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Powering Bangladesh's Future: Risks and Opportunities in Solar Energy Deployment

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HARVARD Kennedy School
RAJAWALI FOUNDATION INSTITUTE FOR ASIA

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About the Author

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The Rajawali Foundation Institute for Asia is housed at the Ash Center for Democratic Governance and Innovation, one of twelve research centers at Harvard Kennedy School. In 2008, under the leadership of Anthony Saich, the Asia Programs at HKS (now the Rajawali Foundation Institute for Asia) joined the Ash Institute for Democratic Governance and Innovation. Two years later, the permanently endowed Rajawali Foundation Institute for Asia was established as part of the Ash Center to bring together academics and practitioners from around the world to enhance research, teaching, and training on public policy and governance issues of critical importance in Asia.

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The Bangladesh Public Administration Project is a multiyear initiative housed at Harvard Kennedy School's Rajawali Foundation Institute for Asia. The purpose of the project is to strengthen the institutional capacity of the Bangladesh civil service and the individual capacity of its civil servants. The project mainly focuses on three interrelated activities: curriculum review at the nation's civil service training institutes, training on interactive pedagogy and core competencies essential for the civil service, and policy research on Bangladesh's most pressing issues.

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Executive Summary

Bangladesh stands at a critical juncture in its energy development trajectory. While the country has achieved remarkable success in expanding electricity access from less than half of the population just 15 years ago to near-universal coverage today, it faces significant challenges in transitioning to a sustainable and reliable energy future. The current energy landscape in Bangladesh is characterized by a heavy reliance on fossil fuels, which has created multiple economic, environmental, and social challenges. Despite these obstacles, the country has significant potential for solar energy development, and the leadership has charted a course to meet ambitious targets relating to renewable energy production capacity. Such ambition should be supported by clear policy reforms. This paper identifies several key barriers to solar energy deployment and proposes eight strategic policy interventions. To ensure effective implementation, the paper concludes with a roadmap to strengthen associated institutional and governance frameworks.

Success in implementing these recommendations would position Bangladesh to achieve its renewable energy targets while addressing energy security, environmental sustainability, and economic development objectives. However, success will require sustained political commitment, institutional coordination, and engagement from all stakeholders in the energy sector.

Introduction

Mounting environmental degradation, volatile prices of increasingly imported fossil fuels, and the weaponization of trade and energy supply lines have created a world seemingly rife with energy insecurity. These pressures are especially salient in the context of rapidly developing economies, which are highly price-sensitive to energy fuels, caught between competing foreign and economic policies of great powers, and driven to provide reliable electricity access to a burgeoning population. In this context, renewable power has emerged as a pivotal solution for political leaders seeking to decarbonize a meaningful segment of the national electricity supply, improve environmental performance at local and global levels, reduce exposure to volatile fuel costs, and provide grid stability.

Many of the above goals are captured in Bangladesh's "Vision 2041" national plan, which targets the achievement of high-income status and promotes sustainable development. The plan's success depends on the nation's renewable energy sector entering a significant transformation phase to support rapid economic growth. From fiscal years 2016 to 2019, Bangladesh witnessed a robust average annual GDP growth of 7.6%, driven largely by the manufacturing and service sectors. This growth trajectory continued in 2022, with the economy expanding by 7.1%, surpassing the growth rates of neighboring India and Pakistan. Similarly, Bangladesh has already achieved a significant milestone of energy equity, growing electricity access from a low 47% in 2009 to near-total access throughout the country by 2023. Such connectivity holds the potential to dramatically improve the productivity, comfort, and livelihoods of all citizens and is necessary to move Bangladesh into higher-value-added modes of economic development.

Yet this national potential hinges upon the country's ability to improve the stability, availability, and quality of such power, coupled with the ability to reduce the carbon intensity, economic cost, and broader social costs of its power system. While nearly all households are grid connected in Bangladesh, electric power in rural areas can be suspended for several hours a day, and per capita consumption in 2022 remained modest at 464 kilowatt-hours (kWh). Cost is a second obstacle. The awarded price per kWh for solar grid-connected photovoltaic (PV) energy in Bangladesh is approximately $0.08, compared with $0.03 per kWh in the nearby Indian power market.[1] Third, the electricity that is available is nearly all produced by fossil fuels and increasingly reliant on imported natural gas. This feature of the national energy system has exposed Bangladesh to fluctuating exchange rate sensitivity, pressure on already declining US dollar reserves, local pollution, and the significant financial burden of high regional natural gas prices.

Bangladesh's commendable strides in expanding its electrification efforts depended historically on the well-recognized success of its solar household rooftop ("captive solar") sector. That program, a collaborative endeavor between Infrastructure Development Company Limited (IDCOL) and various international development partners, was instrumental in expanding energy access to remote, off-grid rural communities. Through the installation of millions of solar home systems, this initiative has not only illuminated households but also catalyzed socioeconomic development, particularly empowering women.[2] Furthermore, the introduction of initial net metering policies in 2018 incentivized the adoption of rooftop solar industrial systems in urban and semi-urban areas, enabling industrial consumers to sell surplus electricity back to the grid.

However, several studies have identified persistent barriers hindering the widespread adoption of rooftop solar in Bangladesh in particular. Academic research has highlighted the lack of awareness and technical expertise among consumers and installers, leading to suboptimal system performance and unrealized energy savings.[3] Moreover, the high upfront costs and limited access to financing mechanisms, especially for low-income households, continue to pose significant obstacles. Finally, the buildout of what is still quite limited grid-tied utility solar plants has begun to cannibalize the rooftop household systems, rendering increasingly large swathes of the decentralized system redundant.

Critically, the development of utility-scale solar power projects in Bangladesh faces greater challenges than those faced in the rooftop solar sector. While the country's first utility-scale solar power plant commenced operations in 2019, the deployment of large-scale solar projects has progressed at a slower pace than anticipated. Policy documents and reports from international organizations have consistently emphasized the need for a comprehensive policy framework, streamlined land acquisition and regulatory approval processes, and robust grid infrastructure to facilitate the integration of utility-scale solar power generation. Land availability has emerged as a critical bottleneck, exacerbated by Bangladesh's high population density and competing land use demands for agriculture and urbanization. Furthermore, academic analyses have underscored the lack of a streamlined process for land acquisition and clearances as a significant impediment to project development, highlighting the need for regulatory reforms.

Despite these challenges, Bangladesh's favorable geographic location, abundant sunshine, and the declining costs of solar technology present significant opportunities for the growth of the solar power sector. The government's ambitious renewable energy targets have placed solar power at the forefront of the nation's energy transition efforts. A growing body of academic literature has underscored the potential socioeconomic and environmental benefits of increased solar power deployment, including job creation, reduced greenhouse gas emissions, and enhanced energy access in rural areas. In the case of Bangladesh, the argument is strengthened by the fact that the current fossil-dominated system is heavily subsidized, plagued by high economic cost, rapidly depleting foreign exchange reserves through the payment of rising imports, and incurring widespread environmental and health costs.

