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Policy Instruments to Promote Renewable Energy in Bangladesh

Khondaker Golam Moazzem
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CENTRE FOR POLICY DIALOGUE

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The present paper titled ***Policy Instruments to Promote Renewable Energy in Bangladesh*** has been prepared by *Dr Khondaker Golam Moazzem*, Research Director, CPD (moazzem@cpd.org.bd), *Ms Helen Mashiyat Preoty*, Research Associate, CPD (preoty@cpd.org.bd), and *Ms Moumita A Mallick*, Programme Associate, CPD (moumita@cpd.org.bd).

Series Editor: *Dr Fahmida Khatun*, Executive Director, CPD.

Abstract

Based on global and regional geopolitical considerations, as well as the challenges posed by climate change, Bangladesh has made commitments in both national and international levels to increase the proportion of RE within its energy sector. But the measures being taken are insufficient to fulfil the commitments as the domestic energy policy landscape is yet to establish RE as a feasible power generation source to meet the domestic requirements. This study will identify the barriers and weaknesses within Bangladesh's energy policy landscape that hinder the attraction of domestic and foreign investments in RE-based power generation. For Bangladesh, a few additional policy instruments may be helpful to support the RE within the existing policy landscape. This study also attempts to grade the reflection of the RE supporting policy instruments such as RPS, strategic planning, tax incentives, financing and refinancing, grants and subsidies, net-metering, and feed-in tariff to rank the category of the selected policies as high, medium, and low. The RE Policy is found to be the most inclusive policy followed by the MCPP. It is discouraging that the energy policy of Bangladesh consists only of two RE-supportive policy instruments, whereas it should have been the most concrete and comprehensive policy document. Further, the study seeks to justify that Bangladesh has sufficient RE resources to achieve the RE goals and targets by accumulating empirical evidence or studies on Bangladesh. Although sufficient policies related to RE are there, a lack of intention and political conflict of interest make the implementation of those policies much harder. By amending the RE policies and building coherence among the public policies, Bangladesh can surely improve the RE landscape. Allocation for RE-based research with higher relative incentives in the sector, aggressive policies to attract private sector investment and promoting domestic investment can help achieve the RE targets smoothly.

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Acronyms

ADB	Asian Development Bank
APSCL	Ashuganj Power Station Company Limited
BADC	Bangladesh Agricultural Development Corporation
BARD	Bangladesh Academy for Rural Development
BARI	Bangladesh Agricultural Research Institute
BBDF	Bangladesh Biogas Development Foundation
BCRECL	Bangladesh-China Renewable Energy Company (Private) Limited
BCSIR	Bangladesh Council of Scientific and Industrial Research
BDP	Bangladesh Delta Plan
BDT	Bangladeshi Taka
BERC	Bangladesh Energy Regulatory Commission
BMDA	Barind Multipurpose Development Authority
BNBC	Bangladesh National Building Code
BPDB	Bangladesh Power Development Board
B-R PowerGen	BPDB-RPCL Powergen
BRRI	Bangladesh Rice Research Institute
CDM	Clean Development Mechanism
CMSME	Cottage, Micro, Small and Medium Enterprise
CPGCBL	Coal Power Generation Company Bangladesh Limited
CSO	Civil Society Organisation
CSP	Concentrating Solar Power
DC	Direct Current
DESCO	Dhaka Electric Supply Company Limited
DNI	Direct Normal Irradiation
DPDC	Dhaka Power Distribution Company
EGCB	Electricity Generation Company of Bangladesh
EPZ	Export Processing Zone
FIT	Feed-in Tariff
FYP	Five Year Plan
GHI	Global Horizontal Irradiation
GoB	Government of Bangladesh
GW	Gigawatt
GWh	Gigawatt hour
GWh/yr	Gigawatt hours per year
IDCOL	Infrastructure Development Company Limited
INGO	International non-governmental organisations

IPP	Independent Power Producer
KEPZ	Korean Export Processing Zone
KII	Key Informant Interview
kWh	Kilowatt hour
kWp	kilowatts peak
MCPP	Mujib Climate Prosperity Plan
MoCHTA	Ministry of Chittagong Hill Tracts Affairs
MoDMR	Ministry of Disaster Management and Relief
MoEFCC	Ministry of Environment, Forest and Climate Change
MoPEMR	Ministry of Power, Energy, and Mineral Resources
MW	Megawatt
NEP	Renewable Energy Policy
NWPGCL	North-West Power Generation Company Limited
PFI	Participating Financial Institution
PP	Perspective Plan
PPP	Public Private Partnership
PSMP	Power Sector Master Plan
PSPGP	Private Sector Power Generation Policy
PV	Photovoltaic
RDCD	Rural Development and Co-operatives Division
RE	Renewable Energy
REP	Renewable Energy Policy
RPCL	Rural Power Company Limited
RPS	Renewable Portfolio Standard
SFPBFI	Sustainable Finance Policy for Banks and Financial Institutions
SREDA	Sustainable and RE Development Authority
SSREL	Super Star RE Limited
T&D	Transmission and Distribution
TWh	Terawatt hour
VAT	Value-Added Tax
W	Watt
WZPDCL	West Zone Power Distribution Company Limited

1. INTRODUCTION

In Bangladesh, the concept of Renewable Energy (RE) first appeared in 1996. The experts and planners of the country started their activities on RE in the same year and ultimately the National Energy Policy (NEP)1996 came to light. However, it is the NEP of 2004 that had set the objective of having a RE share in country's total energy output: at least five per cent by 2010 and 10 per cent by 2020 (NEP, 2004). Based on the Mujib Climate Prosperity Plan (MCPP) of Bangladesh, the country aims to reach 30 per cent RE by 2030 and 40 per cent by 2041 as per the decision of the Ministry of Environment, Forest and Climate Change of Bangladesh in 2021 (MoEFCC, 2021).

On the grounds of the existing global and regional geopolitics and climate change syndrome, the necessity of transition from fossil fuel to RE as far as practicable cannot be denied. Looking into global geopolitics, Europe has already been proceeding slowly towards RE. The Russia-Ukraine War is also making Europe realise the importance of energy efficiency and self-dependency. In other Asian countries such as *India, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand,* and *Vietnam* that have progressed in RE compared to that of Bangladesh had effective policies, supportive tools, and instruments. Despite being self-sufficient with natural renewable fuel sources, Bangladesh is constantly failing to achieve the RE targets which are not even that much ambitious. According to the Sustainable and RE Development Authority (SREDA), the current RE installation capacity of Bangladesh is only 910 Megawatt (MW).

Bangladesh has, of course, been making commitments in the national and international arena to promote the share of RE in the energy sector. However, measures taken to carry out the commitments are insufficient. In addition to mentioning the barriers, the authorities have to investigate and aim at the possible solutions to raise RE shares in the power sector. The government has announced that the five abandoned coal-based power plants will eventually be converted into RE-based power plants. But these are still inferior to the requirements. The domestic narrative and dispensation around energy in our country is fossil fuel-based and grid energy. As a result, all the energy policies have been developed (and undertaken) emphasising fossil fuel-based power generation.

This study will identify the barriers and weaknesses of the existing energy policy landscape in Bangladesh for attracting domestic and foreign investment in RE-based power generation in the country. Additionally, the study seeks to justify that Bangladesh has ample RE resources to achieve the RE goals and targets by accumulating empirical evidence or studies on Bangladesh.

2. METHODOLOGY

2.1 Analytical Framework

Sovacool (2010) developed an analytical framework to evaluate Renewable Portfolio Standards (RPS), green power programmes, public research and development expenditures, systems benefits charges, investment tax credits, production tax credits, tendering, and Feed-in Tariff (FIT) in Southeast Asia. It assesses each of these mechanisms/evaluating variables according to the criteria of efficacy, cost-effectiveness, dynamic efficiency, equity, and fiscal responsibility. The study concludes that one mechanism – FIT– is both the most preferred by respondents, and the only one that meets all criteria.

Besides, Bobinaite & Tarvydas (2013) revealed that the governmental support in the form of RE financing, tax reductions and subsidies, and international funds are important RE sector financing

channels in developing countries. In case of Bangladesh, few additional policy instruments may be helpful to support RE within the existing policy landscape.

