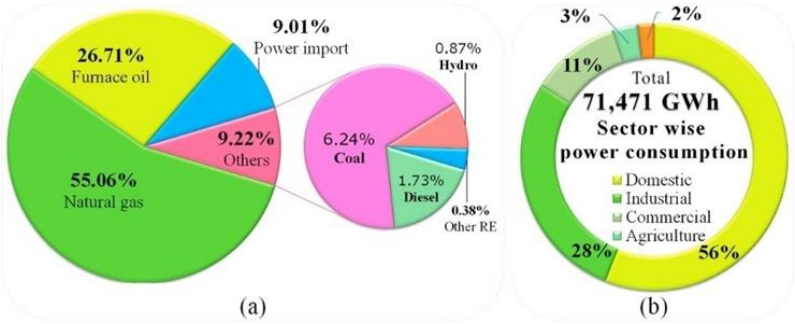

Figure 1. (a) Electricity generation in Bangladesh from all sources in the years 2021 and 2022 (b) Pattern of electricity consumption in Bangladesh by sector from 2021 to 2022 on page 34 Based on data from HCU and BPDB, this was created by the authors.

The South Asian nation of Bangladesh is home to 168.25 million people, making it the eighth most populated country in the world. The population density there is 1265 people per square kilometre or 3277 people per square mile. In the last decade, Bangladesh has been unable to meet the increasing demand for electricity due to a shocking shortage of supplies. Despite the fact that 93.5% of the population used electricity to illuminate their houses in 2019, up from 90.1% in 2018, 79% of users still encounter poor voltage supply and 60% of users endure load-shedding. Low voltage supply, load-shedding and inadequate energy all slow down economic development, decrease exports and impede work activities. In order to meet the sustainable energy demands of the future, the country's energy dilemma has become an urgent matter. There is, therefore, no alternative to RE that can solve the energy dilemma.

The Gross Domestic Product (GDP) of Bangladesh increased by 3.49% from 2020 to 2021, reaching 6.94%. Any nation's progress must begin with sustained increases to its Gross Domestic Product (GDP) and energy is the key ingredient in this recipe. The availability of energy, namely electricity, is crucial to the long-term viability of the economy. Thus, the sustainable development goals depend on adequate energy generation and efficient energy usage.

Current status of running renewable energy in Bangladesh

The GoB has implemented many initiatives to promote the expansion and advancement of Renewable Energy (RE) alongside traditional, nonrenewable energy sources, in response to the rapid depletion of fossil fuels. The energy needs of the nation may be met by tapping into renewable energy resources **(Figures 2-4)**.

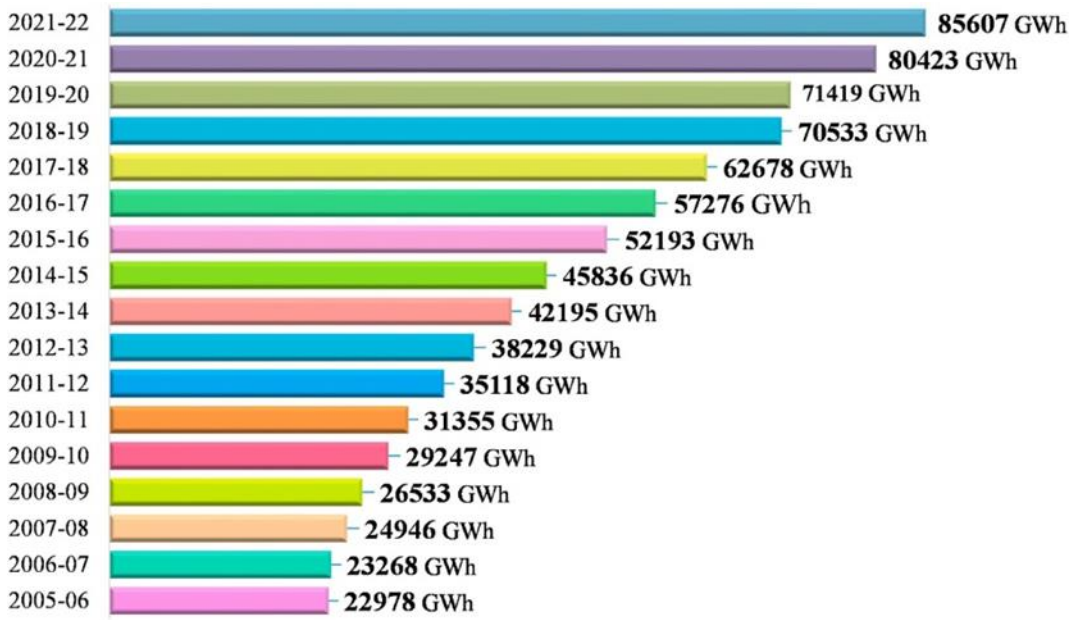

Figure 2. Historical total electricity production in Bangladesh for the fiscal year 2005–2021.

