Paper ID: 527

Present Status and Future Projection of Renewable Energy Resources and Their Impacts on GHG Emission Reduction in Bangladesh

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Abstract

Frequent assessment of the progress of renewable energy resources and their impacts on global greenhouse gas (GHG) emissions is important in the context of the fossil energy crisis and environmental threat. Bangladesh is a fast-growing developing country and its rapid development pinpoints the significant energy consumer in the future. The government of Bangladesh has already signed an international agreement to reduce fossil energy consumption and environmental emissions. In response to the agreement signed the government has already taken initiatives and set the target vision 2041. Adaptation the renewable energy was one of the main initiatives. This paper reviewed the current renewable energy situation, future projections, and their impact on GHG emissions. It was found that the present generation capacity using renewable energy is 1,381 MW and is projected to increase 30% by the year 2030. There are 51 solar park projects and 10 wind park projects to be installed to fulfill the set target by the year 2041. The lack of financing and expertise is identified as a major challenge for the initiatives. The GHG emission for Bangladesh is 169 million tons CO_2 eq in the base year 2012 and is projected to increase 409 million tons CO_2 eq in 2030 for the business as usual. Under the master plan 2041, the country has set to reduce GHG emissions by 21.85% in 2030 for business as usual scenario.

Keywords: Renewable energy, GHG emission, Present status, Projections, Bangladesh.

1. Introduction

The world has already been introduced to the benefits of renewable energy. It has social, environmental, and economic benefits. The global enforcement of renewable energy is due to the current fossil energy crisis and environmental emissions due to fossil fuel combustion. Renewable energy is on track to supply global half of the modern energy demand by 2030 [1]. Bangladesh has already taken initiatives to support the global effort. At present, Bangladesh's renewable energy contribution to power generation is 1.6% [2] and the government has set a target to produce 15% power from renewable sources and reduce carbon emissions by 21.8% within the year 2030 [3]. Therefore continuous assessment of the renewable energy initiatives is required to highlight the progress of the target that has been taken.

The study of the renewable energy situation in Bangladesh is available in the literature. Akash et al., 2024 [4] underscore the role of policies and strategic plans in transforming the current energy landscape. They emphasized the challenges and prospects aligned with achieving sustainable development goals. Rabbani et al., 2024 [5] reviewed the renewable energy situation in Bangladesh. They explored the comparative potential of renewable energy and discussed the challenges. Bijoy et al. 2023 [6] emphasized the renewable energy-based power generation in Bangladesh. The study analyzed the policies, finance, and challenges of renewable energy implementation in Bangladesh. Shabur, 2023 [7] shows how national and regional strategies helped Bangladesh overcome the obstacles to implementing renewable energy. The study suggested augmenting the adaptability of technologies and new ideas. Ranganathan and Baliarsingha, 2022 [8] provided some guidelines for the renewable and sustainable energy sector development. They discovered the different factors that are essential to policymakers. Bhuiyan et al., 2021 [9] represented the review of renewable and sustainable energy sources in Bangladesh. The review also discussed the guidelines for the government would successfully end their plan. Gulagi et al., 2020 [10] analyzed the energy transition pathways for Bangladesh. The optimization tools were used to model the energy transition of Bangladesh. The result showed that the emission costs accelerate the transition towards a fully renewable energy system and renewable energy would contribute 94% of the electricity generation by 2050.

The literature review discussed the renewable energy policies, strategic plans, financing, challenges, and the factors essential to the policymaker. The data presented in the literature seems not up to date and is a few years old. Continuous monitoring of renewable energy adaptation is important to reflect the progress of the national target. This paper includes a brief scenario of the current renewable energy situation in Bangladesh and future projections. The impacts of renewable energy adaptation on GHG emission reduction are also discussed. The objective of this study is to report the current and projected renewable energy situation and its impacts on GHG emission reduction in Bangladesh.

2. Renewable Energy Situation in Bangladesh

2.1 Present scenario

At present, the available renewable energy resources are solar, wind, hydro, biomass, and biogas of which solar and wind have more potential in Bangladesh. To keep pace with the current global trend, Bangladesh is prioritizing the advancement of Renewable Energy. Previously Hydro Power Station in Kaptai, Rangamati was the only renewable energy source in Bangladesh, and Solar Home System (SHS) stand-alone in rural areas. However in recent years, numerous renewable energy projects have been completed successfully to meet the demand, and many initiatives are underway. The contribution of renewable energy for power generation in 2024 is shown in Table 1. It is seen that the total capacity is 1381.32 MW of which off-grid and on-grid power generation capacity is 380.18 MW and 1001.13 MW respectively.