RPS: RPS mandate that utilities use renewable elements to produce a specific amount of their electricity sales or generating capacity (Sovacool, 2010). The RPS policies satisfy the efficiency, cost-effectiveness, and fiscal burden of the government criteria.

Strategic Planning: It includes policy development plans and setting up an Agency to support and include RE policies in the plan. In most cases, strategic planning provides generation or capacity targets to achieve the preset goal(s). Although these targets do not involve any obligation on the part of power companies, they show the government's willingness and the strategies for expanding the RE capacity and generation (Kim, 2020).

Tax Incentives: Tax exemption is applied as a fiscal incentive measure to enhance RE generation in many countries. Tax credits could be applied for the investment, production, or consumption segments of electricity generated by RE sources (Deng & Guo, 2017).

RE Financing and Refinancing: With its focus on promoting RE projects through its business activities, governments sometimes opt to provide financial assistance to financial institutions towards setting up power generation projects for harnessing RE sources such as solar, biogas, small hydro, wind, etc.

Grants and Subsidies: After various reviews on the consequences of different policy implications in four countries viz., South Korea, China, Germany and the United Kingdom to analyse the effectiveness of the policy tools like grants and subsidies, it was found that all these countries started supporting RE markets by capital subsidising in the early stages and FIT, and RPS in later stages.

Net-metering: Net metering is the electricity policy instrument that enables grid-connected customer-generators (homes or businesses that own a Photovoltaic (PV) or other generation technology connected to the grid) to offset some or all their electricity consumption and get paid for excess energy injected into the grid (Dufo-Lopez &Bernal-Agustín, 2015).

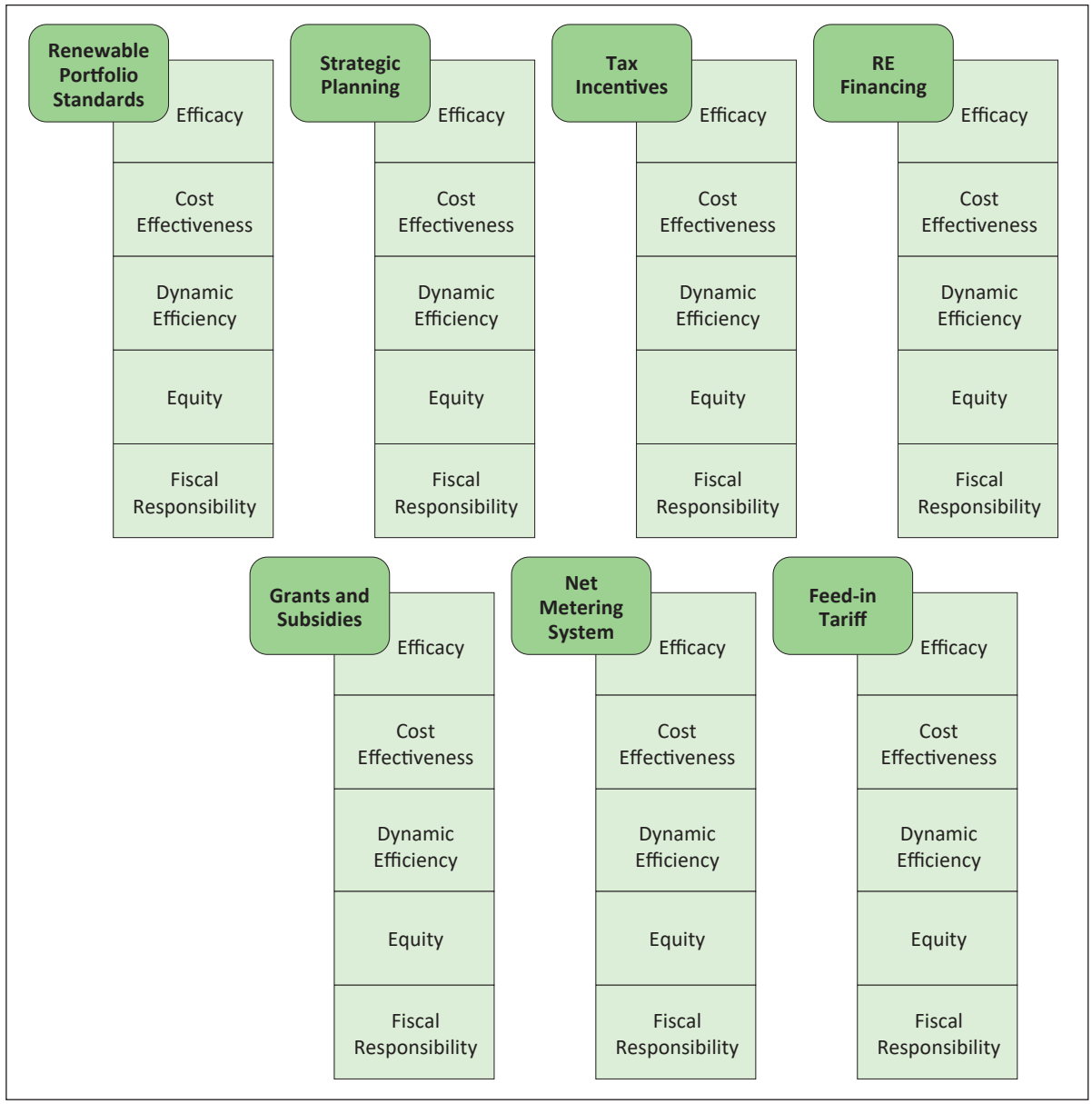
Feed-in Tariff: The FIT provides a fixed price contract, which can be an all-inclusive rate or a fixed premium on top of existing market prices for electricity, over a long period, usually the reasonable life of a system, or 15–30 years. The costs of these higher tariffs are distributed amongst all electricity consumers (Sovacool, 2010). The FIT is an energy-supply policy focused on supporting the development of new RE projects and offers a long-term purchase agreement for the sale of RE electricity (Deng & Guo, 2017).

2.1.1 Criteria for Evaluations

The effectiveness of policy instruments can be assessed based on the evaluation criteria for those policies. Sovacool (2010) developed an analytical framework consisting of the following five criteria to evaluate the eight policies, drawn from interviewed respondents as well as scholarship on public policy for RE. This study adopts this framework (Figure 1) to evaluate the seven policies that have been chosen counting the Bangladeshi policy landscape.

Efficacy: Efficacy of a policy mechanism means its capacity and competence to accomplish the policy target or successfully complete the goals. In the case of RE, the efficacy of the policy is measured by

Figure 1: Policy Instruments Evaluation Criteria



Source: Authors' illustration.

the increment of RE-based power generation through the policy. It also includes the cost-efficient aspect of the policy, indicating that the increased generation must be cost-effective and sustainable.

Cost-effectiveness: As mentioned in the previous criteria, this cost-effectiveness usually refers to the reduction of the societal cost. Through distinctive fiscal measures such as tax and incentives, the societal cost is kept at an effective level. Providing electricity to consumers at the lowest possible price indicates the cost-effectiveness of policies.

Dynamic Efficiency: Policies that ensure diversification of RE sources need to be proper and suitable when evaluating the efficiency of the policy. Dynamic efficiency refers to the suitability of any policy to ensure a diversification of RE sources and technologies. It captures how much a policy encourages the adoption of a basket of RE systems including the most expensive ones. The criterion does face a

Figure 2: Framework of the Renewable Energy Policy Landscapes Ranking

Renewable Portfolio Standard	
High	Sectoral generation target has been set
Medium	A medium to high generation target has been set
Low	A low generation target has been set
Strategic Planning	
High	Includes policy development plans and setting up an agency to support Renewable Energy policies
Medium	Identify what needs to be done
Low	Includes generation or capacity targets to achieve
Tax Incentives	
High	Elaborate on the TAX management clearly
Medium	Clearly includes the per cent or rate of incentive
Low	States the provision of TAX incentive
Renewable Energy Financing	
High	Elaborate on the Renewable Energy financing scheme clearly
Medium	Clearly includes the financing provisions
Low	States the provision of financing
Grants and Subsidies	
High	Elaborate on the grants and subsidy management clearly
Medium	Clearly includes the per cent or rate of grants and subsidy
Low	States the provision
Net Metering System	
High	Elaborates the stakeholders and their roles
Medium	Includes how it is going to function
Low	States the provision of net metering system
Feed-in Tariff	
High	Elaborates the stakeholders and their roles
Medium	Includes how it is going to function
Low	States the provision of feed-in tariff (FIT)

Source: Authors' illustration.

tension with cost effectiveness in the short-term, but in the long-term dynamic efficiency tends to reduce costs as innovation and competition occur.