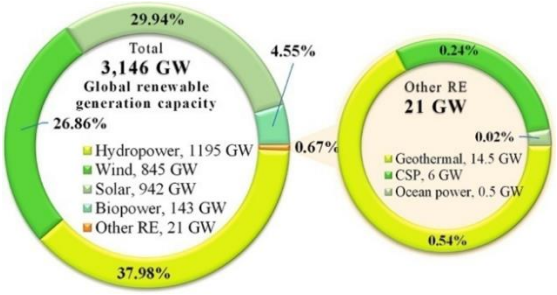

Figure 3. Worldwide energy production capacity by renewable sources in 2021.

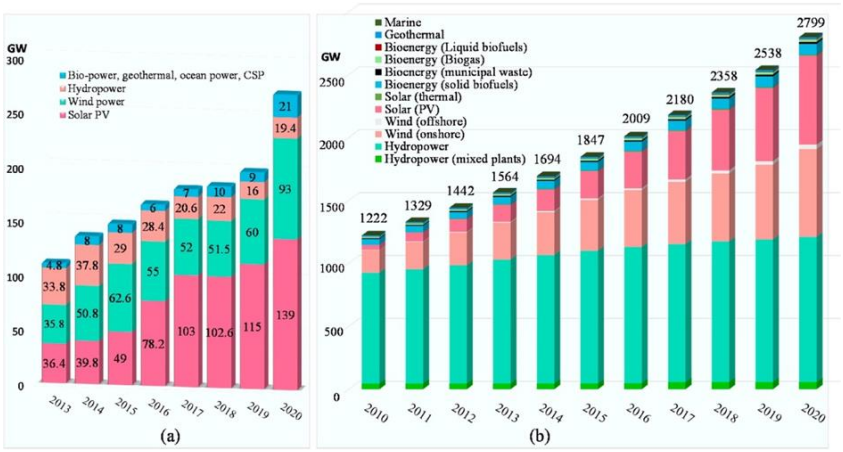

Figure 4. (a) Energy production capacity from renewable sources worldwide, annual new additions (2013–2020). (b) Worldwide historical renewable production capacity by energy (2010–2020).

The renewable generation capacity share will become 5% by 2015, 10% by 2021 and 100% by 2050 respectively. The government has already engaged with several strategies for investment in both public and private division to realize the target. The GoB has so far produced 649.95 MW of RE in accordance with the plan. Although the GoB has taken a target for generating 1676 MW of solar power by 2021. Figure 5 (a) shows the up-to-date electricity generation mix of Bangladesh and Figure 8 (bdisplays the present situation of the nation's potential to produce RE. Up to the middle of April 2021, natural gas accounted for 47.91% of electricity production, hydropower accounts for 23.37%, hydroelectric dams for 8.05%, imported power for 5.20%, renewable power for 3.24%, captive power for 9.87% and coal for 2.35% (Figure 5).

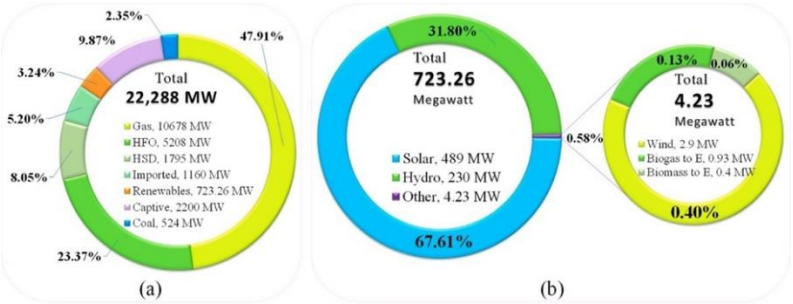

Figure 5. (a) Current electricity generation mix of Bangladesh (b) Current status of RE production capacity of the country.

While renewable energy sources do contribute a little fraction-just 3.24%-to the net national power output right now. Halfway through April 2021, the net energy generating capacity from renewable sources reached 722.592 MW. Of this, 67.61% (489 MW) came from solar, 31.80% (230 MW) from hydro, 0.58% (4.23 MW) from other sources, 2.9 MW (0.40%) from wind, 0.93 MW (0.13%) from biogas and 0.4 MW (0.06%) from biomass.

Figure 5 indicate the current state of the installed renewable energy capacity in Bangladesh. The country's renewable energy plans are structured into three phases:

- Fully operational and finished RE projects,
- Projects in the implementation phase and
- Projects in the planning phase. There are currently 64,08,721 renewable power projects with a combined 723.268 MW of output, approximately 571.956 MW in the implementation phase, 25 renewable projects in the planning phase and 3 projects that were not included in the planning phase, for a total of approximately 1328.81 MW. Following the rejection, there are a total of 60, 88 and 57 renewable projects with a combined capacity of 2624.037 MW.