To realize the potential of Bangladesh's solar power sector, a comprehensive approach is imperative to address these unique challenges. Policy analyses from organizations like IDCOL and the Asian Development Bank (ADB) have advocated for increased public awareness campaigns, standardization of installation and maintenance practices, and innovative financing mechanisms to support solar power development.[4] In the utility-scale segment, recommendations from academic studies and policy reports have emphasized the need to streamline land acquisition processes through centralized land banks and coordinated efforts among relevant ministries and agencies.[5] Additionally, strengthening grid infrastructure, establishing transparent and competitive bidding processes, and fostering public-private partnerships (PPPs) have been identified as crucial steps to attract foreign investment and accelerate the deployment of utility-scale solar power plants.

National leaders in Bangladesh, and leading multilateral lenders, have argued that solar energy must continue to scale, in the form of grid-tied utility solar power production, in order to meet national goals and international commitments.[6] This goal has necessitated a shift from a quantitative approach focused on rooftop capacity expansion to a qualitative one that prioritizes the effective implementation and integration of solar energy into the national grid. While this transition from quantity to quality has long been recognized in Bangladesh, the pressures on such a shift have only grown in the past decade.[7]

Academic papers and policy reports on the development of the Bangladesh's solar industry have also highlighted the urgency of addressing the country's energy security and climate change mitigation goals. A study by Islam et al. (2014) emphasized the imperative of diversifying the country's energy mix and reducing its heavy reliance on imported fossil fuels, which not only contribute to greenhouse gas emissions but also strain foreign exchange reserves—an issue that has long been identified. A 2018 policy brief from the World Bank underscored the need for a comprehensive strategy that aligns Bangladesh's renewable energy targets with its socioeconomic development objectives, ensuring a just and equitable transition toward a low-carbon economy. Such a transition is defined as one that reduces the role of fossil fuels in a manner that reduces inequality, shifting the costs of climate action onto polluters while prioritizing economic, racial, and gender justice.[8]

The national government has responded to such concerns with renewable energy development targets. While ambitious, Bangladesh's targets for solar power generation have been met with skepticism from experts and policymakers, including the short-term target of 4 GW by 2030 and the medium-term target of achieving 40% renewable energy by 2041, as outlined in the Climate Prosperity Plan. Scholars have critiqued the plan's lack of a coherent implementation strategy, highlighting the need for a more realistic and pragmatic approach that considers the country's existing energy infrastructure, financial constraints, and institutional capacity.[9] The recent approval of the Integrated Energy and Power Master Plan (IEPMP), which broadens the target from 40% *renewable* energy to a vaguer and more flexible 40% *clean* energy target, including nuclear and green hydrogen, further highlights the obstacles associated with deploying renewable energy in Bangladesh. As Hasan (2024) noted, through "costly procurement rewards, the country has 912 megawatts (MW) of installed renewable energy (RE) generation capacity, including 678 MW from solar, and is projected to reach 4,100 MW capacity by 2030," suggesting a significant gap between current capacity levels and projected targets. Progress remains slower than expected, as highlighted by the government of Bangladesh's 8th Five-Year Plan, which highlights the sluggish expansion of renewable energy and challenges in financing the energy sector.

To address these challenges, this policy paper aims to provide an analysis of the current state of the solar power industry in Bangladesh, identifying the gaps and risks associated with the implementation of the government's renewable energy goals. By conducting an assessment of financial, economic, and supply security risks, the paper provides the foundation for a discussion of evidence-based policy recommendations to identify potential opportunities for solar power growth and a less fossil-intensive energy supply. These recommendations attempt to streamline and accelerate the deployment of solar power projects by building on recent progress in the country and identifying a range of supplemental strategies, including

- establishing clear and achievable renewable energy targets,
- implementing renewable purchase obligations (RPOs),
- expanding net metering and feed-in tariffs (FITs),
- integrating demand-side management and "time of use" (TOU) pricing,
- streamlining land acquisition processes,
- enhancing financing mechanisms,

- encouraging PPPs, and
- ensuring a "just energy transition."

There are additional policy changes that are more complex. Should the interim government enjoy degrees of freedom to pursue more structural reforms, they would include reducing the current pipeline of fossil fuel power projects, implementing a pilot for transparent and efficient tariff auction or reverse auction mechanisms, and reforming power purchase agreements (PPAs) to enhance their bankability and attractiveness to private sector investors. However, these additional reforms are currently beyond the scope of this policy paper, which focuses on institutional policy "wins" that could provide a foundation for these more transformational changes.

Importantly, the strategies this paper outlines will prove unsustainable if they are not supported by clear steps to institutionalize both the execution of, and accountability for, solar development within Bangladesh's governance structure. As a result, this paper begins by examining the roles of various institutional actors in the Bangladeshi solar ecosystem and concludes with proposed measures to strengthen institutional coordination and establish clear pathways for the effective implementation and monitoring of solar power initiatives.[10]

Ultimately, this policy paper seeks to contribute to the ongoing discourse on Bangladesh's larger energy transition, providing an actionable framework for harnessing the significant potential of solar power to support further economic development. By addressing key related challenges and opportunities, it aims to inform and guide policymakers, industry stakeholders, and civil society organizations in their efforts to chart a sustainable and resilient energy future for the country.[11] These actionable policy recommendations are designed to accelerate the development and deployment of solar power technologies while fostering an enabling environment for collaboration between public and private sector stakeholders. As Bangladesh navigates its energy transition journey, the solar power sector presents a critical pathway toward achieving sustainable development goals, mitigating climate change impacts, and ensuring energy security for future generations.

Finally, it is important to note that the successful transition toward a sustainable and renewable energy future in Bangladesh will not only contribute to the country's energy security and climate change mitigation efforts but also align with the global agenda for sustainable development and environmental protection, as encapsulated in the United Nations Sustainable Development Goals (SDGs). By adopting a comprehensive and evidence-based approach, as outlined below, Bangladesh can pave the way for a resilient and diverse energy sector, fostering economic growth, environmental sustainability, and social inclusivity.

Policy Context and Regulatory Framework

This section provides an overview discussion of Bangladesh's solar power goals in an effort to provide a common starting point for analysis, given the evolution of multiple development plans that at times obscure progress. The discussion begins by providing context and costs of the current fossil-dominated system, and critically analyzing the lower renewable energy target of 4 GW by 2030 and the ambitious, higher target of achieving 40% renewable energy by 2041, as outlined in the Climate Prosperity Plan. The analysis will then provide a foundation for the subsequent analysis of potential inconsistencies and shortcomings within the plan, drawing insights from academic literature and expert opinions to shed light on the feasibility and appropriateness of these goals.

