Obstruction and Advancement in Achieving SDG in Bangladesh

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For a developing country such as Bangladesh, renewable energy is immensely important for its entire development and advancement. Bangladesh has taken steps to increase the development capacity in the renewable energy sector and to fulfill the target of achieving one hundred percent electrification.

solar energy renewable energy sustainable development goal energy sector Bangladesh

1. Introduction

To build a better planet while maintaining global warming as well as environmental balance, the United Nations (UN) has several objectives in the field of Sustainable Development Goals (SDGs) that elevate the world [1][2][3]. The seventh goal of the 17 (seventeen) targets of the SDGs is determined to give the world an affordable, reliable, and sustainable fuel capacity considering renewable fuels as a significant part of production by 2030 [4][5][6]. **Figure 1** depicts the all-seventeenths goal set by the UN for countries around the globe where Goal 7 is entitled “Ensure access to affordable, reliable, sustainable and modern energy for all”. On the other hand, one of the targets of Goal 7 is to “increase substantially the share of renewable energy in the global energy mix by 2030” [7]. It has been mentioned in sustainable development goals that every country must derive a specified portion from the renewable energy sector so that it will be possible to form a pollution-free world by reducing the emission of carbon [8][9][10][11]. Following this, all developed countries have set a mandatory target for renewable energy, which is known as the “Mandatory renewable energy target”.

Figure 1. The Sustainable Development Goals (SDGs) were adopted by the United Nations (UN) [12].

In this trend, the Government of Bangladesh decided that its renewable energy sector achieve the target of 10% of total power generation capacity by 2020 to generate power from renewable energy sources [13]. On the other hand, Bangladesh set targets for 2021 and 2030 to save 15% and 20% of total fuel consumption, respectively [14]. To give importance to the fuel sector, when it had been decided to generate 10% of the total electricity generation by 2020 from renewable energy, at that time the capacity from renewable sources needed was about 2000 MW [15].

2. Targets for Sustainable Renewable Energy for Achieving SDGs in Bangladesh

Bangladesh’s foray into renewable energy began in 1957 with the construction of the Karnafuli River Hydropower Station at Kaptai in Chittagong. The first and only hydropower plant in the country was started in 1962 in Kaptai Upazila of Rangamati District. Bangladesh’s first wind power plant, located at Sonagazi on the banks of the Muhuri River in Feni District, was

launched in 2005 as a pilot project called Muhuri Project. The plant has four turbines with a capacity of 225 kW and a generating capacity of about 1 megawatt. Another wind power plant with the same capacity was commissioned on 10 February 2017, at Kutubdia in Cox's Bazar, where the power plant used 50 turbines of 20 kW capacity to supply electricity to more than 500 customers.

The model presented for achieving the Sustainable Development Goals in the renewable energy sector in light of the 7th Five-Year Plan adopted by the department of Power and Energy of Bangladesh is presented in **Figure 2**. The Seventh Goal of Sustainable Development Goals is intended to make affordable, reliable, sustainable, and modern fuel accessible to all. Objective 7.2 calls for a significant increase in the number of renewable fuels in global fuel by 2030. In addition, there are guidelines for considering the use of renewable fuels as a significant component in the use of total fuels for operation. To achieve the "Sustainable and Pollution Free Fuel" goal of the Sustainable Development Goals, the goal set by Bangladesh in the Power and Fuel Sector in the 7th Five-Year Plan intends to ensure sustainable efficiency in production, consumption, and utilization of power and fuel resources. In line with the Sustainable Development Goals, four indicators of power generation, known as KPIs, have been identified under the heading "Key Performance Indicators (KPI)". The KPI Index has set a target of achieving 10% of the total production capacity of renewable fuels by 2020 [15].