Figure 5 shows that solar, wind, hydro, biogas and biomass energy are the most prevalent renewable energy resources in Bangladesh at the moment.

RESULTS AND DISCUSSION

Solar energy

An enormous source for alleviating Bangladesh's power outage, solar power is among the purest, green and environmentally friendly renewable energy sources. From photosynthesis to PV electricity generation, the sun is a source of energy that the all-powerful creator has made. The sun generates enough energy to cover the world's continuous energy demands for a whole year at any one point. Nearly all energy comes from the sun, with Earth contributing about 0.01%. An estimated 450 EJ of solar energy may be released, which is equivalent to 7,500 times the world's present energy needs.

Solar Photovoltaics (PV) are considered the industry standard in the energy business. A growing number of countries are using PV systems to generate over 20% of their power needs. A number of nations have shown great interest in making a significant transition to solar energy in the last three years. These include Brazil, Algeria, Egypt, Mexico, Turkey, Pakistan and the Netherlands, among many others (Figure 6).

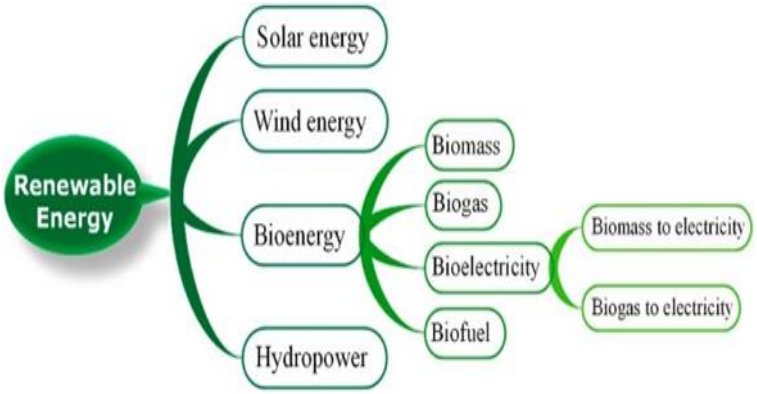

Figure 6. Current status of renewable generation capacity of Bangladesh.

Current status of solar energy in Bangladesh

In Bangladesh, there are several configurations that use solar energy, including parks, rooftops, irrigation, grids (mini- and nano-grids), charging stations, household systems, solar-powered telecom BTS and street lights. A quick rundown of the different solar energy methods in Bangladesh is shown in Figure 7.

Despite this, over 42% of rural communities still lack access to reliable energy. With more than 6 million solar PV systems deployed as of mid-April 2021 **(Figure 7)**, the country is producing 723.26 MW of power from renewable sources. There are now 108 solar project systems with an installed capacity of 569.49 MW, 21 systems in the planning phase with an estimated capacity of 1257.813 MW and three systems with an estimated capacity of 200.25 MW that were rejected during the planning phase. The overall number of continuing solar systems (including i, ii and iii) is 63, 25, 407 and their capacity is 2316.347 MW, after rejection.

Working in tandem with the government, about 125 RE players in Bangladesh, including the World Bank and other public and commercial sector organisations such as MoDMR, BREB, BPDB, IDCOL, EGCB, RDCD, etc., are constructing one of the biggest national solar projects in the world. In 2017, Bangladesh was second only to Nepal in terms of the percentage of its power that comes from off-grid solar energy installations. Figure 2 shows the energy output and deployed solar power capacity in Bangladesh during the past few years.

Wind energy

One of the most sustainable renewable energy sources is wind power, which generates electricity by harnessing the kinetic energy of wind. The blades of the turbine are turned by the wind. Figure 7 shows the generator that produces energy as a result of the turbine's rotation. Coastal regions, hilltops, mountain gaps and other spots with favorable wind speeds are ideal for constructing wind farms. Residential and

institutional buildings can be powered by smaller, off-grid wind turbines, whereas large-scale wind farms are often linked to the national grid.

Wind power has become widely employed in many parts of the world, including the Americas (the United States, Canada, Mexico, Brazil, Chile and Argentina), Africa and the Middle East (Kenya, Egypt and South Africa), Asia and the Pacific (Asia, the Pacific Rim, Vietnam, South Korea, Thailand and the Philippines), Europe (the United Kingdom, France, Iceland and Germany) and many more (Figures 7-9).