Table 1. The contribution of renewable energy to power generation capacity in 2024 [11]

SL.	Source	Off-grid (MW)	On-grid (MW)	Total (MW)
1.	Solar	377.09	710.23	1087.33
2.	Wind	2	60.9	62.9
3.	Hydro	0	230	230
4.	Biogas to power	0.69	0	0.69
5.	Biomass to power	0.4	0	0.4
	Total	380.18	1001.13	1381.32

Figure 1 shows the share of renewable energy sources on the generation capacity. It is seen that 79% of the generation capacity is found from solar energy. The contribution of hydro is 17% which is also significant. The wind resource in Bangladesh has limited potential and hence its contribution found is 4%. The contribution of biogas and biomass found is insignificant.

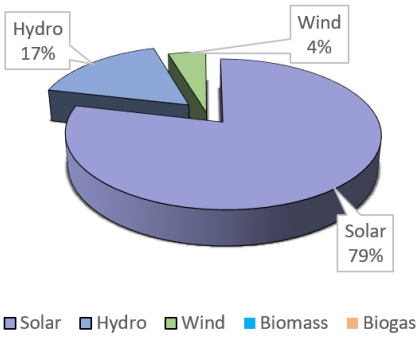


Fig. 1. Contributions of different renewable energy sources on power generation in Bangladesh

2.2 Projected scenario

Bangladesh has a vision for 2041which focuses on two principles such as establishing a sustainable and cost-effective power generation technique prioritizing renewable energy, and creating a suitable primary fuel that incorporates competitive options within the generation framework [12]. The power sector of Bangladesh is mostly dependent on gas. At present, the share of total installed capacity is natural gas 39 %, coal 18 %, liquid fuel 23 %, imported 3 %, renewable 4 %, and captive power 9 % [13]. The projected power generation capacity using renewable energy for the years 2025-2041 is shown in Table 2. As of May 2024, the cumulative power generation capacity is 29,371 MW. To achieve the government 2041 target specified in Table 2, Bangladesh requires 31.32 GW of built capacity from solar and wind energy if the capacity factor is 16%.

Table 2. Projected generation capacity using renewable energy sources from the year 2025-2041 [12].

Renewable Energy Installation Capacity Targets to 2041	2025	2030	2035	2041
Electricity generation target (TWh)	144.32	205.7	322.84	446.02
Generation target from renewable energy (TWh)	14.43	20.55	32.28	44.60
Total installed capacity target from RE (GW)	10.29	14.66	23.03	31.32

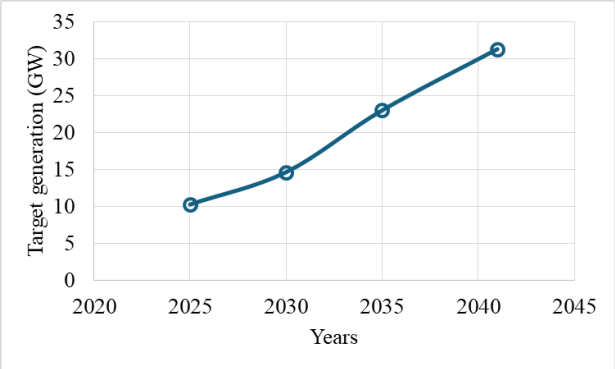


Fig. 2. The projected energy generation capacity until 2041

The projected power generation target is shown in Figure 2. It is seen that the rate of increase in the generation until 2030 is a little flat whereas from 2030 to 2041 the generation is expected to rise sharply. The projected increase in power generation for the first five years is 30% and for the next five years is 36% and after that 26%.

3. Government Initiatives to Fulfill the Target

The execution of the power and energy sector plan in the year 2021 accomplished significant achievement, particularly in power generation, establishing a platform for further development. Under the target in the year 2021, renewable energy progress was modest, with the share of non-hydro renewables reaching 2.8% by 2019. On-grid solar power added around 80 MW between fiscal year 2010 and 2018, while off-grid systems contributed 334 MW, primarily from solar. The 3% renewable energy target for 2021 is likely to be met, but development has been slower than anticipated [14].