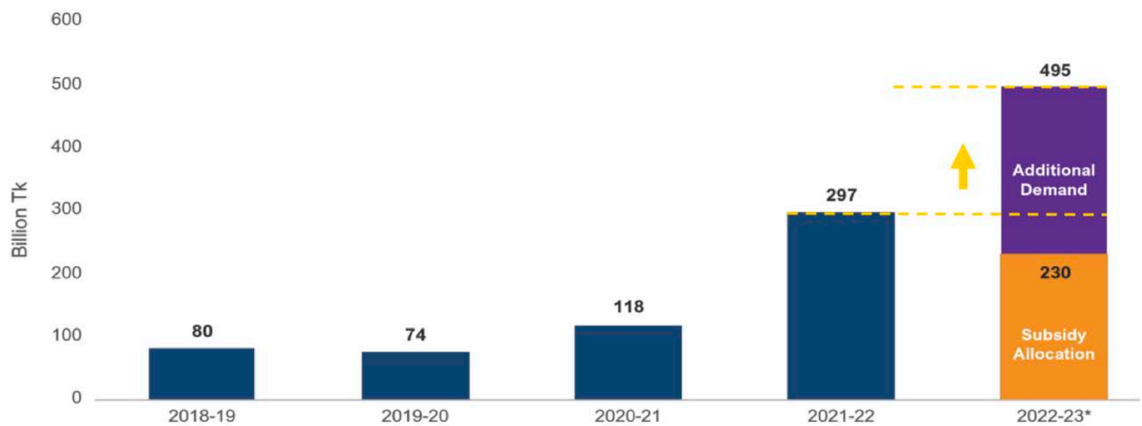
Current Costs of Status Quo

The economic, political, environmental, and social costs of Bangladesh's current reliance on fossil fuels represent a complex interplay of challenges that significantly affect the country's development trajectory. As one of the fastest-growing economies in South Asia, Bangladesh faces substantial energy demands, leading to a persistent dependence on fossil fuels such as natural gas and coal for electricity generation. This reliance has created a host of economic issues, including rising energy costs, overcapacity in installed power generation, persistent load shedding, and diminished competitiveness in key industries like textiles, which contribute to over 80% of the nation's exports.[12]

The reliance on fossil fuels in Bangladesh and overcapacity of fossil power generation has significant economic implications. In 2020, electricity subsidies alone totaled US$1 billion or 0.4% of GDP.[13] As a recent Bangladesh Power Development Board report outlined, the per-unit cost of power from the newly built Payra coal-fired plant in FY2020–21 increased 36.5% year on year, reaching Tk8.6/kWh, arguing "[t]his was driven by capacity payments made to the plant as one of its units stands idle due to a delay in construction of power transmission infrastructure."[14] The same report notes that usage rates of power plants nationally are a low 42% and predicted to drop to 38%.

By 2022, total energy sector subsidies accounted for approximately 5.4% of national GDP and 34% of national subsidies.[15] Such costs, which account for 15%–20% of production expenses in energy-intensive sectors like textiles and cement, exacerbate the financial pressures faced by these industries. These energy subsidies have reached a significant scale, totaling approximately $3.5 billion in FY2022, with electricity subsidies alone accounting for about $2.1 billion that year. Natural gas subsidies were estimated at $1.2 billion annually, while petroleum product subsidies vary significantly with international prices.[16] See chart below for such subsidy trends since 2018. Currently, 12,967 MW of power capacity is under construction, well over 95% of which will be powered by fossil fuels, with 3,404 MW in the planning phase and 333 MW in the tendering process, all expected to become operational by 2026.[17] However, further investments in fossil fuel infrastructure risk committing Bangladesh to a high-carbon future and could hinder achieving its renewable energy goals and international pledges.

Figure 1. Power Sector Subsidy Burden 2018–2023

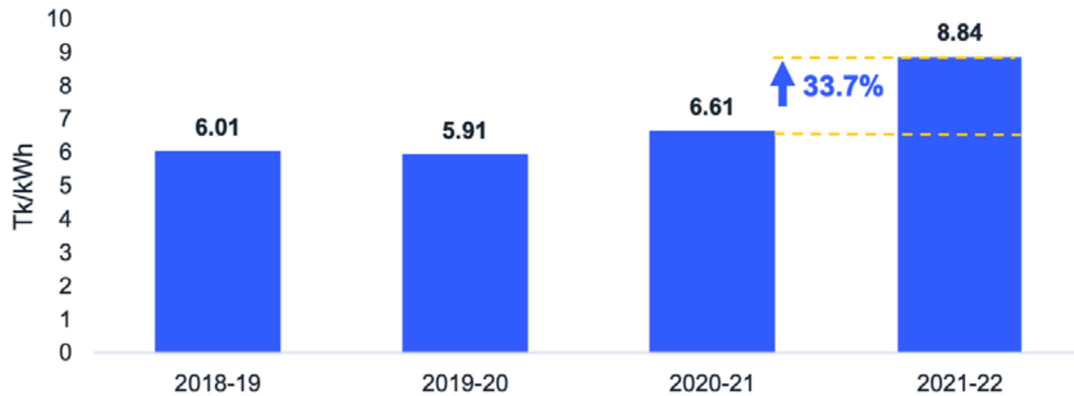


Source: Alam. (2023)

Moreover, the shift toward imported fossil fuels—primarily oil and coal—has exposed Bangladesh to high and unpredictable fuel costs, further complicating the economic landscape. In 2022, the nation faced prices for natural gas that were 5 to 10 times higher than in previous years, which severely affected the garments industry, a critical contributor to the economy, potentially doubling production costs and eroding its competitive advantage. The volatility of international fossil fuel prices, influenced by events like the COVID-19 pandemic and geopolitical tensions, has compounded these challenges, creating a precarious economic environment.