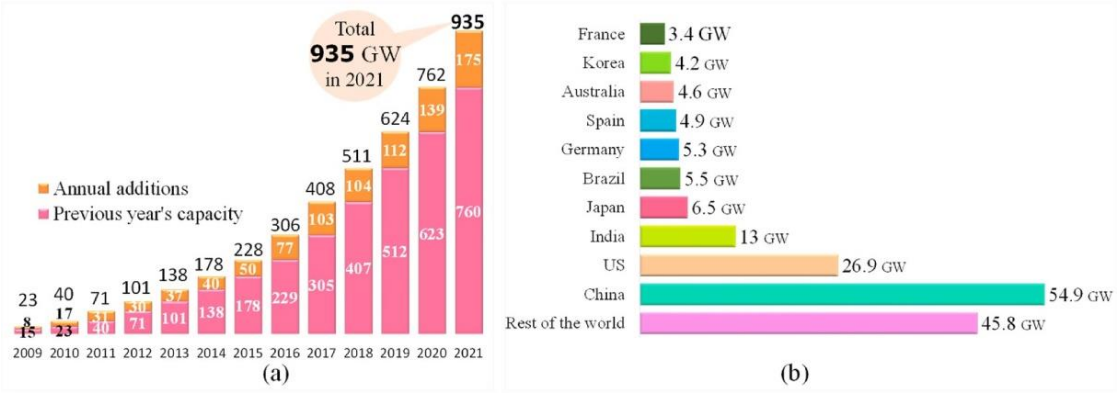

Figure 7. Solar PV global capacity and top 10 countries (a) Solar PV global capacity and annual additions (2009–2021), (b) Global solar PV capacity additions in 2021, top 10 countries.

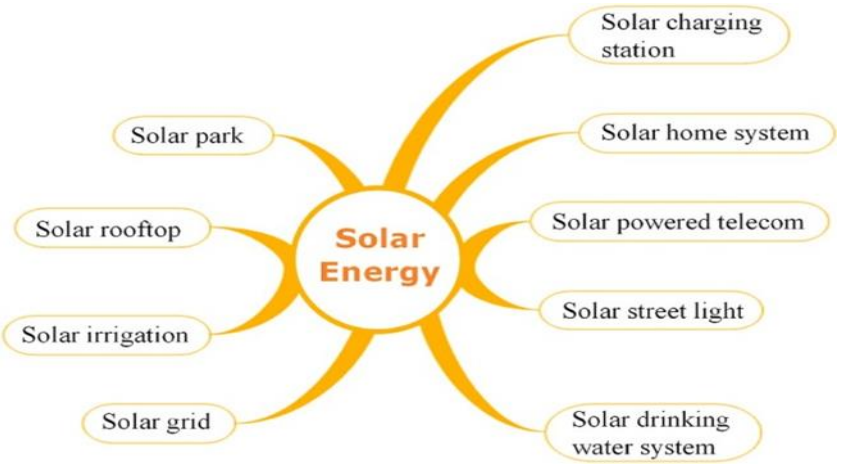

Figure 8. Diversity of solar energy practice in Bangladesh.

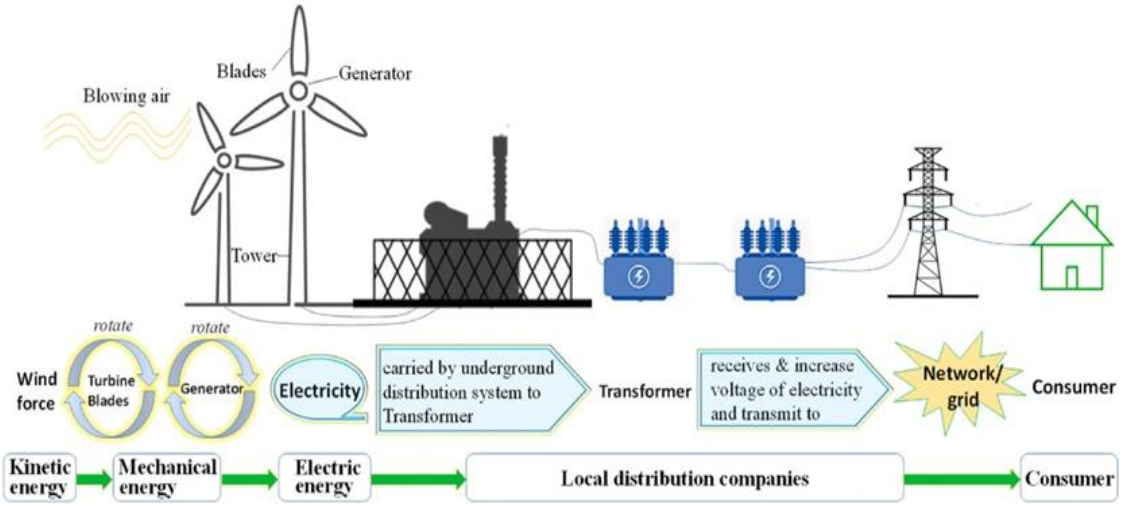

Figure 9. Wind power system, from generation to consumption.

Present status of wind energy in Bangladesh

Due to its tropical location, Bangladesh has significant wind flow throughout the year, particularly in the southern part of the nation where strong trade winds blow during summer. Table S3 shows the average wind speed at a few notable places in Bangladesh. Coastal zones, offshore islands, hilltops, riverbanks and other places with favourable wind speeds are suitable sites for wind farms, albeit not everywhere has the ability to generate wind power. Approximately 37,000 km^2 of Bangladesh's 47,201 sq. km of coastline is located within a 50 m depth zone, while the entire coastline is around 710 km long. The shoreline of Cox's Bazaar in the Bay of Bengal is home to the world's longest sea beach. The Bay of Bengal is also home to a plethora of smaller islands. Wind energy might be harnessed in all these places.