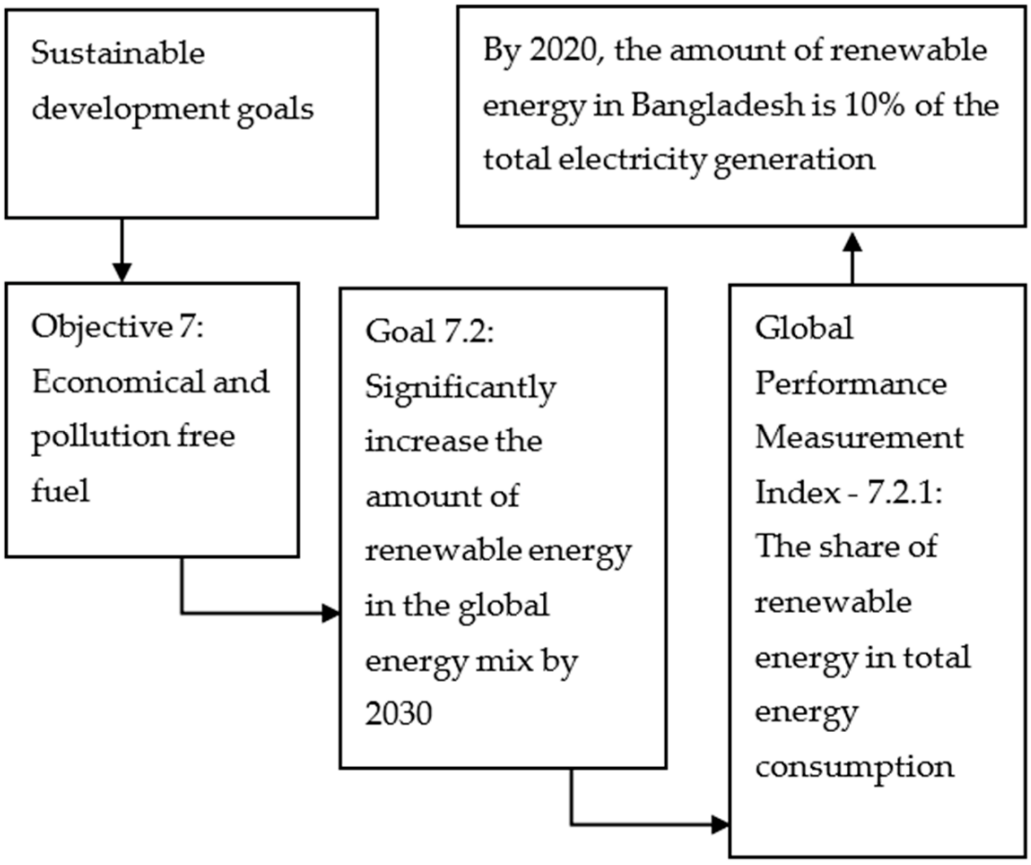

Figure 2. Bangladesh's plans in the renewable energy sector to achieve the Sustainable Development Goals.

3. Steps Taken by Bangladesh in the Renewable Energy Sector to Achieve SDG

3.1. SREDA Formation

Bangladesh formed the Sustainable and Renewable Fuel Development Authority (SREDA) to ensure sustainable development in the fuel sector, as well as to provide a fuel-conscious environment by providing fuel security and reducing carbon emissions. SREDA's priorities are to reduce the dependence on fossil fuels to ensure the safety of fuel, to develop renewable fuels, to take appropriate action to save fuel, and to continuously explore new potential sustainable fuels. Steps taken for this purpose include formulating policies, rules, and regulations to motivate people to save fuel; developing various business models to create entrepreneurs for investment; identifying and analyzing access to various funds for sustainable energy development; hiring short-term and long-term skilled and experienced consultants in specialized activities; conducting various studies to evaluate the feasibility of renewable fuels; and experimentally introducing new technologies and models for

this. In order to implement projects related to renewable energy, financing activities have been expanded through government financial institutions such as Bangladesh Bank and private commercial banks, and Bangladesh has provided exempt incentives on renewable fuel products.

3.2. Home Electrification

In order to bring Bangladesh under 100% electrification by 2021, solar home system programs were running in those areas where it is not possible to get electricity. As a result of the IDCOL program, it had been possible to install about 5 million solar power systems among more than 13 million customers, and the rate is increasing by about 60% every year. The IDCOL target had been set to reach 220 MW capacity in the solar home systems sector by 2021. This large-scale renewable energy home electrification program has gained a great reputation around the world. Furthermore, Bangladesh is also considering the installation of rooftop (roof surface) solar power as a potential sector. As of July 2019, IDCOL approved 11 rooftop projects, 4 of which are already supplying 3 MW of electricity. Although the statistics are very small, it is a good initiative. Additionally, plans had been made to increase the capacity of this sector to 300 MW by 2022 [16].

3.3. Mini-Grid Placement

If a solar power network of 100 kW to 5 MW capacity with a minimum of 10 subscribers provides power disconnected from the national grid, it is known as mini-grid solar power. Similarly, solar power systems with a capacity of 10 to 100 kW and 3 to 10 kW are known as micro- and nano-grids, respectively. So far, 11 solar mini-grids have been set up in remote areas with the funding of IDCOL, and 15 more mini-grids are in process with a combined capacity of 2.19 MW to 3.17 MW [14].