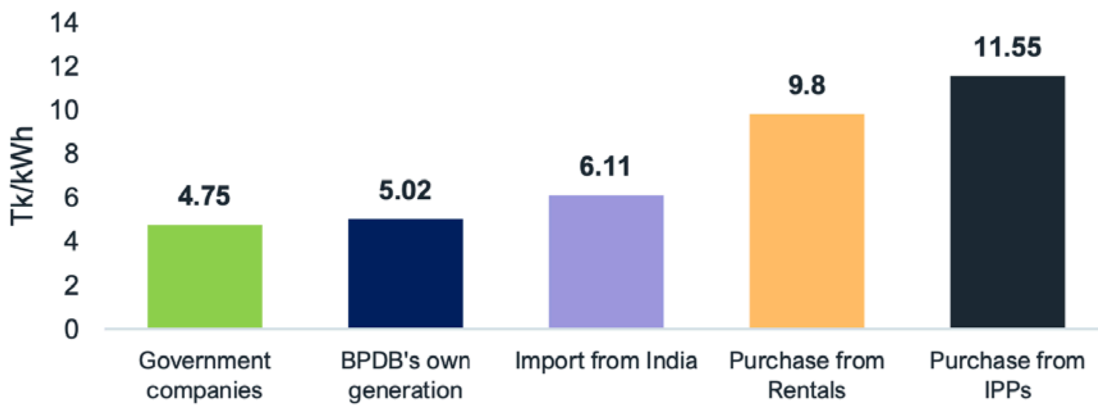
Electricity prices have begun to rise, with increases reported in both 2019 and 2020, while gas tariffs saw a nearly 23% rise more recently. However, these frequent and unpredictable tariff hikes not only disrupt industrial efficiency but also deter potential investments. The effects of power cuts are evident in delayed production processes, which make it challenging for manufacturers to meet export deadlines, thus diminishing their competitiveness in the global market. Small business owners, such as restaurant operators, have noted a decrease in customer turnout due to enforced energy-saving measures, reflecting the broader impact of energy constraints on local economies. All of these factors have led to increases in the cost of electric power in the country, particularly power purchased from power rental units and from independent power producers (IPPs), as the two charts below illustrate.

Figure 2. Average Power Generation Cost (2018–2022)



Source: Alam. (2023)

Figure 3. Average Power Generation Cost by Ownership (2021–2022)



Source: Alam. (2023)

Politically, Bangladesh's fossil fuel dependency complicates governance and international relations, particularly amid regional geopolitical tensions involving major powers like China and India. The cost of energy subsidies has strained public finances, with significant fiscal resources allocated to maintain artificially low energy prices, which, according to the World Bank, has cost the nation around $11.2 billion annually.[18] This financial burden, coupled with growing public discontent over austerity measures implemented to mitigate rising costs, has prompted debates about the need for reform in energy management and regulatory frameworks.[19]

Environmentally, the reliance on fossil fuels exacerbates serious pollution issues, with Bangladesh often ranked among the world's most polluted countries. As the World Bank has estimated, 32% of all deaths in Bangladesh are linked to environmental degradation, particularly to outdoor and household air pollution as well as poor water quality and lead exposure.[20] Air pollution is linked to approximately 272,000 premature deaths, direct health costs of $4.4 billion, and an estimated $1.2 billion annually in lost productivity, contributing to health crises and reducing life expectancy by nearly seven years.[21] Climate change is only compounding such costs, with annual losses from tropical cyclones alone equaling 0.7% of GDP. Socially, the impact of energy shortages and rising costs disproportionately affects low- and middle-income households, exacerbating inequalities and straining livelihoods across the country.[22] Rural areas experience four to six hours daily outages, while industrial zones face two to three hours of supply disruption daily.

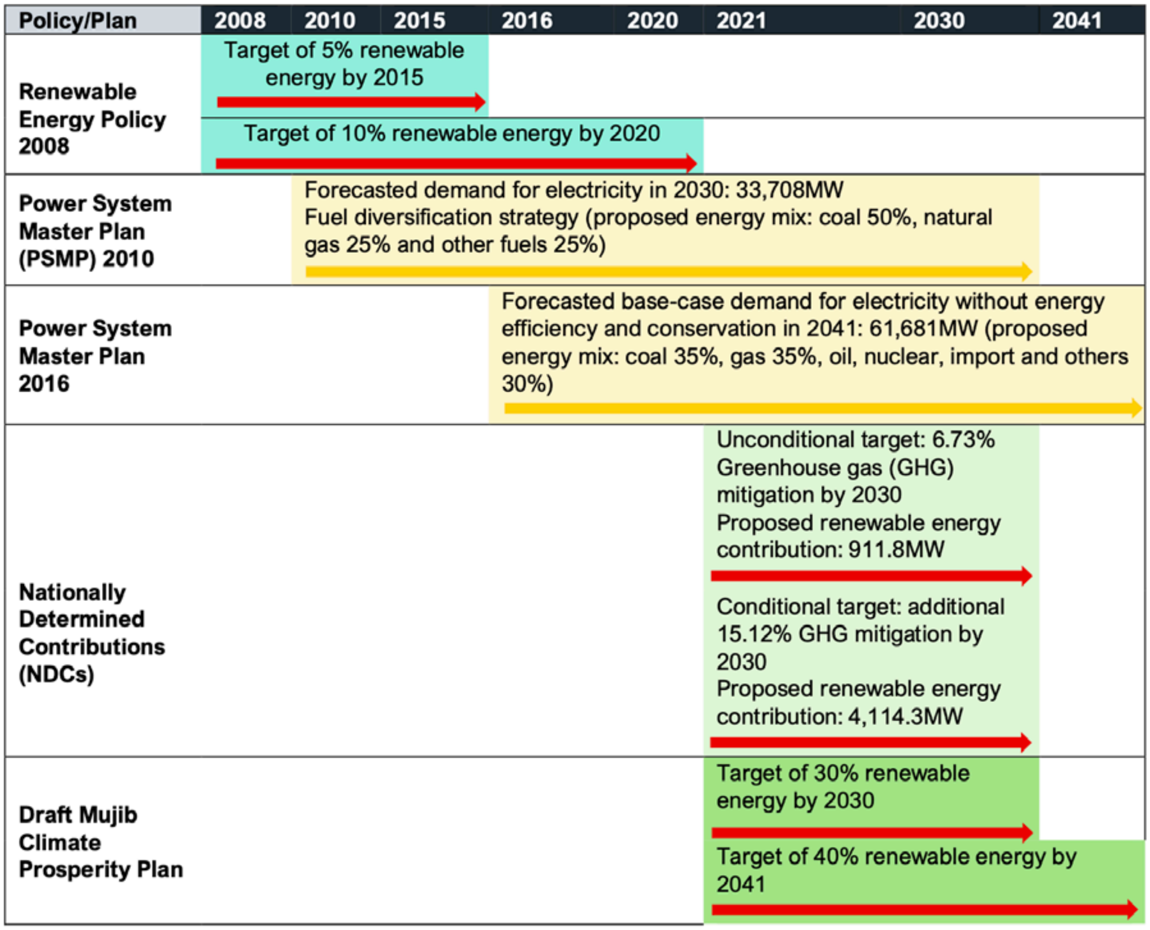
Institutional Landscape and Policy Evolution

Bangladesh's main government entities related to the regulation of solar power are the Ministry of Power, Energy, and Mineral Resources (MoPEMR) and the BPDB. MoPEMR is responsible for policies and regulations related to (i) power generation, transmission, and distribution from conventional and renewable sources; and (ii) import, distribution, exploration, extraction, and pricing of primary fuels in Bangladesh. It has two divisions: the Power Division and the Energy and Mineral Resources Division. The Sustainable and Renewable Energy Development Authority (SREDA) was formed in 2012 under the Power Division to ensure sustainability and energy security through the expansion of renewable energy and the promotion of energy conservation.