See Figure 3 for a breakdown of the wind farms in Bangladesh: Three of them, totaling 2.9 MW, are operational at Sonagazi (Feni) and Kutubdia (Cox's Bazar); another, at Sirajganj sadar, has a capacity of 2 MW and three more, totaling 70 MW, are in the planning stages at Kalapara (Patuakhali), Maheshkhali (Cox's Bazar) and Chakaria (Cox's Bazar). In addition, the GoB announced plans for three additional wind farms with a combined capacity of 150 MW. These farms will be located in Chandpur, Dakop upazila, Khulna and Inani Sea Beach, Cox's Bazar. Each plant would have a capacity of 50 MW (Figure 10).

Figure 10. (a) Historic development of total installations of global wind power (2001–2021), (b) Historic development of new installations of global wind power (2001–2021).

Bioenergy

Bioenergy refers to the energy that is produced from biomass or biological resources. Renewable bioenergy sources include thermal energy (from biomass and biogas combustion), biopower (from biomass combustion or its transformation into gaseous fuel or oil for power generation) and biofuels (for use in vehicles).

Biogas to biopower scenario in Bangladesh

Figure 11 (a) shows biogas to electricity large project scenario in Bangladesh and Figure 11 (b) shows biogas small projects scenario in Bangladesh. In Bangladesh, primarily six large biogas project systems now have a capacity of 0.63 MW, one big system is currently being implementation with a capacity of 0.06 MW and plans are underway to construct an additional grid-connected power plant with a capacity of 1 MW. At Thakurgaon, plans are afoot for an additional 1 MW biomass-based major project system **(Figure 11)**.

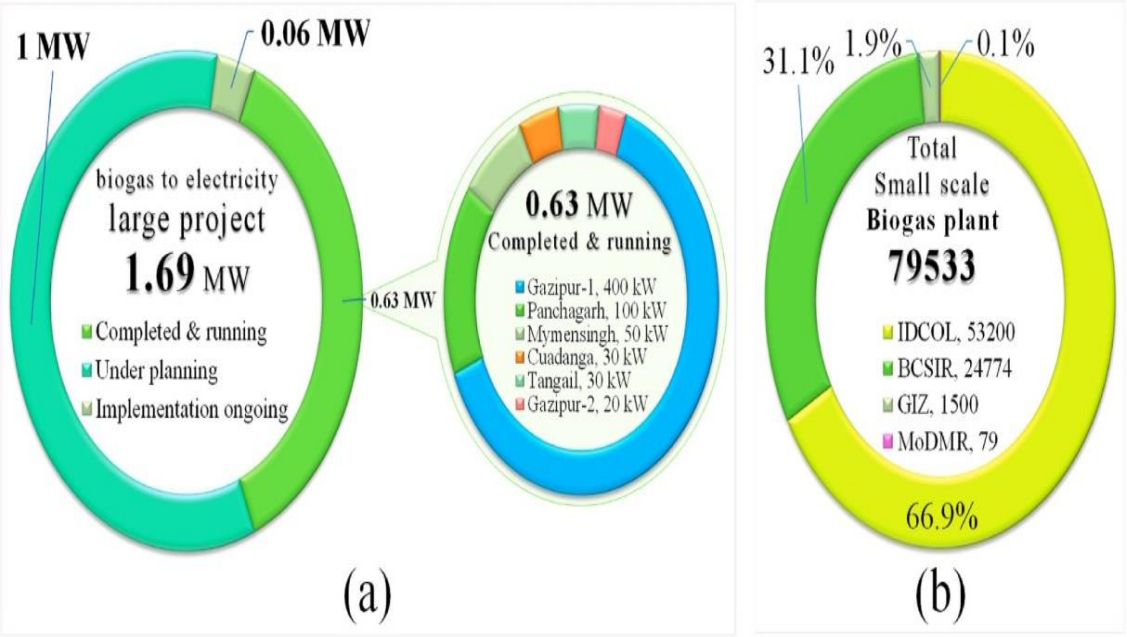

Figure 11. (a) A large-scale project scenario in Bangladesh converting biogas into power. b) A scenario for a small-scale biogas project in Bangladesh. Written by the authors using data from SREDA and IDCOL as a starting point.