Equity: Equity refers to the eligibility of a policy mechanism. Does a policy assist all small-scale electricity producers and homeowners, or is it only eligible for a small and consolidated group? In this study, a policy was equitable if it offered support not only to power generation companies and manufacturers but also the end users, consumers, and firms outside of the energy sector.

Fiscal Responsibility: Fiscal Responsibility refers to how much a policy costs a government. A fiscally responsible policy would be self-sustaining and would not require continual revenue disbursement on the part of the government. In this study, a policy was found to be fiscally responsible if it was paid for by consumers themselves and not by the government.

This study tried to grade the reflection of the RE supporting policy instruments to rank their category within the selected policies of Bangladesh. The reflection or existence of the instruments has been ranked as high, medium, and low. Figure 2 below postulates the classification of the rank based on the policy instruments.

2.2 Data Collection

Aiming to understand the appropriate policy instruments developed and utilised to attract investment in RE sector of the country, this study has reviewed policy packages which are successfully applied in different developed and developing countries. To demonstrate the potentiality of RE in Bangladesh, the study has referred to and reviewed several evidence-based research, case studies on Bangladesh and potential scopes that can be explored in the future.

The data for this report has been collected from both primary and secondary sources. In some cases, information has been gathered from the websites of the responsible government or public agencies such as Bangladesh Power Development Board (BPDB) and SREDA. Several Key Informant Interviews (KIIs) involving government officials, private sector, and civil society organisations (CSOs), and academia have been conducted. Three KIIs were conducted involving the government or public sector, two KIIs were conducted with the private sector, and two KIIs were carried out with CSOs and academia.

3. MAPPING THE RENEWABLE ENERGY POLICY LANDSCAPE OF BANGLADESH

Bangladesh has been performing up to the mark in terms of policy formulation. Hence, the policy landscape of the country is impressive. Nevertheless, an extensive assessment that whether these policies are RE responsive is required, is an important objective of this study.

The widespread application of the new RE technologies has heralded the necessity to introduce new policies catering to the promotion and implementation of innovative, environmentally friendly, and resilient mechanisms. Historically, the Renewable Energy Policy (REP) support has been mostly extended to the power sector. But recently heating and cooling, transport, and communication sectors are also gradually emerging. However, the RE policy supports can be broadly categorised into direct and indirect ones. Direct policy measures clearly pursue the increased deployment process by prescribing mandates or offering financial incentives, and indirect policies are usually aimed at creating an enabling environment and effective operating conditions for RE technologies. The REP incentives also vary based on the level of RE share on energy mix, technical and market integration

of increasing share of RE that are three main focuses of policymakers from comparatively matured RE markets. On the other part, in the case of the emerging and less mature markets, the RE related policies are typically aimed at increasing RE capacity and generation to meet demand, ensure energy security, and enhance access to modern energy services. Public policies also effectively influence corporate sourcing of RE generation.

3.1 Mujib Climate Prosperity Plan (MCPP): Decade 2030

The MCPP is the most recent addition to the REP landscape of Bangladesh. This policy is the aggregate plan to secure resilience, energy sufficiency and energy security, and attempts to be a net green energy exporter to the world. With international and other investment support, the aim is to reach 30 per cent RE by 2030 and at least 40 per cent by 2041, by way of grid resilience and modernisation. The flagship energy projects include the Mujib Bangoposagor Independence Array which is one of the first large-scale hybrid RE-adaptation infrastructure projects targeted to revitalise a mangrove green belt to protect our threatened coastlines. As with strategic Mujib Energy Hubs, coal plants will be converted into green energy facilities such as hydrogen works.

So, it is clearly visible that the MCPP contains three of the seven supporting instruments (Table 1) among the existing policies of Bangladesh.

Table 1: Level of Reflection of Renewable Energy Support Mechanisms in MCPP

RE Support Mechanism	Description of the matched part of the Mechanism in the Policy	Level of Reflection
RPS	The MCPP sets a target for RE in the energy mix of Bangladesh for 2030 and 2041. The plan outlines 30 per cent RE by 2030 and 40 per cent by 2041 under the scenario MCCP-Maximised (subject to international and other investment support). Under the MCCP scenario described as realistic climate prosperity scenario, the target is 10 per cent by 2030.	Medium
Strategic Planning		Absent
Tax Incentives		Absent
FITs		Absent
RE Financing	The Plan mentioned investment opportunity is worth at least USD 10 billion over the next decade in RE -based generation alone.	Low
Grants & Subsidies	The Plan aims at gradual phase out of the existing fossil fuel subsidies.	Low
Net-metering		Absent

Source: Authors' illustration.

3.2 The Renewable Energy Policy of Bangladesh

The REP 2008 is the first ever RE related policy of Bangladesh that focuses only on RE. But unfortunately, the landscape of RE has evolved over the period. It has developed far in recent times, especially in terms of technological changes. The goal of the REP was to spread the utilisation of RE technologies across the country by ensuring and strengthening a favourable technological, financial, and legal environment. More specifically, the policy document guides the necessary institutional arrangement, which led to the formulation of the SREDA. The policy document also outlines a few resources, technology, and programme development steps, and provides scopes for potential investment as well as fiscal and regulatory incentives (Table 2).

Table 2: Level of Reflection of Renewable Energy Support Mechanisms in REP

RE Support Mechanism	Description of the matched part of the Mechanism in the Policy	Level of Reflection
RPS	One of the objectives of the REP of Bangladesh was to achieve the targets (five per cent by 2010 and 10 per cent- by 2020) as set by NEP in 2004.	Medium
Strategic Planning		Absent
Tax Incentives	RE Policy of Bangladesh introduced the 15 per cent Value-Added Tax (VAT) exemption on all RE equipment and related raw materials in producing RE. The policy shortens the period for corporate income tax exemption from 15 years (in NEP, 2004) to five years, with a clause to extend periodically following impact assessment of tax exemption on RE.	High
FIT	Provide fund for the development of standardised RE configurations to meet common energy and power applications, such as solar, biogas and bio-diesel for mechanical irrigation and improved community practices for forest management and conversion and use of fuel wood by using grant, subsidy and/or carbon/ carbon emission trading (CDM) fund. Existing RE financing facility shall be expanded to those capable of accessing public, private, donor, CDM and carbon funds and providing financing for RE investments. Power Division under the MoPEMR will facilitate investment in RE and energy efficiency projects. SREDA, in co-operation with local government offices, will set up an outreach programme to develop RE programmes.	Medium
RE Financing		Absent
Grants & Subsidies	Develop financing mechanisms and facilities by using grants, subsidies and/ or carbon/CDM funds for public and private sector investments in all forms of sustainable energy	Low
Net-metering		Absent

Source: Authors' illustration.

The REP 2008 turned out to be the most inclusive RE policy as it includes four out of seven RE supporting instruments. These instruments viz., RPS, Tax Incentives, FIT, Grants and Subsidies have been discussed in the RE policy but not extensively enough.

3.3 National Energy Policy (NEP)

The NEP was first announced in 1996. The aim of the policy was to ensure energy sources are properly explored, and energy is produced, distributed and used rationally by various sectors. Later, in view of several limitations of this policy and the rapidly changing global and local energy scenarios, the NEP received a subsequent upgradation in 2004. The revised NEP stresses highly on the RE implementation across the country by setting a RE generation capacity target (10 per cent share of renewable power by 2020). It also aimed to encourage both local and foreign private investment by allowing various fiscal incentives and other facilities.

Unfortunately, the energy policy of Bangladesh consists of only two RE supportive policy instruments (Table 3) but it should have been the most concrete and comprehensive policy document.