BPDB is the single largest entity in the power sector, owning 48% of generating capacity in October 2023, including generation by its subsidiary companies. Independent power producers provide the balance of generation capacity. BPDB functions as the exclusive buyer of all produced electricity, which it then wholesales to various distribution utilities. Power Grid Company of Bangladesh is the transmission utility that owns and manages the transmission network and 132 kilovolt (kV), 230 kV, and 400 kV substations. BPDB, its subsidiaries (Dhaka Electricity Supply Company, Dhaka Power Distribution Company, and Western Zone Power Distribution Company), and the Rural Electrification Board distribute power to urban and rural areas.

Renewable energy first emerged in Bangladesh's energy policy landscape in the National Energy Policy of 1996. However, the revision of that policy, the National Energy Policy 2004, first set the objective of meeting at least 5% of total electricity demand by 2010 and 10% by 2020 from renewable energy sources. Since 2008, many plans and guidelines have been formulated in Bangladesh on the promotion of renewable energy, as shown below:

Figure 4. Electricity Sector Policy Development



Source: Alam. (2023)

In the Renewable Energy Policy (REP) 2008, targets were revised to produce 5% of electricity from renewable sources by 2015 and 10% by 2020. REP 2008 offered key incentives such as tax exemptions for renewable energy materials, micro-credit for rural areas, facilitation of private investments, subsidies, corporate income tax exemption for investors, incentive tariffs for electricity from renewable sources, and streamlined lending procedures for renewable projects.

The Power System Master Plan (PSMP) 2016 set specific renewable energy targets, aiming for a domestic renewable energy power generation of 2,470 MW by 2021 and 3,864 MW by 2041. Additionally, it targeted domestic biogas production to reach 790,000 m^3/day by 2021, with an increase to 3 million m^3/day by 2041. The plan also emphasized the importance of cross-border energy imports, projecting the need for 3,500–8,500 MW by 2031 and 9,000 MW by 2041. Following this, in the Bangladesh Delta Plan 2100, the renewable energy target was revised to 30% of the total electric power generation by 2041. In addition, the Perspective Plan (PP2041) further pushed up the target that 35% of the total energy mix is to be supplied by domestic renewable energy together with cross-border energy import (assuming hydropower generation in neighboring counties) by 2041.

Both the targets aimed in the PP2041 and the PSMP2016 became obsolete when at COP26 in November 2021, the prime minister confirmed that the country had canceled 10 coal-fired power projects and declared to generate 40% of energy from renewable sources by 2041. With the new policy ambition to significantly increase the share of renewables in the total energy mix, the increase in coal-fired power generation projected in the PSMP2016 can no longer be developed. This shift in direction was strengthened by other power-related policy, in particular Bangladesh's net metering policy, introduced in 2018 and revised in 2019, marking a significant move toward promoting renewable energy, specifically through industrial rooftop solar installations. By allowing customers to connect their systems to the grid, the policy has added 36 MWp from 1,500 systems by February 2022. However, limitations, such as the restriction to three-phase consumers and a 10 MW capacity cap, curtail its potential.

In 2021, Bangladesh's NDC (Nationally Determined Contributions) was submitted to the United Nations Framework Convention on Climate Change with unconditional and conditional renewable energy targets of 911.8 MW and 4,114.3 MW, respectively, by 2030. The preliminary report of the Mujib Climate Prosperity Plan (MCPP) was released in September 2021, which presented the following four scenarios:

1. NDCs: Based on the first NDC submitted (to be updated along with future NDC submissions)
2. Business-As-Usual (BAU): The reference scenario in Vision 2041 (PP2041)
3. MCPP: A realistic climate prosperity scenario based on current and expected prospective access to resources and support
4. Mujib Climate Prosperity Plan Maximized (MCPP-M): A maximized climate prosperity scenario based on a significant increase in resources made available both from international support and the private sector (domestic, regional, and international)

SREDA is currently updating the REP 2008. According to the Center for Policy Dialogue, the new policy is expected to take a more detailed approach to renewable energy, establishing a master plan and setting up institutional frameworks for energy production and regulation. It aims for 40% of Bangladesh's energy from renewables by 2040, emphasizing solar solutions like rooftop installations and advocating for cost-effective low-carbon technologies.

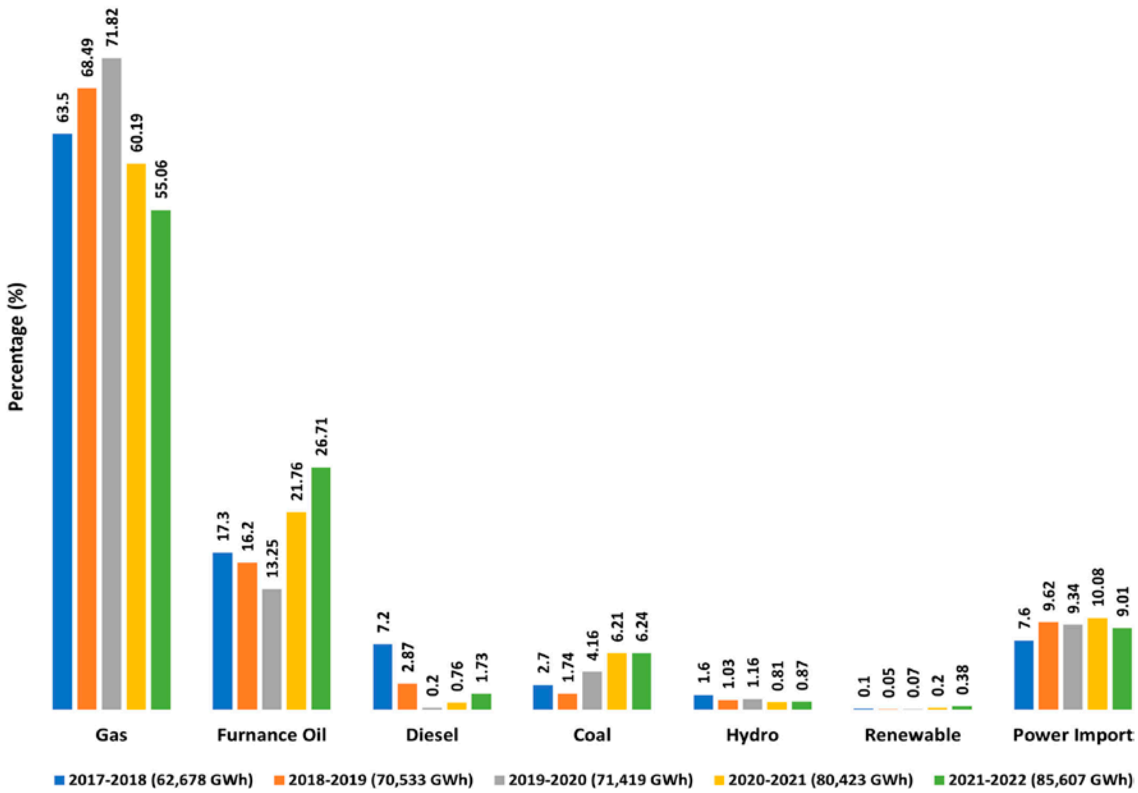
The latest policy document that captures the country's renewable energy targets and goals is the IEPMP, approved in November 2023. Unlike the previous plans, IEPMP takes a slightly different approach by focusing broadly on "clean energy" rather than "renewable energy." According to the IEPMP, clean energy is defined as a source of energy that does not emit carbon dioxide, such as nuclear power, renewable energy, ammonia-fired thermal power, and hydrogen-fired thermal power.