3.4. Establishing Wind Power Plants

To further enrich the renewable energy sector, Bangladesh has taken various initiatives besides setting up wind power plants, which will enable a generation capacity of 1360 MW by 2021. To this end, the collection of wind-flow data has been completed in 2016 in nine potential regions of the country, including the coast, under the “Wind Resource Mapping Project”. The Bangladesh Power Development Board (BPDB) had planned to set up two 50 MW wind power plants at Inani Beach in Cox’s Bazar and Independent Power Producer (IPP) at Mongla in Khulna with the target of completion by 2021 [17][18].

3.5. Establishing Biogas Plants

Gas and electricity are generated from biogas plants, and the residue can be used as excellent organic fertilizer. The country’s first integrated waste management project was set up in 2016 in the Hamidpur area of Jessore municipality. The plant has the capacity to generate 720 cubic meters of biogas and about 430 kilowatts of electricity daily. As of December 2019, according to IDCOL, more than 53,200 biogas plants have been set up in the country through 36 partner organizations, through which it is possible to produce a maximum of about 25 cubic feet of biogas daily [19]. According to another estimate by IDCOL, several biogas-based power plants of 250 to 400 kW have been financed. Many private companies are playing an important role in this regard by financing in various ways. Grameen Shakti, one of the leading NGOs in Bangladesh, has set up more than 13 thousand plants across the country so far.

3.6. Identifying a Tidal Area

The most favorable locations for power generation in Bangladesh through the application of tidal power are in the eastern part of the delta region, such as Sandwip. It is considered to be the most suitable place to set up a tidal power plant, as the tide here is fast enough and the water level is up to seven meters. Experts identify Cox’s Bazar district as a potential area for this sector and see the potential to generate 2.23 gigawatt-hours of electricity annually. Net-metering customers will be benefited financially as the unit price of electricity generated from renewable fuels is less than the unit price of electricity taken from the grid. In view of this, the cost of setting up renewable fuel power plants in industries will rise in a few years. Net-Metering Guidelines were formulated in 2017 to implement the government’s goal of popularizing the renewable energy sector [20]. As a pilot program, the power distribution companies were given the target of creating 20 net-metering subscribers by mid-2018, but all but the Rural Electrification Board (REB) failed to meet this target. This target was later raised to 100 per company [21].

4. Bangladesh’s Achievements in Renewable Energy

4.1. Progress on SDG Goal-7: Affordable and Clean Energy in SDG Index

In the Sustainable Development Report 2022, it can be seen that in East and South Asia, Bangladesh and Cambodia have made the most progress in achieving the Sustainable Development Goals between 2015 and 2022 [22]. However, the same report also mentions that most of Bangladesh’s 17 goals have major challenges.

4.2. Present Renewable Energy Generation Capacity

Table 1 presents the current renewable energy production capacity of Bangladesh. Among the renewable energy sources, the maximum generating capacity is solar power at 716 megawatts. The capacity for hydroelectricity is 230 MW. The only hydropower plant in Bangladesh has a generating capacity of 230 MW, but it is necessary to start such a new power plant. Various projects have been undertaken to expand biogas power, but it is limited to 0.69 MW. Although three wind power plants have been completed, only two are operational, from which only 2.9 MW is being generated. As a result, the total generation capacity of Bangladesh's current renewable energy sector is about 951 MW. Since 2015, the continuous development of the renewable energy sector in Bangladesh has increased the generation capacity according to demand at various times, as presented in **Table 2**.

Table 1. Production capacity in various renewable sectors of Bangladesh [23].

Technology	Capacity (MW)
Solar Power	716.73
Wind Power	2.9
Hydroelectricity	230
Biogas	0.69
Biomass	0.4
Total (MW)	950.72

Table 2. Year-wise Production capacity enhancement in various renewable sectors [24].

Year	Installed Capacity (MW)
2022	54.12
2021	169.97
2020	64.77
2019	43.73
2018	39.99
2017	18.79
2016	19.36
2015	18.41

4.3. Present Renewable Energy Generation Capacity

All the projects that Bangladesh has undertaken to increase renewable energy production capacity SREDA have been classified into two categories, small renewable projects (small RE) and large renewable projects (large RE). Under the small-project category, the projects included Solar Home System, Solar Street Light, Solar Water Heater, and Biogas Plant.