Table 3: Level of Reflection of Renewable Energy Support Mechanisms in NEP

RE Support Mechanism	Description of the matched part of the Mechanism in the Policy	Level of Reflection
RPS	The NEP first set a portfolio standard for RE in Bangladesh. It stated a target of having five per cent RE share by 2010 and 10 per cent by 2020.	Medium
Strategic Planning		Absent
Tax Incentives	This is the first policy NEP that had set the framework to promote renewable energy in Bangladesh. Under this policy, renewable energy project sponsors can enjoy corporate income tax exemption for 15 years. There are other fiscal incentives- 100 per cent depreciation in the first year for solar projects; 100 per cent depreciation in five years for wind, biomass, geothermal, tidal, and small hydro projects; duty and VAT free import opportunity for plant and equipment. There are also some incentives for foreign investors like income tax exemption, tax exemption on royalties, tax exemption on interests, tax exemption on capital gain from transfer of share, opportunity of avoiding double taxation in case of bilateral agreements.	High
FIT		Absent
RE Financing		Absent
Grants and Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

3.4 Perspective Plan (PP) of Bangladesh, 2021–2041

The General Economic Division of the Planning Commission of the government published the final draft of its PP of Bangladesh 2021–2041 in January 2020. A separate chapter in that plan has been dedicated to the energy sector. The visions set for the energy sector by 2041 include the capacity to meet the energy demands of an upper, middle and high-income economy which Bangladesh aims to be one by that time with a sustained and universal access, an efficient supply of electricity at an affordable price, achieving 100 per cent energy security, maintaining consistency between environmentally safe energy production and supply, and building a nationwide pipeline network for faster, safer, and environment-friendly transportation of petroleum products.

Based on these visions, the document outlines key objectives and targets and briefly discusses several strategies and policies that would be instrumental in achieving the targets. For instance, the Plan projects that by 2041, there should be no gap between the peak demand and electricity supply owing to a massive 115 GW of generation capacity. The RE and energy imports are predicted to jointly supply 35 per cent of the energy mix. Such predictions with greater emphasis on sustainable energy sources present a great contrast when compared to the previous PP published in 2012 by the Planning Commission. Another important point of deviation is the choice between the least-cost power generation expansion path phasing-out quick rentals and the establishment of a low-cost primary fuel supply infrastructure.

Though the PP of Bangladesh 2021–2041 is made of three supporting policy (Table 4) instruments, all those policies have ranked low.

Table 4: Level of Reflection of Renewable Energy Support Mechanisms in the Perspective Plan

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS	The document outlines key objectives and targets and briefly discusses several strategies and policies that would be instrumental in achieving the targets. For instance, the Plan projects by 2041, there should be no gap between the peak demand and supply owing to a massive 115 GW of generation capacity.	Low
Tax Incentives	Consideration will also be there to the adoption of a carbon tax to reduce carbon emission from the use of fossil fuel and to promote investment	Low
FIT		Absent
RE Financing		Absent
Grants and Subsidies	PP 2041 promises to ensure that all fossil fuels are properly priced to eliminate the subsidy	Low
Net-metering		Absent

Source: Authors' illustration.

3.5 Eighth Five Year Plan (8FYP) July 2020 – June 2025

The latest addition to the policy documents concerning the development of RE technologies in Bangladesh is the 8FYP 2020 to 2025. The government's commitment towards low-carbon sustainable energy and power technologies appears in this document. Since the government plans to lay emphasis on coal projects as a short-term strategy, parallel importance is attached to RE to compensate the negative impact of this untidy fossil fuel. The 8th FYP has set the target for RE options including hydropower to supply five per cent of the total electricity by June 2025. The 8th FYP also rightly recognises the significant role to be played by the private sector in setting the initial stage based on which the more active and visible energy transformation may take place in the coming decades. Several solar PV and wind Independent Power Producer (IPP) projects are mentioned in this document which are either under planning or will be implemented within the timeframe of this 8FYP. The document also mentions that there is still a gap in the policy and regulatory framework concerning financial incentives and technical rules that will appear to be indispensable with the increasing grid-penetration of variable RE technologies (Table 5).

Table 5: Level of Reflection of Renewable Energy Support Mechanisms in 8FYP

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS	8th Five Year Plan (FY2021—FY2025) is going to focus on attaining the 10 per cent RE target of Bangladesh. The policy intends to achieve the target through Independent Power Producers.	Low
Strategic Planning		Absent
Tax Incentives		Absent
FIT		Absent
RE Financing		Absent
Grants & Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

The 8FYP only includes one RE support mechanism which is RPS. The rest of the six support mechanisms are absent in this policy document. It indicates that the level of reflection of RE mechanisms in 8FYP is very low and poor.

3.6 Bangladesh National Building Code (BNBC) 2020

The BNBC was first conceptualised and formulated in 1993 by the Ministry of Housing and Public Works of Bangladesh to regulate the technical details of building construction and to maintain the standard of construction. It was a detailed document specifying safe and acceptable practices in all aspects of building design and contraction. Later, it was amended in 2007 and 2020 subsequently. The BNBC contains essential aspects of requirements to ensure a safe working environment like the definition of the high-rise building, the size of the premise area, how the fire system will feature in the building structure; for factory or industry, how will be the storage system of the buildings, the size of windows and doors, the number of restrooms in each floor of the factory. Moreover, Bangladesh National Building Code provides for the regulation requiring the buildings to supply a portion of their electric load from renewable electricity. According to the regulation, a residential building should supply three per cent of the total electric load of the building from solar or other renewable source(s); for non-residential buildings such as factory, industry or the like, this quota is five per cent. Table 6 demonstrates the level of reflection of RE support mechanisms in the BNBC.

Only one RE support mechanism, RPS has been observed in the Bangladesh National Building Code (BNBC). However, the level of reflection is high. But the rest of the six support mechanisms are absent in this policy document.

Table 6: Level of Reflection of Renewable Energy Support Mechanisms in BNBC

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS	The BNBC now provides for the regulation that requires buildings to supply a portion of their electric load from renewable source. According to the regulation, residential building should supply three per cent of the total electric load of the building from solar or other renewable sources, and for non-residential buildings, it's five per cent.	High
Strategic Planning		Absent
Tax Incentives		Absent
FIT		Absent
RE Financing		Absent
Grants & Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

3.7 Net Metering Guidelines – 2018

In July 2018, the Power Division of the Ministry of Power, Energy and Mineral Resources (MoPEMR) launched the Net Metering Guidelines-2018 (NMG) with the target to incentivise the installation of rooftop solar PV systems on a massive scale. Turning the consumers into prosumers was the core idea behind the Net Metering mechanism. Prosumers are the consumers who also produce electricity by connecting their RE systems to the distribution grid via a bi-directional smart meter. The prosumer consumes the electricity produced from the RE system, and the excess electricity (if there is any) will be fed into the grid via the net meter. The prosumers accumulate kWh credit for

any excess electricity supplied to the grid after self-consumption. The Kilowatt Hour (kWh) credit is allowed to roll over until the end of the settlement period and by the end of it, the prosumers are entitled to receive the equivalent price of net export.

In comparison to this, the Net Metering Guidelines has proved to be a much inclusive policy as it also includes three policy instruments, where two of them have ranked as better (Table 7) followed by the NEP.

Table 7: Level of Reflection of Renewable Energy Support Mechanisms in NMG

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS		Absent
Strategic Planning	It includes a detailed guideline on eligibility criteria, consumer categories, capacity and energy export limits, energy accounting and settlement, tariff structure, metering arrangement, and detailed application procedure. It also includes feeding method of re system, equipment standards, connection types, general interconnection requirements, voltage functions and imbalance, re generator power factor, reactive power compensation, short-circuit level, protection guidelines & schemes, safety requirements.	High
Tax Incentives		Absent
FIT		Absent
RE Financing		Absent
Grants & Subsidies		Absent
Net-metering	The guidelines state a detail on all the net metering issues such as eligibility criteria, consumer categories, capacity and energy export limits, energy accounting and settlement, tariff structure, metering arrangement, detailed application procedure; it also includes feeding method of re system, equipment standards, connection types, general interconnection requirements, voltage functions and imbalance, re generator power factor, reactive power compensation, short circuit level, protection guidelines & schemes, safety requirements.	High

Source: Authors' illustration.

3.8 Bangladesh Delta Plan (BDP) 2100

The latest addition in the RE-related policy landscape is the adoption and approval of the BDP 2100 in September of 2018. It is the maiden initiative by the Government of Bangladesh (GoB) to adopt such a long-term strategy for floods and soil erosion prevention, managing rivers and wastes, and ensuring nationwide water supply. The document is relevant and worthwhile in respect of the RE landscape from multiple viewpoints. In this plan, a renewed target of generating 30 per cent of the total energy from renewable sources by 2041 has been set. This policy document also indicates significant land reclamation potential along the major riverbanks and in the estuary region that can be utilised for setting up stand-alone solar panels. It speculates that the large piece of land available from accelerated natural reclamation process through building cross dams and other infrastructures can be utilised for any suitable purposes like urbanisation or industrialisation. The reflection of RE support mechanisms in BDP is represented in Table 8.