The IEPMP expresses reservations about the widespread adoption of renewable energy, citing the country's high population density and limited land as major constraints, and predicting that renewables will not surpass 20% of the energy mix by 2050. However, the plan does foresee growth in solar energy, with a focus on expanding large-scale solar parks and rooftop installations. By 2030, solar developments are expected to use available lands, shifting toward reclaimed river lands thereafter, in alignment with the Bangladesh Delta Plan. The IEPMP projects that by 2050, solar parks will contribute 6 GW, rooftop solar will add another 12 GW, and wind energy will provide an additional 20 GW from both onshore and offshore projects.

Transitioning Toward a Cleaner Energy Mix

As seen in the chart below, Bangladesh's power sector still relies nearly exclusively on fossil fuels for electricity generation. Natural gas is currently the main fuel used for electricity generation. A British Petroleum report confirmed that the indigenous gas reserve in Bangladesh will likely last until 2026, considering the remaining reserves and yearly production and growth rate. Therefore, the government is importing liquified natural gas to make up the difference.

Figure 5. National Energy Mix 2017–2022



Source: Hossain et al. (2023)

Bangladesh has significant solar energy potential throughout the country due to its geographical location and wind potential along the coastal zone. Several studies indicate its grid-connected solar PV and wind energy potential. According to the World Future Council, Bangladesh has the potential for 150 GW of utility-scale solar power plants. Around 5,000 MW of electricity can be generated by installing solar panels on the rooftops of ready-made garment, textile, and other industry buildings in the country. According to Energy Tracker Asia, 1,500 square kilometers (km^2) of pond space can accommodate 15 GW, and 2,500 km^2 of shallow water regions can accommodate 25 GW of floating solar power plants. The US National Renewable Energy Laboratory showed that an area of more than 20,000 km^2 exhibits wind speeds of between 5.75 and 7.75 meters per second, with a gross wind potential of over 30 GW.

Bangladesh contributes less than 0.47% of global emissions despite being one of the most susceptible countries to climate change. In the IEPMP, Bangladesh aims to develop a long-term energy plan up to 2050, with a concept of "S plus 3E" representing safety, energy security, economic efficiency, and environment as the central pillars. The IEPMP assumes an Advanced Technology Scenario (ATS)[23] and adopts the PP2041

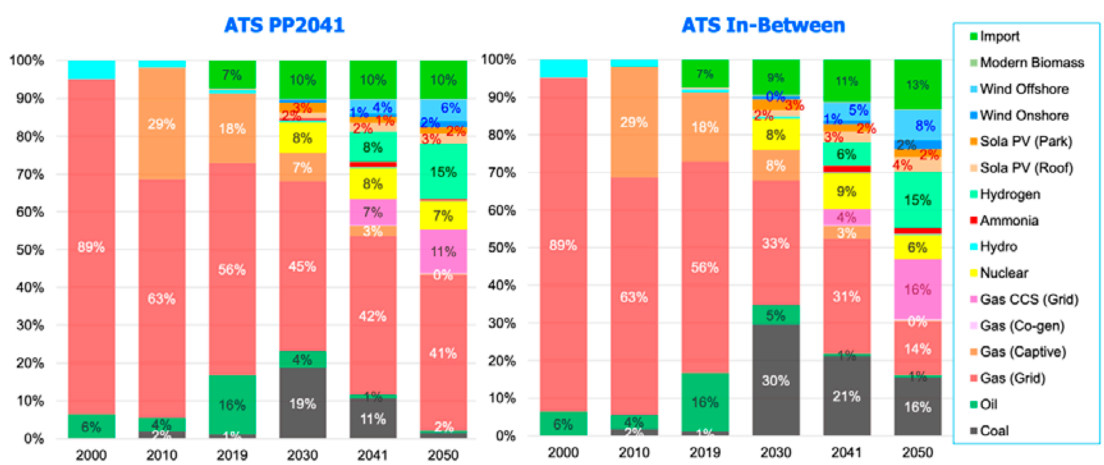
GDP case (an optimistic economic growth case to achieve a high-income country status by 2041) as the base case scenario while running an exercise case on the in-between GDP case (an economic growth case in between the PP2041 and the projections made by the International Monetary Fund's World Economic Outlook).

According to the IEPMP, hydrogen and ammonia-fired power plants, as cleaner energy sources, incur generating costs over double that of traditional coal and gas plants. Hydrogen plants, however, are more efficient and have lower fuel expenses than ammonia counterparts. Adding carbon capture and storage (CCS) to gas plants raises costs by 2.2 US cents per kWh. Solar energy is the cheapest among renewables, costing about 4 US cents per kWh in 2020 with anticipated declines, while offshore wind, costing 14 US cents per kWh in 2020, is expected to become cheaper in the future.

The IEPMP recognizes the early stages of technological evolution, yet it outlines strategies for evolving the energy sector, including integrating ammonia in coal-fired plants and shifting from gas to hydrogen in power generation. Moreover, it forecasts significant progress in offshore wind energy, highlighting its future cost advantages over traditional power sources.

In the ATS PP2041 scenario, while clean energy hits a 40% share by 2041, renewables have a modest increase. Natural gas remains the leading energy source by 2050, complemented by significant contributions from hydrogen and CCS-equipped gas power. Despite coal power reducing to just over 10% by 2041 and nearing disappearing by 2050, domestic renewables grow modestly compared to the substantial roles of nuclear power and imported energy.