Under the large-project category, Wind, Hydro, Bio Gas, Biomass, and Solar have been categorized through various production activities such as Solar Park, Solar Net Metering, Solar irrigation, Solar Minigrid, Solar Micro Grid, and Nano Grid Charging Station. Bangladesh's renewable energy production capacity has been divided into small and large renewable energy sectors since 2015, and it can be seen from Table 3 that the renewable energy production capacity of Bangladesh has gradually increased in the years since 2015.

Table 3. Production capacity in small and large projects renewable sectors of Bangladesh [23].

Year	Small RE (MW)	Large RE (MW)	Total (MW)
2015	168.7	252.371	421.0706
2016	178.73	271.7306	450.4606
2017	228.73	290.5206	519.2506
2018	245.24	330.5206	575.7606

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Year	Small RE (MW)	Large RE (MW)	Total (MW)
2019	267.31	374.2506	641.5606
2020	288.79	439.0206	727.8106
2021	288.79	608.9906	897.7806
2022	288.811	663.1106	951.9216

4.4. Year-Wise Generation Capacity of Solar Technology

In terms of renewable energy capacity in Bangladesh, **Table 4** presents the number of capacity additions from solar sources in the activities undertaken from 2018 to 2022. In **Table 4**, it can be seen that the solar generation capacity addition in 2018 is about 40 MW, and the maximum generation capacity increase is in 2021 at about 170 MW. Further, the production capacities of 54 and 64 MW have been added in the years 2020 and 2022, respectively, while 43.73 MW was added in 2019.

Table 4. Yearly solar-sources production capacity of Bangladesh [24].

Year	Installed Capacity (MW)
2022	54.1185
2021	169.9691
2020	64.46358
2019	43.73679
2018	39.99964

4.5. Electricity Generation Share

Table 5 presents the necessary data to represent the dependence on different energy sectors for electricity production in Bangladesh. It shows how much electricity is being produced in Bangladesh from which energy sources, and what percentage is dependent on these energy sources. It can be seen that the production capacity of electricity produced with gas as fuel is 11,476 MW, which is almost half (44.53%) of the total production capacity. A very important energy source is renewable energy, which accounts for 3.59 percent of the total generating capacity, and has a generating capacity of about 951 MW. This production capacity was planned by the Bangladesh government to increase by ten percent by 2020 to achieve SDG.

Table 5. Renewable-energy share with production capacity of Bangladesh [25].

Fuel/Resource	Installed Capacity (MW)	Share
Coal	1768	6.86%
Gas	11,476	44.53%
HFO	6278	24.36%
HSD	1341	5.2%
Imported	1160	4.5%
Renewable	950.8	3.69%
Captive	2800	10.86%
Total	25774	100%

4.6. Energy Generation and Carbon Savings

Carbon dioxide (CO_2) emissions are often measured as elemental carbon in kt (kilotons). The installed capacity of renewable energy systems as sources in Bangladesh and the expected energy generation from them are presented in **Table 6**. Furthermore, the amount of carbon emissions reduced by the electricity generated from each source is shown in the third column. It can be observed that the highest carbon dioxide-emission reduction was achieved through large hydro systems with a capacity of 230 MW and an expected energy generation of five trillion-watt hours, which is the highest among other technologies.

Table 6. Technology-wise CO_2 emission reduction predicted by SREDA [26].

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Technology Name	Installed Capacity (MW)	Till 18 January 2023 Expected Energy Generation (GWh)	Till 18 January 2023 CO_2 Emission Reduction ($ktCO_2$)
Solar Park	261	548	259
Net Metering Rooftop Solar	53.51	122	58
Solar Irrigation	50.55	250	118
Solar Roof Top (On and off Grid)	57.54	297	140
Solar Mini and Nano Grid	6.8	41	19
Solar Charging Station	0.2824	2	902
Solar Drinking Water System	0.095	1	511
Solar Home System	263.69	2000	973
Solar Street Light	17.07	63	30
Wind (On and off Grid)	2.9	40	19
Large Hydro (On-Grid)	230	5000	2000
Biogas to Electricity (Off and on Grid)	1.39	10	5

4.7. Net Metering Capacity

Continuing to meet the targets of SDGs, the net metering system was introduced in Bangladesh in 2017 to increase the renewable fuel capacity, and great efforts began to increase its scope. The overall picture of the net metering system in Bangladesh is illustrated in **Table 7**. It can be observed that the maximum amount of net metering capacity was added in 2021 at 19.41 MW, while the second-highest was 15.34 MW in 2022. A total of 10.04 MW was added in 2019.