Table 8: Level of Reflection of Renewable Energy Support Mechanisms in Bangladesh Delta Plan

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS	The Bangladesh Delta Plan 2100 sets a target of 30 per cent energy production from renewable sources by 2041 aiming at a prosperous country.	Medium
Strategic Planning		Absent
Tax Incentives		Absent
FIT		Absent
RE Financing		Absent
Grants & Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

Similar to the 8FYP and BNBC, the Bangladesh Delta Plan also only includes the RE support mechanism RE Standard with a medium level reflection. All the other RE- support mechanisms are absent in this plan indicating that the plan is not very supportive towards RE.

3.9 Private Sector Power Generation Policy of Bangladesh, and Policy Guideline for Enhancement of Private Participation in Power Sector

The Private Sector Power Generation Policy (PSPGP) was first formulated in 1996; and later, it was revised in 2004. Through this policy, participation of the private agencies/electricity generation projects in Bangladeshi energy and power sector was officially introduced. The policy lays down in concrete terms the modality for the implementation of private power projects including financial arrangements, security packages, tariff structure, and interconnection of IPPs to transmission lines. Even though there is no separate mention of RE, the policy and guidelines apply to all power-generating fuels including renewable sources.

Published in 2008, the Policy Guideline for Enhancement of Private Participation in the Power Sector is an updated version of the 'Private Sector Power Generation Policy (PSPGP) 1996' that considers the depleting domestic reserve of natural gas and/or limited attempts at natural gas exploration at domestic level and the global trend of increasing RE utilisation. The main objective of the policy is to introduce and regulate competition by allowing private investment in the power sector and establishing new commercial power plants and rehabilitating old ones through Public Private Partnership (PPP). These policy guidelines include the directives of using any other alternative fuel including RE sources considering the depleting natural gas reserve and are free to find their buyers to sell electricity at a mutually negotiated tariff. Non-competition from public utilities is ensured in case there is a contract with large consumers. However, depending on the location, they must sell 20 per cent of electricity to public utilities at a bulk tariff rate as determined by the Bangladesh Energy Regulatory Commission (BERC).

In terms of the policy instruments, the Private Sector Power Generation Policy of Bangladesh has only two of the seven instruments (Table 9). But the entire policy is applied to any type of fuel used to generate power.

Table 9: Level of Reflection of Renewable Energy Support Mechanisms in PSPGP

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS		Absent
Strategic Planning		Absent
Tax Incentives	Private Sector Power Generation Policy of Bangladesh allocated fiscal incentives and some special incentives for foreign investors. Fiscal incentives include income tax exemption for a period of 15 years, duty and VAT free import of spare parts for a period of 12 years, stamp duty payments. Tax exemption on royalties, on interest of foreign loans, on capital gains are some of the incentives provided in the policy for foreign investors.	High
FIT	The FIT mechanism is partially applied in the Private Sector Power Generation Policy which is applicable for all type of fuels. Under the policy, the bidders can get a levelised tariff over the contract period which will be evaluated based on the criteria provided in the RFP.	Low
RE Financing		Absent
Grants & Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

3.10 Sustainable Finance Policy for Banks and Financial Institutions (SFPBFI) 2020

In 2020, a Sustainable Finance Policy for Banks and Financial Institutions was published by the Bangladesh Bank, including a green finance taxonomy as well as analysis regarding a green bond standard. Government's development plan, global commitment for sustainability and the BB's strategic goals were the major drivers in formulating this comprehensive policy for sustainable finance by the Sustainable Finance Department of the central bank of Bangladesh. The policy document includes Sustainable Finance Taxonomy with a country perspective of Green Taxonomy. The Green Finance and the Sustainable Linked Finance together comprise the Sustainable Finance. Comprehensive lists of green products/projects/initiatives and identical areas of sustainable linked finance have been included in the policy. Sustainable Finance contains Green Finance, which is one of its components along with Agriculture, CMSME (Cottage, Micro, Small and Medium Enterprise) and Socially Responsible Finance linked to sustainability. Table 10 shows the level of reflection of RE support mechanisms in SFPBFI.

Table 10: Level of Reflection of Renewable Energy Support Mechanisms in SFPBFI

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
RPS		Absent
Strategic Planning		Absent
Tax Incentives		Absent
FIT		Absent
RE Financing	Bangladesh Bank Refinance Scheme's (BDT04.00 billion) low-cost/ supporting to Participating Financial Institutions (PFIs) (Banks/FIs) against their financing of RE generation and other environmentally benign projects. The size of the fund has been increased from BDT 02.00 billion to BDT 04.00 billion following the growing demand for	

(Table 10 contd.)

(Table 10 contd.)

RE Support Mechanism	Description of the matched art of the Mechanism in the Policy	Level of Reflection
	financing of environment friendly products / projects / initiatives. The scheme includes 55 green products/ projects/ initiatives under nine categories	Medium
Grants & Subsidies		Absent
Net-metering		Absent

Source: Authors' illustration.

The SFPBFI 2020, the only mechanism that has been found is RE financing. The RE financing mechanism has been reflected at the medium level. None of the other mechanisms are reflected in the document, not even RE Standards.

4. CRITERIA FOR EVALUATION OF RENEWABLE ENERGY POLICIES AND INSTRUMENTS IN BANGLADESH

An evaluation of the public policy instruments can be undertaken based on the proposed evaluation criteria of the framework demonstrated in Table 11. The policy that will check and ensure all the evaluation criteria ought to be the most RE supportive policy of Bangladesh.

Table 11: Criteria for Evaluation of Renewable Energy Policies and Instruments

Criteria	MCJPP	REP	NEP	PP	8FYP	BNBC	NMG	BDP	PSPGP	SFPBFI
Efficacy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost-effectiveness	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
Dynamic Efficiency	X	✓	✓	✓	X	X	✓	X	✓	✓
Equity	X	✓	X	X	X	X	✓	X	✓	✓
Fiscal Responsibility	✓	✓	✓	✓	✓	✓	✓	✓	✓	X

Source: Authors' illustration.

5. OVERALL ASSESSMENT OF RENEWABLE ENERGY POLICIES

The concept of RE was introduced not so prior to 2000; and so, the potential for the RE were unexplored. The existing renewable policies in Bangladesh do not involve all the instruments simultaneously. There are few policies only based on one renewable policy instrument such as net-metering policy (only based on a net-metering system), whereas some policies address more than one policy instrument. The assessments of these policies are based on whether they meet the renewable policy instruments or not. The policy instruments indicate the effectiveness of the policies to promote RE in Bangladesh perspective. It is expected that the RE policies would play a significant role in promoting RE. But the expectations have not been met in most of the cases (Table 12).

Those policies are primarily target-based, but mainly from a point of view of energy security. As to climate change discussions, phasing-out fossil fuels and adopting sustainable RE is more important. These measures have been working as a push factor, but not strong enough to prioritise carbon-emission reduction as a development step. Cheaper primary energy fuels are requisite for the energy policy development in Bangladesh.

Table 12: Overall evaluation of Renewable Energy policies and instruments

Policy	RE Supportive Instruments	Level of Reflection of the Instrument	Evaluation Criteria mMet of the Instrument
MCPP 2021	Renewable Portfolio Standards	Medium	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Low	• Efficacy • Dynamic Efficiency • Equity
	Grants & Subsidies	Low	• Efficacy • Equity
	Net-metering	Absent	
REP of Bangladesh	Renewable Portfolio Standards	Medium	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	TAX Incentives	Absent	
	Feed-In Tariffs	High	• Cost Effectiveness • Dynamic Efficiency
	Feed-In Tariffs	Medium	• Efficacy • Cost Effectiveness • Dynamic Efficiency • Equity • Fiscal Responsibility
	RE Financing	Absent	
	Grants & Subsidies	Low	• Efficacy • Equity
	Net-metering	Absent	
NEP	Renewable Portfolio Standards	Medium	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	High	• Cost Effectiveness • Dynamic Efficiency
	Feed-In Tariffs	Absent	
	RE Financing	Absent	
	Grants & Subsidies	Absent	
	Net-metering	Absent	
PP of Bangladesh 2021–2041	Renewable Portfolio Standards	Low	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	Low	• Cost Effectiveness • Dynamic Efficiency
	Feed-In Tariffs	Absent	

(Table 12 contd.)