Figure 6. Projected Electric Power Generation Mix (2000–2050)



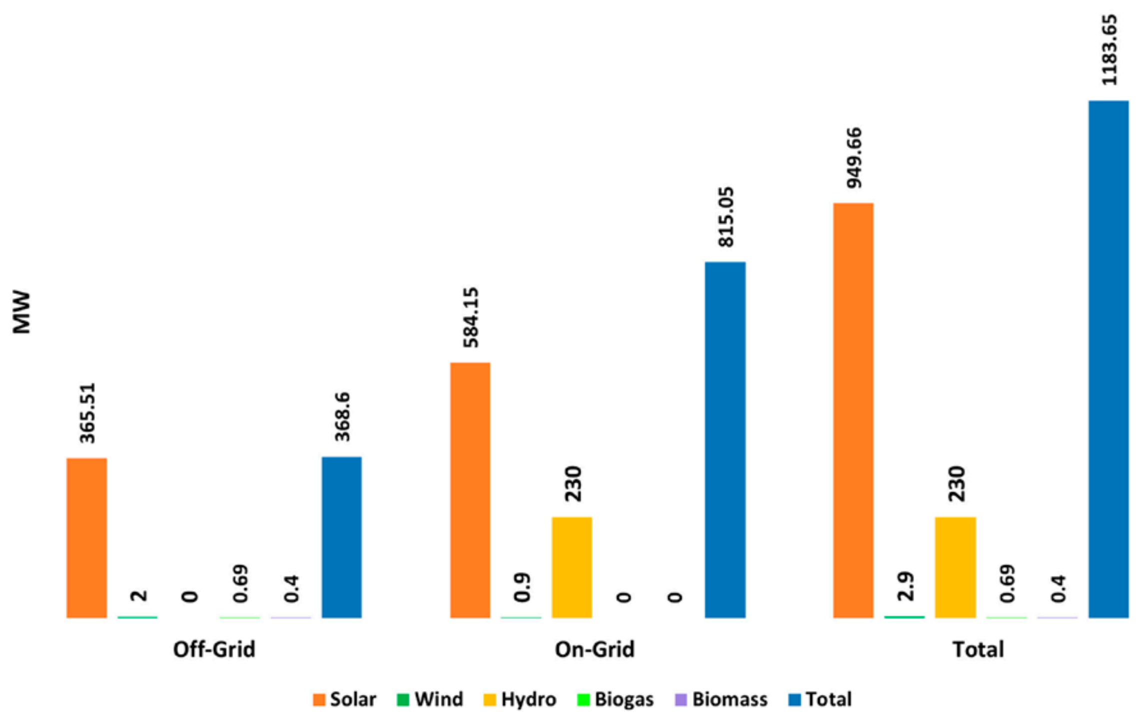
Source: MoPEMR (2023)

A recent report published by BloombergNEF criticizes the IEPMP for overlooking the potential of proven renewable energy sources like solar and wind in Bangladesh. It argues that the heavy reliance on fossil-fuel thermal power plants will compromise the country's energy security, drain foreign currency reserves, and increase local pollution. BloombergNEF's analysis highlights that solar energy is already cost-competitive with new coal and gas power plants and will become the cheapest option by 2025. Furthermore, the report emphasizes that retrofitting thermal power plants for hydrogen or ammonia will not be economically viable compared to building new renewable energy projects. It highlights the need for Bangladesh to prioritize renewable energy deployment over the expansion of thermal power plants, which could saddle the country with significant financial risks.[24]

Renewable Energy Installation: Experiences and Takeaways

Despite its potential, renewable energy still holds only a small share of the market. The lack of enabling policies and government agency cooperation, land scarcity, and the comparatively high initial cost of setting up renewable energy plants are the key roadblocks to large-scale, on-grid renewable energy projects. The following table shows the renewable energy installation status as of June 2023:

Figure 7. Renewable Energy Installed Capacity



Source: Hossain et al. (2023)

Solar energy's share of renewable energy is highest at 80.4%; the second position is occupied by hydro with 19.3%. The share of wind and biogas/biomass is less than 1%. However, the contribution of the new 60 MW wind power plant at Cox's Bazar has not been added. The total on-grid installed capacity of renewable energy power generation is less than 3.5% of the total grid capacity of approximately 26,000 MW (January 2024); in terms of electricity generated in 2022–23, it is less than 1%.

Bangladesh's off-grid solar initiative, particularly the Solar Home Systems (SHS) program, represents a pioneering example of large-scale, off-grid electrification with significant socioeconomic benefits. From 2003 to 2018, the program successfully installed over 4.1 million solar home systems, transforming the lives of around 20 million rural inhabitants by providing them with access to basic electricity services far sooner than they would have through conventional grid extension.

The program's success is attributed to a blend of market-based strategies; extensive collaborations with microfinance institutions, nongovernmental organizations, and private sector entities; and a robust support structure facilitated by IDCOL. This integrated approach allowed for the rapid deployment of solar solutions across rural Bangladesh, highlighting the country's commitment to sustainable energy access.

One of the program's most notable achievements is its significant contribution to rural electrification, which saw an increase from 27% in 2003 to 95.2% by 2020. This expansion in access to electricity brought myriad benefits, including improved educational outcomes, as children could study longer under better lighting conditions, and enhanced safety and health conditions by reducing reliance on kerosene lamps, thus avoiding associated respiratory illnesses and fire hazards.[25]

Moreover, the SHS program catalyzed the development of local industries related to solar power, from manufacturing to after-sales services, while also generating employment opportunities and fostering technological advancements in rural areas. Financially, the program was instrumental in mobilizing significant investment from both international and domestic sources, demonstrating a viable model for rural electrification that combines development financing with private sector engagement.

The program ended in 2018 due to rapid grid expansion in rural areas and the government's distribution of free systems to the ultra-poor segment of society. Achieving 100% rural electrification quickly has significantly benefited rural communities. However, this progress led to the near abandonment of over five million SHS units. Additionally, IDCOL's other off-grid solar projects, such as solar irrigation and mini-grids, have experienced only modest success.

In Bangladesh, one of the primary obstacles to developing utility-scale renewable energy projects is the scarcity of available land. Significant amounts of land are needed for these projects, with approximately 3.5 to 4.0 acres required to generate 1 MW of solar energy, considering the solar irradiance levels in Bangladesh. The country's high population density means that land comes with a high opportunity cost, especially when it could be used for agriculture, commerce, or housing. However, government-owned lands on river islands and in areas prone to seasonal flooding, which are generally not fit for habitation, are deemed most appropriate for utility-scale renewable energy developments.