Since the late 1990s, tiny biogas plants have been installed; now, there are about 80,000 units up and running, with another 60,000 in various stages of development. In Bangladesh, bioenergy projects have been carried out by various organisations such as IDCOL, GIZ, BCSIR, MoDMR, etc. IDCOL has supported the construction of over 57,000 biogas plants, with a daily generation capacity ranging from 1.2 m^3 to 25.0 m^3. BCSCIR has installed approximately 24,774 plants, GIG 1500 plants and MoDMR 128 plants. Based on data provided by IDCOL, these biogas plants are able to save 51,000 tonnes of firewood annually, produce 316,000 tonnes of organic fertiliser and decrease CO_2 emissions by 204,000 tonnes. This results in a reduction of 45,000 tonnes of chemical fertiliser.

Biomass

Biomass refers to biodegradable organic materials derived from plants and animals. To rephrase, biomass refers to any naturally occurring organic material, whether it be from plants or animals, that may be immediately transformed into firewood, fuel or other products prior to incineration. It encompasses a wide range of biological resources, including fuel wood, aquatic flora, plant and animal waste, rice husks, dead trees, branches, wood chips and other marine plants.

Wood fuels (such as dead trees, branches and wood chips), agricultural leftovers (such as rice husks) and animal dung (mostly cow dung) are the primary biomass fuels utilized by rural, isolated and low-income communities in Bangladesh. It is worth mentioning that LP gas, whether in a piped or cylinder form, is commonly utilized for heating and cooking by urbanites and those with higher incomes. Traditional solid biomass cooking, which over 94% of rural Bangladeshis still use, is inefficient and, as a result, produces harmful carbon oxide and particulate matters as a result of incomplete combustion. These pollutants are the main cause of respiratory illnesses. Women who use indoor smoking are three times more likely to suffer from chronic bronchitis or emphysema than women who use gas or electricity to cook and children are also more likely to be exposed to secondhand smoke. Coal consumption has also increased the risk of lung illness by a factor of two,

particularly in females.

Biogas

The most common gases in biogas are CH_4 (40%-70%) and CO2 (30–60%), with small amounts of water vapour (1%-5%), nitrogen gas (0%-5%) and tiny amounts of ammonia, sulphur and carbon monoxide. Manure (particularly cow dung), plant material or garbage (urban and agricultural) can all be used to make it. Figure 12 shows the byproducts of biogas facilities, which include gas, fertiliser and fish feed (Figure 12).

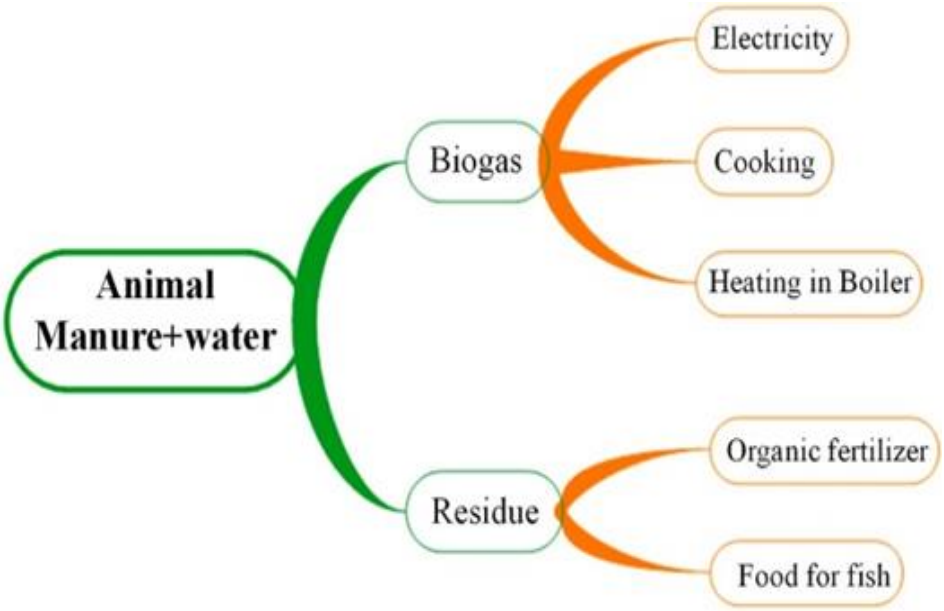

Figure 12. An outline of biogas generation and its uses.

Cook stoves that use biomass fuel, such as biogas cookers, are becoming increasingly common in many developing nations. In Rwanda, the government has distributed around 30,000 cook stoves powered by biomass, as reported by REN21. Approximately one-third of the fuels utilized in clean cook stoves in South Africa in 2018 were biomass briquettes and pellets. About 15.5 BCM of biogas was produced in 2018 for use in cooking; 13.1 BCM came from China and 1.6 BCM from India. The same year also saw a surge in interest in biogas as a cooking fuel in Vietnam, Nepal and Bangladesh. Approximately 70,000 biogas digesters were installed in East Africa between 2014 and 2018, providing clean cooking to half a million people. African nations such as Burkina Faso, Kenya, Tanzania, Ethiopia and Uganda saw an increase of over 40% to approximately 46 Million Cubic Metres (MCM). However, from 2014 to 2018, the demand for biogas as a cooking fuel declined in both China and India.