(Table 12 contd.)

Policy	RE Supportive Instruments	Level of Reflection of the Instrument	Evaluation Criteria mMet of the Instrument
	RE Financing	Absent	
	Grants & Subsidies	Low	• Efficacy • Equity
	Net-metering	Absent	
8th Five Year Plan July 20 – June 25	Renewable Portfolio Standards	Low	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Absent	
	Grants & Subsidies	Absent	
	Net-metering	Absent	
BNBC 2020	Renewable Portfolio Standards	High	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Absent	
	Grants & Subsidies	Absent	
	Net-metering	Absent	
Net-Metering Guidelines 2018	Renewable Portfolio Standards	Absent	
	Strategic Planning	High	• Efficacy • Cost Effectiveness • Dynamic Efficiency • Equity • Fiscal Responsibility
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Absent	
	Grants & Subsidies	Absent	
	Net-metering	High	• Efficacy • Equity • Fiscal Responsibility
BDP 2100	Renewable Portfolio Standards	Medium	• Efficacy • Cost-Effectiveness • Fiscal Responsibility
	Strategic Planning	Absent	
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Absent	

(Table 12 contd.)

(Table 12 contd.)

Policy	RE Supportive Instruments	Level of Reflection of the Instrument	Evaluation Criteria mMet of the Instrument
	Grants & Subsidies	Absent	
	Net-metering	Absent	
PSPGP of Bangladesh & Policy Guideline for Enhancement of Private Participation in the Power Sector	Renewable Portfolio Standards	Absent	
	Strategic Planning	Absent	
	TAX Incentives	High	• Cost Effectiveness • Dynamic Efficiency
	Feed-In Tariffs	Low	• Efficacy • Cost Effectiveness • Dynamic Efficiency • Equity • Fiscal Responsibility
	RE Financing	Absent	
	Grants & Subsidies	Absent	
	Net-metering	Absent	
SFPBFI 2020	Renewable Portfolio Standards	Absent	
	Strategic Planning	Absent	
	TAX Incentives	Absent	
	Feed-In Tariffs	Absent	
	RE Financing	Medium	• Efficacy • Dynamic Efficiency • Equity
	Grants & Subsidies	Absent	
	Net-metering	Absent	

Source: Authors' illustration.

The REP 2008 turned out to be the most inclusive REP as it includes four out of seven RE supporting instruments. The RPS, Tax Incentives, FIT, Grants and Subsidies are discussed but not extensively enough. Followed by the MCPP, the policy contains three out of the seven supporting instruments among the existing policies of Bangladesh. Next, upon the adoption of the PP of Bangladesh 2021-2041, it consisted of three supporting policy instruments but all those three have ranked lower. Compared to this, Net Metering Guidelines has proved to be a much inclusive policy as it also includes three policy instruments but two of them have ranked as high followed by the NEP. It is most discouraging that the energy policy of Bangladesh consists only of two RE supportive policy instruments, whereas it should have been the most concrete and comprehensive policy document. In terms of the policy instruments, Private Sector Power Generation Policy of Bangladesh has only two of the seven instruments. But the entire policy is applied to any type of fuel used to generate power. All the remaining policies, acts and rules, 8FYP, BDP 2100, BNBC, Statutory Regulatory Order 141 and SFPBFI qualify only for one policy instrument each.

Strategic Planning is the least observed RE supportive policy instrument, while the RE financing is also one of the least found or least observed policy instrument in Bangladesh. The lack of these policy instruments is assumed to be the main drivers of target failures that were set to achieve in different Power Sector Master Plans (PSMPs).

6. RENEWABLE ENERGY-LED POWER GENERATION INITIATIVES IN BANGLADESH

6.1 Renewable Energy Projects

6.1.1 Renewable Energy Projects: Currently in Operation

Now, the RE accounts for generating 910 MW of electricity in the country, which is approximately 3.56 per cent of the total electricity generation mix. It is observed that public projects generate 901.733 MW of power, while private projects generate 8.356 MW (Table 13). Among all the organisations, Infrastructure Development Company Limited (IDCOL) has 4,495,712 solar projects with a total power production capacity of 234.221 MWp; the Ministry of Disaster Management and Relief (MoDMR) has 1,809,417 solar projects with a total power generation capacity of 87.95 MWp; the BREB, NESCO, and BPDB have 15,721, 14,026, and 1,173 solar projects respectively, with the electricity generation capacity of 25.597 MWp, 2.819 MWp, and 244.19 MWp respectively. The Barind Multipurpose Development Authority, Dhaka Electric Supply Company (DESCO), Dhaka Power Distribution Company (DPDC), Ministry of Chittagong Hill Tracts Affairs (MoCHTA), West Zone Power Distribution Company Limited (WZPDCL), Rural Development and Co-operatives Division (RDCD) and Bangladesh Agricultural Development Corporation (BADC) operate 786, 535, 299, 273, 255, 200, and 171 solar projects respectively across the country; and their total generation capacity stands at 4.381 MWp, 40.113 MWp, 12.227 MWp, 0.005 MWp, 1.585 MWp, 3.15 MWp, and 2.219 MWp respectively. There are other RE projects, too, such as Ashuganj Power Station Company Limited (APSCL), Bangladesh Academy for Rural Development (BARD), Bangladesh Agricultural Research Institute (BARI), Bangladesh Council of Scientific and Industrial Research (BCSIR), BPDB-RPCL Powergen (BR PowerGen), Bangladesh Rice Research Institute (BRRI), Coal Power Generation Company Bangladesh Limited (CPGCBL), SREDA (Table 13).

Table 13: Renewable Energy Projects Currently in Operation with their Yield

	Public Projects	
Type of Renewable Energy	**No. of Projects**	**Total Capacity (MW)**
Solar	6,338,729	667.443
Wind	3	2.9
Hydro	1	230
Biogas	87,544	0.99
Biomass	1	0.40
Total >	6,424,778	901.733
	Private Projects	
Solar	2,421	8.356
Biogas	1,500	N/A
Total >	3,921	8.356
Total	**6,428,699**	**910.089**

Source: Authors' calculation from SREDA Data.

6.1.2 Renewable Energy Projects: Under Implementation

Aside from the completed and operational projects, 23 projects are in the process of implementation under public, private, and joint ventures. As per the Bangladesh Power Development Board (BPDB), these projects are expected to generate an estimated 1,941 MW of energy (Table 14). The BPDB

has six projects under its belt with a total capacity of 576 MWp. The EGCB has five projects in the process of implementation with the capacity of 420 MWp. The Rural Power Company Limited (RPCL), CPGCBL, APSCL, and Bangladesh-China RE Company (Private) Limited (BCRECL) have 4, 2, 2, and 1 project respectively that account for a total generation capacity of 640 MWp.

Table 14: Projects in the Process of Implementation

	Public Projects	
Type of Renewable Energy	**No. of Projects**	**Total Capacity (MW)**
Solar	15	1,406
Wind	4	180
Total >	19	1,586
	Private Projects	
Solar	1	100
Waste	1	45
Total >	2	145
	Joint Ventures	
Solar	1	160
Wind	1	50
Total >	2	210
Total >	**23**	**1941**

Source: Authors' calculation based on BPDB data.

6.1.3 RE Projects: Under Planning

According to the Sustainable and RE Development Authority, 34 public projects are currently under planning and are to generate an estimated 1,769.522 MWp of energy [Table 15]. The BPDB, EGCB, RPCL, CPGCBL, NWPGCL, APSCL, & B-R PowerGen are planning to operate 24 solar projects. The BPDB, CPGCBL, and RPCL are planning to operate seven wind projects, while the BPDB is planning to operate three biogas projects.

Table 15: Projects Under Planning

	Public Projects	
Type of Renewable Energy	**No. of Projects**	**Total Capacity (MW)**
Solar	24	1,425.022
Wind	7	295
Biogas	3	49.5
Total	**34**	**1,769.522**

Source: Authors' Calculation from SREDA Data.