Table 7. Periodic capacity statement of net metering [24].

Year	Installed Capacity (MW)
2022	15.34
2021	19.41
2020	4.54
2019	10.04
2018	3.82
2017	0.36
Total	53.51

4.8. Recent Net Metering Progress

Table 8 shows the net metering progress in the last three months wherein the current capacity of various responsible companies and the amount of capacity increase are presented. Dhaka-based companies DESCO and DPDC, which have great potential for solar rooftops, have made disappointing progress.

Table 8. Recent progress of institutional net metering capacity in Bangladesh [27].

Utility Name	October 2022 (MW)	November 2022 (MW)	December 2022 (MW)	Progress in Three Months (kW)
BPDB	16.109	16.136	16.163	54
BREB	27.883	28.133	28.716	833
DPDC	2.946	2.946	2.946	0
DESCO	2.585	2.59	2.589	4

Utility Name	October 2022 (MW)	November 2022 (MW)	December 2022 (MW)	Progress in Three Months (kW)
WZPDCL	1.174	1.203	1.203	29
NESCO	1.763	1.763	1.763	0

4.9. Progress of Renewable Energy Share in Bangladesh

Table 9 presents the year-wise population growth and population growth rate of Bangladesh, GDP growth rate, and renewable energy share. It can be observed that the population density growth of Bangladesh has not changed much between 2015 and 2022, but the GDP growth rate has increased slightly between 2015 and 2019 and decreased to 3.45 percent in 2020, which then increased in 2021 and 2022, respectively, from 6.94 percent to 7.20 percent.

Table 9. Year-wise growth of population, GDP, and percentage of renewable energy share [28][29][30].

Year	Population Density (per Sq. Km)	Population Growth Rate	GDP (Billions of $)	Per Capita	% of GDP Growth	% of Total Power Generation Capacity
2022	1156.84	1.08%	460.75	$2824	7.20%	3.69%
2021	1144.48	1.16%	416.26	$2503	6.94%	3.58%
2020	1131.40	1.15%	373.90	$2270	3.45%	2.75%
2019	1118.53	1.12%	351.24	$2154	7.88%	3.94%
2018	1106.14	1.17%	321.38	$1991	7.32%	4.47%
2017	1093.37	1.26%	293.75	$1840	6.59%	5.77%
2016	1079.79	1.24%	265.24	$1679	7.11%	5.85%
2015	1066.58	1.20%	195.08	$1248	6.55%	6.44%

5. Obstacles to Achieving SDGS in the Renewable Energy Sector

Bangladesh is a densely populated country. The number of landowners is high relative to the number of many small plots of land with the potential for setting up plants. Although there is a large amount of land suitable for setting up large-scale solar projects, it is the property of many landowners. As a result, more time has to be spent on land acquisition and legal processes [31]. Large areas along the rivers of riverine Bangladesh are considered to be suitable for setting up solar plants, but as these are lowlands, most of the rivers are flooded every year. Therefore, in order to implement solar projects, additional funds have to be spent on structural development in these places [32].

There are only two grid-connected solar projects in Bangladesh, one at Jamalpur's Sarishabari and the other at Teknaf. In most cases, skilled engineers have to be brought in from other countries to solve problems with these. An analysis of the two ongoing projects shows that there is a large shortage of skilled engineers and human effort to implement large-scale solar power projects [33]. The amount of energy produced from solar power depends on the elements of nature, such as light intensity, dust, and the presence of light. As these elements of nature change, the rate of power generation decreases or increases. As a result, the grid to which solar power will be connected has to endure these changes and various unforeseen errors [34]. To cope with such a situation, the national grid of Bangladesh has not been enriched by modern technology to a large extent.

Technical standards and codes are required at the national level for the implementation of large projects. Skilled suppliers are reluctant to implement projects considering the risks involved, as there is no code or standard for implementing large projects through solar technology. It has also been suggested that bureaucratic complexity is one of the major obstacles to the spread of renewable energy. Although it is now mandatory to conduct online purchases of goods and services, in some cases more than twenty approvals are required to allow a service provider to start with a project plan. Such conditions can be considered one of the major obstacles to achieving set goals.