The Government is prioritizing the development of Renewable Energy resources to enhance energy safety and construct a sustainable energy framework along with traditional energy sources. The government has initiated further plans (vision 2041) to establish a long-term goal for socio-economic development with a major focus on the increased utilization of renewable energy. A target has been set up by the Bangladesh government of covering 40% of its power generation with green energy by 2041 which includes 10% from renewable sources and plans to import around 9 GW under regional and sub-regional collaborations. The Ministry for Power, Energy, and Mineral Resources intends to achieve an installed capacity of 40 GW by 2030 and 60 GW by 2041 [15]. To achieve Vision 2041, the Bangladesh government initiated the development of 51 solar parks with a capacity of 3926.21 MWp and is planning the establishment of 10 wind power plants with a capacity of 717 MWp as a part of its renewable energy strategy. These projects are aimed at expanding the country's clean energy capacity and reducing its reliance on fossil fuels while supporting sustainable growth and environmental protection. Table 3 shows the projects under the plan to cover 10% renewable energy generation from renewable sources.

Table 3. Projects under the government plan for 10% generation from renewable energy [15]

Sources	Technology	Number of projects	Capacity (MWp)
Solar	Solar Park	51	3926.21
Wind	Wind park	10	717

4. Present Challenges and Recommendations

Bangladesh has established a framework for expanding grid-dependent renewable energy and now requires to provide specific support to this emerging sector. Based on the theory of energy experts, a thorough literature review, and group discussions from different energy workshops, these are the present challenges for Bangladesh in the adaptation of renewable energy shown in Table 4.

Table 4: Challenges and recommendations for the adaptation of renewable energy in Bangladesh [16]

Focus Areas	Challenges	Recommendations
Policy	Insufficient incentives to expedite the advancement of grid-integrated renewable energy.	Formulate thoughtful policies, guidelines, and incentives to attract competent developers and investment.
Land	Land scarcity for constructing the necessary infrastructure for renewable energy.	Conduct a land study that identifies options for land use for utility-scale renewable energy, including exploring options for zoned renewable energy areas.
Grid Network	Restricted spare grid capacity in the existing network and inability to ascertain the precise amount of available grid capacity.	Perform an analysis to identify regions of excess capacity for potential connections of renewable energy facilities to the grid. Determine network enhancements that might readily provide more capacity.
Renewable Energy Resource and Potential	Insufficient mapping of wind and solar resource potential in Bangladesh.	Perform resource potential assessments to delineate areas suitable for renewable energy project implementation. Determine limitations include land accessibility, roadway connectivity, and electrical grid development strategies.
Financing	Commercial banks exhibit a deficiency of expertise, resulting in a reluctance to engage in renewable energy projects and often providing unfavorable lending conditions and elevated interest rates.	Facilitate a comprehensive sector-wide consultation with local and international lenders to ascertain their financing criteria and identify strategies to mitigate critical risks impacting project viability.
Procurement	Insufficient information in government-led procurements hinders the submission of competitively priced bids.	Standardize the bidding procedure with a clear and equitable assessment of offers, since unsolicited submissions sometimes result in elevated bid amounts.
Institutional Capacity	Lack of institutional capacity within the public and private sectors and poor coordination between government institutions.	Develop a strategic strategy to enhance knowledge and institutional capacity in public utilities, particularly for utility-scale renewable energy.

5. GHG emission in Bangladesh

5.1 Present GHG emissions

The total greenhouse gas (GHG) emission in Bangladesh is 281.38 million tons of CO_2eq in the year 2023 and this is 0.53% of the global GHG emission. The per capita GHG emission in Bangladesh is 1.61-ton CO_2 equivalent which is consistent for the last two-year 2022 and 2023 [17]. The GHG emissions for the base year 2012 in different sectors and sub-sectors are shown in Table 5. It is seen that the total greenhouse gas emission counted 169.05 million tons of CO_2eq in the base year. The Energy Sector accounts for the largest share of 55% of GHG emissions of the country (Fig. 3) [18].

Table 5. GHG emission for Bangladesh in the year 2012 (Base year) [18]

Sectors	Sub Sector	GHG Emission
		The base year (2012)
		Million Ton of CO_2eq
Energy	Power, Transport, Industry, Households, Agriculture, Brick Kilns Fugitive,	93.09
Agriculture, forestry, and other land use (AFOLU)	Agriculture and Livestock	46.24
Waste	Municipal and Solid Waste	24.11
Industrial process and product use	Cement and Fertilizer	5.61
	Total Emissions	169.05

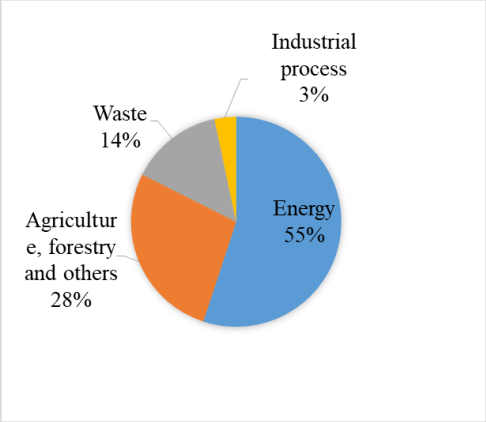


Fig. 3. Base year (2012) GHG emission in different sectors

5.2 Projected GHG emissions

Table 6 shows the projected GHG emissions for Bangladesh compared to the base year. It is seen that the total GHG emissions are forecasted to increase 2.42 times under the scenario of business as usual (BAU) with an increased value of 409.41-million-ton CO_2eq by 2030.