Future prospect of RE in Bangladesh

Future prospect of solar energy in Bangladesh: Electric energy storage is an essential component of any future power generation and distribution system. Bangladesh is an ideal site for solar energy storage and use due to its position in South Asia, between 20°34′ N and 26°38′ N latitude and 88°01′ E and 92°41′ E longitude. Because of its location, the nation enjoys abundant sunshine for the most of the year, making it an ideal site for solar power generation. The solar power potential of Bangladesh is shown in relation to its geographic position in Figure 13.

Because of its latitude and orientation, Bangladesh receives an abundance of sunshine for the most of the year, making it an ideal location for solar power plants. From March through April, the sun emits its most intense rays, while December and January have the lowest levels of radiation. Excluding cloud cover, precipitation and fog, Bangladesh boasts a substantial amount of solar energy, with a range of 4.0 to 6.5 kWh/m^2/day. The country also enjoys bright daytime hours ranging from 6 to 9 h/day, for around 300 days each year. According to previous research, this means that the amount of radiation available is sufficient to fulfil the need for solar energy. The government of Bangladesh has begun constructing a number of solar projects to generate power, therefore the country's solar energy future is looking good (Figure 13).

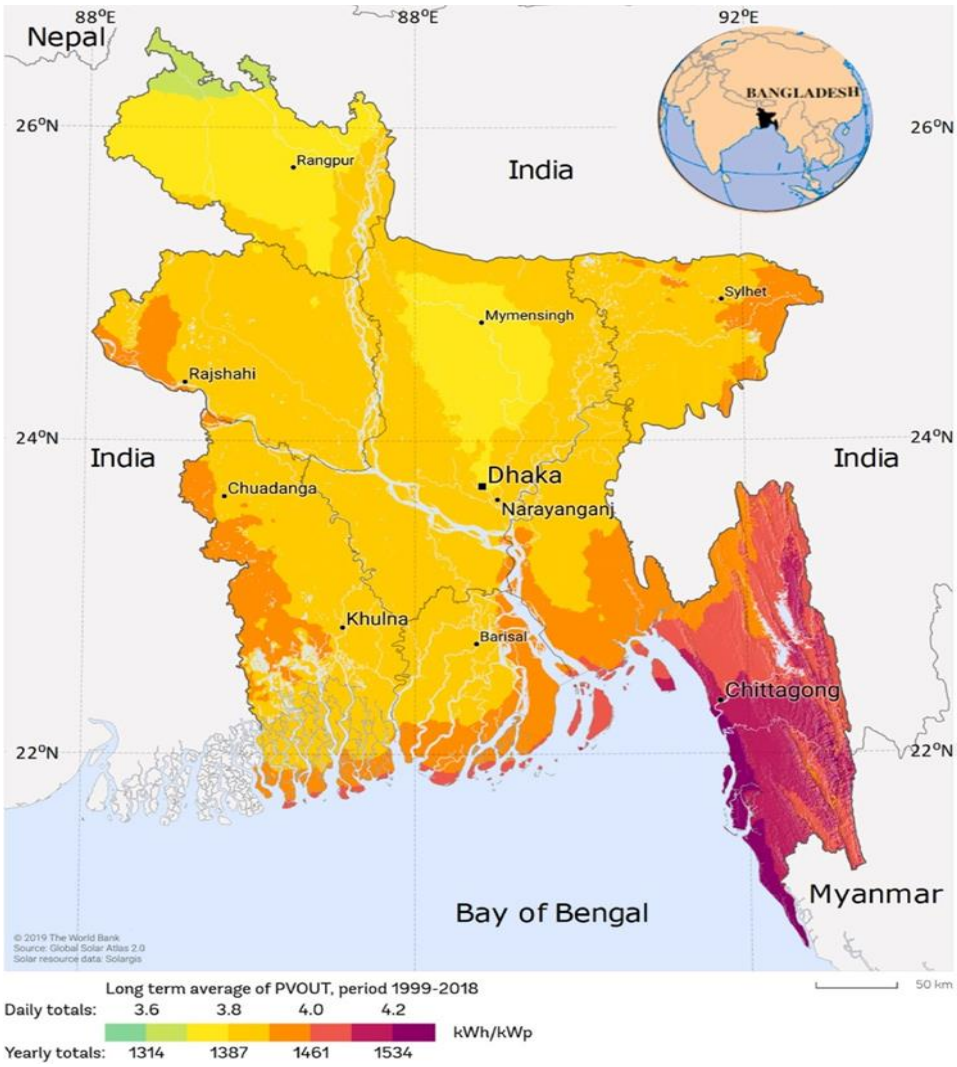

Figure 13. Bangladesh's solar power potential with geographic location.