6.2 Evidence-based Research on the Possibilities of Renewable Energy

Bangladesh has sufficient RE resources to meet the energy demand domestically. So-lar energy, biogas, and biomass are the most productive and beneficial resources. Teske et al. (2019) stated in their report titled '100 percent RE for Bangladesh- Access to RE for all within one generation' that by 2050, 100 per cent RE yield will be technically achievable, commercially viable, and socially desirable in Bangladesh. They also projected Bangladesh has an offshore wind potential of 134 GW between

50 to 120 kilometres off the coast. This is to be supplemented by approximately 16 GW of onshore wind potential, mainly in the coastal districts of Khulna, Barishal, and Chattogram. Furthermore, the country has the capacity to install up to 156 GW of utility-scale solar PV electricity. By 2050, floating solar PV installations will account for around 20 per cent of these utility-scale solar farms. Bangladesh also has a 285 MW bio-energy potential with an annual production of 1,840 GWh/a. It is appropriate to confirm here that extensive research has been conducted over the years to determine Bangladesh's potential for electricity generation from RE sources.

6.2.1 Scopes of Power Generation from Solar Energy

Concentrating Solar Power (CSP) is a prospective power generation system that uses concentrated solar radiation to create high temperatures in a solar thermal power plant. With an annual Direct Normal Irradiation (DNI) of 2,000 kWh/m2, approximately two square kilometres of area is re-quired to generate 100MWe of energy. Bangladesh has an annual DNI of almost 1,900 kWh/m2, which is adequate to run a CSP plant. Noor & Muneer (2009) evaluated the investment necessary to build a 1MWe parabolic trough power plant. The worked-out investment cost of the proposed pilot project was found to be USD 7.20 million. The estimate was based on the Andasol 1 power plant in Spain's Granada Province.

In a study by Mondal & Islam (2011), annual electricity generation was calculated for Dhaka, Rajshahi, Sylhet, Khulna, Rangpur, Cox's Bazar, Dinajpur, Kaptai, Chattogram, Bogra, Barishal, Jashore, Mymensingh, and Sherpur districts based on the amount of equivalent Direct Current (DC) electrical energy delivered to the utility by the proposed 1 MW solar grid-connected system. The Dinajpur PV system produced the maximum power, around 1,844 MWh/year. With an annual pow-er generation of 1,653 MWh/year, Barishal has the lowest production. The planned facility can generate an average of 1,728 MWh/year of power in Bangladesh from anywhere in the country.

In the article 'What Causes Climate Change?', Huque (2016) noted following due consideration that only building rooftop solar PV plants can produce over 2GW of electricity alone in Dhaka city and that it might exceed 6GW throughout the country [utilising 60 per cent of usable rooftop area and leaving the remaining 40 per cent for other types of use].

Scopes of solar power are not limited to household rooftops only. Chakraborty et al. (2016) considered and evaluated the potential of solar tilts, radiation, and available roof surface area of 2,000 registered trawlers of Chattogram Fishery Ghat, Bangladesh, in their research to assess the solar photo-voltaic potential of the trawlers, which would usher in and establish a new zone for power generation through PV application. Applying the available data and resources, this paper used a four-step method to investigate the rooftop solar potential of fishing trawlers and found that 639.85 MW could be generated from such surfaces.

Mazumder et al., (2017) presented a preliminary evaluation of a coast side building's rooftop - utilising it as a wind and solar energy harvesting site in Chattogram. The location was close to Chattogram's seacoast. The structure utilised was an apparel factory in the Chattogram Export Processing Zone (EPZ) . The authors estimated that the total annual energy output might be 6,960 kWh.

Super Star RE Ltd. (SSREL), one of Bangladesh's pioneer entrepreneurs of sustainable energy solutions, constructed and implemented a 241.68-Kilowatt Peak (kWp) Solar PV Mini Grid at Char Baghutias (Ahmed, 2017).

An innovative idea of a floating PV system was demonstrated in a research paper of Rahman et al. (2017) that takes advantage of the available water surface on dams, reservoirs, and other waterbodies. The authors calculated electricity generation by floating solar panels on Kaptai Dam (Rangamati, Chattogram Hill Tracts, Bangladesh). Using 17,500 total array units and considering the maximum ideal power of the solar panel to be 435.5W, the total power output was estimated at 7.62 MW.

Huque (2017) in his article 'Ways to Solve Space Problem to Install PV Module for Electricity Generation' stated generating one megawatt of solar power takes around four acres of land and involves an expenditure of approximately BDT 4 crore. It generates power at a cost of BDT 15 per unit. In contrast, if panels are deployed on floating platforms, the required area would be 10-20 per cent less. The capital cost of such plants will be roughly BDT 9 crore per MW, with power produced around BDT 9 per unit.

As per IDCOL, 1,500 representatives of the Bangladesh Textile Mills Association possess 42 million square feet of rooftop area that might be used to build 400 MW solar PV systems. Rooftop solar systems, according to SREDA, have enormous potential in Bangladesh. Using this capacity, 1,000 MW of power may be generated, 400 MW of which will be generated on government/semi-government owned buildings (Ahmed et al., 2020).

According to Hossain and Chisti (2020), 1 per cent of the country's agricultural land would facilitate the installation of about 50,000 MW of solar power plants using the thumb rule of 4 acres of land required for 1 MW of solar electricity. Given Bangladesh's average capacity factor of 4.5 hours per day, the power output from 1% of agricultural land would roughly be 82,000 GWh, which exceeds the overall demand in 2020. As per the PSMP 2016, the total power demand in 2040 would be 450,000 GWh; therefore, electricity generated on the 1% land would account for more than 18 per cent of Bangladesh's entire electricity requirement in 2040. If solar power replaces LNG-based electricity at a cost of USD 0.10 (10 cents) per kWh, the total value of the electricity produced would come to USD 8.20 billion. Even if imported LNG is saved, it would exceed USD 5.00 billion. Crops cultivated on 1 per cent agricultural land are worth between USD 200 to 500 million, depending of course on crop and land variety. Hence, even if agricultural land is compromised, allocating land for solar farming would yield more than tenfold return.

Wilshaw (2020) found that the southeast region of Bangladesh, near Cox's Bazar, has the maximum average value of Global Horizontal Irradiation (GHI), at roughly 4.98 kWh/m2. In contrast, the northwest and central regions have a lower average value of GHI, at around 4.27 kWh/m2. Practically, these variations are negligible, and given the existing solar resource statistics, country has a promising future for floating solar PV.

According to the draft Bangladesh's National Solar Energy Action Plan 2021–2041, major riverbanks can provide the land required to generate 15,000 MW solar electricity by 2041. Land on the Meghna River can yield 3,000 MW solar power generation, whilst Jamuna banks at Gaibandha, Jamalpur, and Sirajganj can each fetch 2,000 MW.

Talut et al.,(2022) presented a methodology that identified and evaluated 6,045 solar plants with roof sizes ranging from 100 m2 to 50,000 m2 , as well as modelled the instalment of solar PV technology that can deliver electricity through on-site grid infrastructure. The results indicated that such roofs could support roughly 7.4 GWp of PV capacity, with an annual power out-put of 11 terra watt hour.

This is more than six per cent of the current power usage in the country and more than half of the 2030 objective.

Summit Power wants to deploy floating PV on a waterbody at a coal power station in Barapukuria, Bangladesh. SREDA and the Asian Development Bank (ADB) conducted a feasibility assessment on the location. They found that a floating solar power plant with a capacity of 40 MW to 50 MW could be constructed there. Bangladesh currently has only one floating solar power facility at Mongla under Bagerhat district. Solar EPC Development Ltd., a private sector developer, built the 10-kW project. Meanwhile, Bangladesh Government is planning to construct a 50-MW floating solar power plant on Kaptai Lake in the Rangamati area (Islam, 2022).

In 2021, Youngone Corporation, a South Korean multinational conglomerate, has constructed Bangladesh's biggest rooftop solar power plant at government allocated Korean Export Processing Zone (KEPZ) to meet the country's energy needs and as a move to promote RE generation. The firm will generate 40 megawatts of solar power on the rooftops of the manufacturing buildings investing USD 40 million in the process. According to KEPZ authorities, additional solar PV units will be built in two phases within the next year-and-a-half to produce the remaining 24 MWs of power (Suman, 2021).