Table 6. GHG emission for Bangladesh projected in 2030 (BAU scenario) [18]

Sector	Sub Sector	GHG Emission BAU 2030 Million Ton of CO_2eq
Energy	Power, Transport, Industry, Households, Agriculture, Brick Kilns Fugitive,	312.54
Agriculture, forestry, and other land use (AFOLU)	Agriculture and Livestock	55.01
Waste	Municipal and Solid Waste	30.89
Industrial process and product use	Cement and Fertilizer	10.97
	Total Emissions	409.41

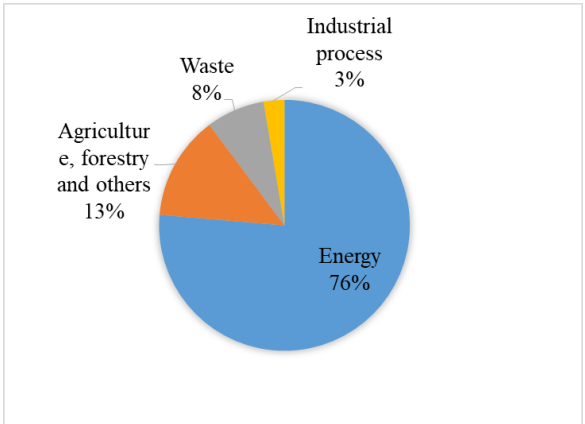


Fig. 4. Projected GHG emission in different sectors in the year 2030

6. GHG Emission Reduction Target

Bangladesh's Government has formulated some policies for GHG emission reduction, renewable energy enhancement, and climate change mitigation which include Nationally Determined Contributions (NDC), Bangladesh Delta Plan 2100, NDC Implementation Road map 2018, and Bangladesh Energy Efficiency and Conservation Master Plan up to 2030. The GHG emission reduction target is shown in Table 7.

Table 7. GHG emission reduction target [19]

Contributions	Target
Unconditional Contribution (Using own resources)	Bangladesh will reduce its GHG emission by 27.56 MtCO2e or 6.73% in 2030 • 26.3 Mt CO_2 eq (95.4%) emission reduction from the Energy sector • 0.64 Mt CO_2 eq (2.3%) emission reduction from AFOLU (Agriculture) • 0.6 Mt CO_2 eq (2.2%) emission reduction from waste
Conditional Contribution (With international support)	Bangladesh will reduce its GHG emission by 61.9 MtCO_2eq or 15.12% in 2030 • 59.7 Mt CO_2 eq (96.46%) emission reduction from the Energy sector • 0.4 Mt CO_2 eq (0.65%) emission reduction from AFOLU (Agriculture) • 1.84 Mt CO_2 eq (2.97%) emission reduction from waste
Combined Total Contribution	Bangladesh will reduce its GHG emission by 89.47 MtCO_2 or 21.85% as BAU in 2030

7. Conclusion

The present and future projections of renewable energy resources and their impacts on greenhouse gas emission reduction in Bangladesh are reported in this paper. The following conclusion can be drawn from the analysis-

- The renewable energy's contribution to the power generation capacity at present is 1,381 MW, of which 1,087 MW (79%) is produced from solar energy resources. The projected increase in power generation is 30% by the year 2030.
- The government of Bangladesh has already taken initiatives to achieve the goal set in Vision 2041. The initiative includes 51 solar parks and 10 wind parks to be installed.
- There are challenges to adaptation the renewable energy in Bangladesh. The lack of financing and expertise are identified as the major challenges.
- The total GHG emission accounted for Bangladesh is 169 million tons of CO_2 eq in the base year 2012 and is projected to increase by 409.41 million tons of CO_2 eq by 2030 for business as usual scenario.
- Under the renewable energy master plan for Vision 2041, Bangladesh's GHG emission is expected to reduce by 21.85% in 2030 for business as usual scenario (89.47 million tons of CO_2 eq).

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