Future prospect of wind energy in Bangladesh

In 2018, a nationwide wind resource assessment was developed in collaboration with the GoB, USAID Bangladesh and the nationwide Renewable Energy Laboratory (NREL). As per this evaluation, the coastal regions of the Chattogram, Barishal and Khulna divisions experience wind speeds above 6 m/s at an altitude of 120 m, which is sufficient for the generation of wind power. Approximately 3200 square kilometres of the country's southern region are off-limits for onshore sites, while 50 to 120 kilometres off the coast are reserved for offshore locations. With 16 GW available onshore and 134 GW available offshore, the total potential wind power generation is at least 150 GW. The chart also shows that there is a lot of room for offshore wind but just a tiny amount of land for onshore wind.

Future prospect of biomass to biopower in Bangladesh

As one of its main crops, rice is essential to Bangladesh's economy and the country's abundance of rice husks contributes to this Statista. The agricultural nation of Bangladesh ranked fourth in the world for paddy rice production in 2018–2019, with a production of around 97.24 million tonnes of rice husk (MT), as shown in Figure 14. The total global output of rice husk was 424.36 MT. The process of converting rice husk into producer gas and then using that gas to power a generator for electricity generation is a viable option for these waste products. In addition, this method can also provide other important compounds like silica and calcium carbonate, which are used in cement manufacture. Since December 2015, IDCOL has funded a single big biomass-to-electricity facility in Bangladesh's Thakurgaon district, with a capacity of 0.4 MW.

Future prospect of biomass in Bangladesh

Before the discovery of fossil fuels, the major source of energy was biomass, which mostly consisted of tree parts such as dead leaves, branches and wood chips. This practice dates back to the dawn of civilization. For most people in Bangladesh, especially those living in rural areas or with poor incomes, biomass remains the primary energy source. Even if burning biomass is bad for the environment, they won't have a choice until

they're well-off. Nevertheless, biogas has the potential to enhance combustion competency, decrease harmful chemicals and save time and money for rural communities by eliminating the need to gather or purchase solid biomass. Furthermore, with the installation of a digester, a biogas farm may produce enough biogas for their own use and even sell excess gas to households in the surrounding area. Additionally, rice husks may be refined into frying oil, while cow manure is a versatile fertilizer and biogas source material.

Future prospect of biogas in Bangladesh

Figure 14 shows the overall number of cattle and fowl in Bangladesh. Approximately 307.28 million people are involved in the poultry and animal industries; of this number, 296 million are located in rural regions and 11.27 million call metropolitan areas home. Populations of 189.26 million chickens, 67.53 million ducks, 1.45 million turkeys, 28.49 million cows, 0.38 million buffalo, 19.29 million goats and 0.89 million sheep are included in this Khanam. A large portion of the 155.8 million tonnes (155,820,000 metric tonnes) of poultry and animal manure that the nation generates annually ends up in the environment as pollution.

Temperatures between 25 to 45 degrees Celsius, with an average of 35 degrees Celsius, are optimal for anaerobic fermentation in order to generate biogas. More than 70% of the country's major energy comes from biomass, primarily from wood and agricultural waste and Bangladesh has the best potential for biogas/bioenergy generation due to its typical temperatures ranging from 21.2 to 30.4°C.

CONCLUSION

One of the obstacles to the growth of Bangladesh's economy is the country's energy crisis. Nearly half of the world's power comes from natural gas, yet this resource will be depleted very soon. Energy consumption is on the rise and load shadowing is still an issue for about 60% of the population. Sustainable demand may be met in large part by renewable energy.

The present and future of renewable energy in Bangladesh are presented in this assessment. The statistics show that renewable energy generation in Bangladesh is relatively young, but shows promise for the future. Renewable energy sources in Bangladesh might provide a lot of power and help the country's power supply and demand balance out. Different types of solar energy systems are used in Bangladesh. These systems include solar parks, rooftops, irrigation, grids (minigrids, microgrids, picogrids and nanogrids), charging stations, residential systems, street lights, drinking water and solar powered telecom BTS. For local wind energy to generate power, strong summer breezes near coastlines might be essential. Biomass and biogas are already providing substantial energy, especially to those living in rural areas of Bangladesh. Bangladesh has the greatest potential for biogas/bioenergy generation in the country due to its large poultry and animal populations (307.28 million) and significant annual manure production (155.82 million tonnes). There are various waterfalls and tributaries in the mountainous regions of the nation that are ideal for installing micro hydropower, such as the rivers Karnafuli, Shangu and Matamuhuri. But more funding for renewable energy sources should allow Bangladesh to satisfy its energy demands in the future. Bangladesh has to plan ahead, attract investors and boost organisational effectiveness if it wants to fortify its energy sector. Therefore, the GoB should be mindful of energy challenges and should reflect a strategy of attractive investment in Renewable Energy (RE) in both the public and commercial sectors. Notably, to alleviate the burden on the power supply, Bangladesh must not only increase energy production but also increase consumer education and decrease electricity loss in order to preserve energy.

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