Universal Jeans Ltd, a Pacific Jeans company, spent USD 0.50 million to build a rooftop solar power plant with an automated cleaning system at the Chattogram EPZ as part of its green energy initiative. This 3.5 MW electricity generation will meet 10 per cent of the factory's total power needs. This power generation will save BDT 10 lakh in energy per month ('Pacific Jeans Launches 3.5 MW Solar Power Plant,' 2022).

Liza and Islam (2020) highlighted in the Journal of Energy Research and Reviews a set of adverse scenario/phenomena encountered in obtaining power from solar energy, which are land scarcity; land ownership; land development; erosion protection; harsh weather conditions; dust; more ex-tended implementation period; inadequate local human resources; scarcity of information about available services; weak grid; inadequate transmission infrastructure; insufficient technical standards; and cost and research losses.

Chowdhury and Aziz (2020) emphasised the issues that must be addressed to speed up the implementation of large-scale solar PV power facilities: evaluating and securing suitable areas for in-stalling solar PV projects to address the issue of land availability; the most accessible solar PV power plant installation land is in distant places with limited grid access. This grid connectivity issue must also be resolved; most PV projects established to date have experienced frequent grid outage disruptions, resulting in loss of power generation not because of any defect of the PV projects. The performance of the grid that connects the PV installations should be upgraded, as well.

6.2.2 Scopes of Power Generation from Wind Energy

A study by Saifullah et al. (2016) sought to evaluate wind energy potential in Bangladesh as a long-term solution to the country's energy crisis. Wind speed was measured at six coastal zones near the Bay of Bengal in the south: Patenga, Cox's Bazar, Teknaf, Charfesson, Kuakata, and Kutubdia. A near-shore wind farm was considered at these locations, with a 574-kilometre coastline. This sea-side wind farm generated 1,855.25 MW of electrical power with an array of 5,104 horizontal axis wind turbines with hub heights of 100 m, rotor diameters of 75 m, and wind speeds of 7 m/sec.

The government is working on a handful of wind energy projects that will produce approximately 350 MW power. By the end of December 2023, Bangladesh is expected to generate around 180–240 MW of energy from wind-powered facilities. One of the plants, with a total generation capacity of 60 MW, is scheduled to be completed by December 2022. The USD 116.51 million project is funded by Wuling Power Corporation Limited and implemented by US-DK Green Energy (BD) Ltd. (SPIC). (Sarker, 2022).

6.2.3 Scopes of Power Generation from Hydro Energy

The BPDB has proposed to expand the Karnafuli Hydro Project by 100 MW and has identified Sangu and Matamuhuri Rivers as the possible hydropower generating sites. Through private initiatives, the first micro hydropower plant of 10 kW was deployed in a Bandarban community. The project provides power to 140 households in the community as well as a Buddhist temple. The Sangu Project will be a new project with a capacity of 140 MW and an approximate annual energy output of 300 GWh/yr. The Matamuhari Hydropower Project might have a capacity of 75 MW and an annual energy output of 200 GWh/yr (Wazed & Ahmed, 2008).

In his article 'Hydropower in Bangladesh', Mahadi (2016) stated that a credible analysis estimates a small-scale hydropower generation capacity of 60 MW, allowing to produce 200 GWh of electricity per year.

6.2.4 Scopes of Power Generation from Biogas & Biomass Energy

Using data of the year 2013, Nahian & Islam (2016) determined the total volume of biogas production and energy generation from organic waste in Bangladesh. Poultry waste generated 3,033 MW power, cattle dung generated 12,211 MW power, and municipal waste generated 2,301 MW power.

In collaboration with JB Biogas, Aisin Seiki Ltd launched an initiative to evaluate the potential of bio-gas-fired power generation in Bangladesh. They began by conducting a survey in five Upazilas in Gazipur district. It has been discovered that there are over 500 poultry/dairy farms where biogas-fired generators can be installed. According to the survey results, there is potential for installing more than 20,000 biogas generators in the country. Given that the average generator size is 5kW, these generators' total power generation capacity would be 100MW (Rana, 2017, p. 115).

In a collaborative effort with Noakhali Science and Technology University and Practical Action, an International Non-Governmental Organisation (INGO), the Bangladesh Biogas Development Foundation (BBDF) studied the 'Potential of Maize as Biogas Raw Materials'. It was estimated that an acre of land produces around 20 tonnes of biomass. Biogas technology can generate 2,000 m3 of biogas. Maize is grown on around 800,000 acres of land in Bangladesh and approximately half of this area is cultivated for two crops every year. Based on this, 16,000,000 tonnes of biomass could be generated annually, fetching 2,400 million m3 of gas (Gofran, 2020, p. 88-96).

The Dhaka-based Amin Bazar Waste to Energy Project has a capacity of 42.5 MW. The project is now undergoing approval. It will only go through one phase of development. After completing the construction, the project is expected to be operational in 2024 (Carmen, 2021).

There is enough evidence to establish Bangladesh has enough potential to generate power from renewable sources. But owing technical obstacles and/or policy gaps, these potentials are still unexplored.

7. RECOMMENDATIONS

Policy Instruments are indispensable to promote RE in the Bangladeshi landscape. Realistic RE targets should be set and policy instruments need to be determined accordingly. There are, of course, policies related to RE, but the lack of intention and political conflict of interest make implementation thereof much harder. In line with domestic RE generation, the targeted RE can be obtained through energy import from neighbouring countries.

Amendment of RE Policies: The policies related to RE, or energy security are outdated in the present context. The technology and sources of RE have evolved in recent times warranting invariable revision of the policies and amendment of those further in the right direction. Amendment of the existing NEP along with renewable energy policy are direly required. And such amendments must be more comprehensive and inclusive of all the RE aspects such as sourcing, generation, price, Transmission and Distribution (T&D) system, etc.

All the public policies need to be coherent with one another: The inconsistency within the renewable portfolio standards among several policies are widely visible. MCPP sets a target of achieving 30 per cent RE by 2030 and 40 per cent by 2041. In contrast to that, Bangladesh Delta Plan sets the target at 30 per cent by 2041. These targets need to be consistent and coherent, and one policy should be compatible with another in achieving the desired goal.

A concrete plan should be in place to meet the target: Whatever policy target is being set, there should be a detailed plan regarding that target. Lack of planning is one of the reasons that the previous goals were not achieved. There are scopes to overcome the failure by assessing the reasons, re-viewing them, and redesigning the future work plan to meet the targets.

Relative incentives in RE must be more than that of fossil fuel: The GoB has been subsidising and providing incentives to fossil fuel-based power generation. There are some tax benefits provided to the producers engaged in RE-based power generation. But this financial incentive is barely enough as the return from fossil fuel-based power generation is still much higher than that of RE-based power generation. So, the relative incentives provided by the GoB need to be higher comparatively to inspire the producers to invest more to generate green power.

Aggressive policies required to attract private sector investment: In 2010, the Speedy Sully of Power and Energy (Special Provision) Act was adopted in a critical circumstance to enhance electricity generation. It was a drastic decision but timely, too. Formulating and adopting something similar to this is inevitable amid the current situation to boost up the RE generation. In other words, green power generation to effect green energy calls for another special provision.

Policy incentives are required to promote domestic investment: The high price tag of the renewable energy producing appliances still a constraint in Bangladesh. All the necessary requisites in this respect like battery, panels, turbines, storage systems are imported, and thus the renewable energy production cost goes upwards. So, the best possible solution is to develop a domestic market for their easy and smooth availability. Domestic investments would be a catalyst here to encourage and influence concerned traders/ businessmen to make necessary investment in the renewable energy business in the domestic climate of Bangladesh.

Grid stability needs to be ensured: A significant drawback of the existing RE structure is the unstable grid. Because of grid instability, the power generated from RE sources cannot be attached to the

national grid. Hence, it remains as a variable power causing irregularity in energy transmission. The smart grid system needs to be adopted nationwide for the inclusion of as well as uninterrupted transmission of renewable power in the national grid.

Allocation should be made separately for RE-based research: Currently, Bangladesh is left with almost no option other than exploring sources of RE. The government of Bangladesh needs to allocate resources not only to advance and speed up exploration but also for research to further discover (a) from which sources renewable and green energy can be generated, and (b) how they can be generated, stored and transmitted to every grid of the country.

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