Other on-grid solar technologies, such as solar rooftops (with or without net metering) and solar irrigation pumps, play a role in contributing to the overall electricity supplied to the grid, as outlined in the table below. Solar parks offer a steady supply of electricity to the grid during sunny periods, while additional on-grid solar solutions contribute directly by supplying power to the grid or indirectly, like off-grid technologies, by reducing the overall demand on the grid.

Bangladesh holds significant potential for integrating rooftop solar installations within its industrial zones, such as economic zones and export processing zones, to achieve its ambitious renewable energy goals. This approach also provides a strategic avenue to pursue the country's solar energy agenda, circumventing the challenges posed by limited land availability. According to the IEPMP, it is projected that by 2050, solar parks will supply 6 GW of power, whereas rooftop solar installations will contribute twice as much, at 12 GW.

In 2018, Bangladesh promulgated a net metering policy targeting the industrial sector. Implementing net metering in this sector faces several hurdles, including the absence of suitable financing options, issues with tariff cross-subsidization, concerns about the quality of components, and gaps in installation and maintenance expertise. Moreover, engaging utilities in a program perceived as potentially undermining their business model is another critical aspect of this strategy. Consequently, after three years, the initiative has seen limited uptake, with only around 1,600 rooftop solar projects, totaling a capacity of 48.3 megawatts-peak (MWp), being incorporated into the net metering system across six power distribution companies in Bangladesh.

Incentive Structure

Globally, numerous policies have been designed to incentivize renewable energy investments by reducing the associated costs. These strategies include (1) offering subsidies and rebates to lower initial capital costs, (2) providing tax relief to reduce post-purchase capital costs, (3) granting production tax credits to compensate for costs based on electricity production, (4) offering concessionary loans and financial assistance, and (5) leveraging economies of scale to decrease capital and installation expenses.

In Bangladesh, the government has rolled out several incentive schemes from the inception of its policy framework to support and accelerate the generation of electricity from renewable sources. Through major policy documents like the National Energy Policy 2004, Private Sector Power Generation Policy 2004, and Renewable Energy Policy 2008, the government has announced various investment and fiscal incentives aimed at attracting both local and international investors. Despite these efforts, there are notable inconsistencies within the renewable energy sector's policies, particularly concerning the

National Board of Revenue (NBR) duty exemption list. The absence of renewable energy power plant equipment on this list has led to challenges for sponsors in availing benefits from government agencies, such as customs duty exemptions from the NBR.

The costs associated with developing utility-scale solar power projects in Bangladesh are notably higher than in many other countries and nearly double that of India. This increase in investment costs can be attributed to several factors specific to the local context, including the following:

- Lengthy approval process for unsolicited proposals
- High cost of land due to scarcity and local influence
- Nonagricultural lands, often located in floodplains or coastal regions, necessitating significant additional investments for development and erosion control measures
- Necessity of obtaining development and erosion protection approvals from multiple governmental bodies, leading to further delays and increased expenses
- Requirement for extra land to build transmission lines, especially for projects situated far from the national grid
- Necessity of obtaining numerous approvals and/or permits from various agencies, both before and following financial closure

Moreover, Bangladesh's local banking sector struggles to offer the long-term financing and comprehensive due diligence that utility-scale renewable energy projects demand. Except for IDCOL and another government-owned infrastructure fund, Bangladesh Infrastructure Finance Fund Limited, the main source of local infrastructure financing is typically trade finance (such as letters of credit) and balance sheet corporate financing. The capacity for financing in foreign currencies is also constrained in Bangladesh, largely due to the cautious risk appetite of international financiers. To this point, the main avenues for obtaining long-term foreign currency debt capital for utility-scale solar projects have been through multilateral and bilateral development agencies, IDCOL, and a few refinancing options provided by the central bank.

While the availability of sufficient financing for solar projects is crucial, it does not appear to be the main obstacle to their broader adoption. Bangladesh continues to provide attractive tariffs for utility-scale solar. Despite the devaluation of the taka against the dollar reducing much of this incentive, the current tariff rate remains appealing for investment. Over the nearly decade-long duration of the program, the primary challenge has been securing adequate land. This issue has led numerous well-known international investors to withdraw from the country after extensive unsuccessful efforts to acquire suitable land at affordable cost.

Risk Analysis to Master Plan Implementation

The successful implementation of Bangladesh's master plan for renewable energy expansion is contingent upon a comprehensive assessment and mitigation of potential risks. As the country embarks on an ambitious journey to achieve its renewable energy targets of 4 GW by 2030 and 40% by 2041, it is crucial to identify and address the financial, economic, and supply security risks that may impede progress. This section aims to provide a risk analysis that draws upon empirical data, economic modeling, and case studies from comparable contexts.

One of the primary risks to the master plan implementation is the financial and economic viability of renewable energy projects. Despite the declining costs of renewable energy technologies, with solar PV costs falling by 82% between 2010 and 2019, the upfront capital investments required can be substantial.[26] According to a study by Rahman et al. (2023), the lack of access to affordable financing, with interest rates ranging from 9% to 12% for renewable energy projects in Bangladesh, has been a significant barrier to their widespread adoption.

Innovative financing mechanisms, such as green bonds, are often deployed to attract private sector investments in renewable energy projects. A recent study by the World Business Council for Sustainable Development emphasizes the need for comprehensive financial risk assessments and risk mitigation strategies, such as government guarantees and PPAs, to ensure the bankability of renewable energy projects.[27]

Another significant risk to the master plan implementation is the country's heavy reliance on imported fossil fuels for energy generation. Bangladesh is on track to import approximately 1.5 million metric tons of crude oil and 6.5 million metric tons of refined petroleum products in 2024, accounting for a significant portion of the country's import bill.[28] This dependence on imported natural gas and coal not only contributes to greenhouse gas emissions but also strains the nation's foreign exchange reserves, which declined by 19% to $34.5 billion in 2022.[29] Furthermore, the volatility in global energy prices, exacerbated by events such as the Russia-Ukraine war, exposes Bangladesh to significant economic risks.

A recent study by Islam et al. (2022) emphasizes the need to address supply security risks by diversifying the energy mix and reducing the country's reliance on a single energy source. For instance, Bangladesh's current electricity generation mix is heavily skewed toward natural gas, accounting for 73% of total generation in 2021.[30] The integration of multiple renewable energy sources, such as solar, wind, and hydropower, can mitigate the intermittency challenges associated with individual technologies and enhance the overall reliability of the energy supply.

A proper risk analysis must also consider the potential impacts of climate change on the performance and lifespan of renewable energy infrastructure. A recent report by the Coastal Development Partnership highlighted the vulnerability of Bangladesh to climate-related disasters, such as cyclones, floods, and sea level rise, which can damage or disrupt renewable energy projects.[31] For example, the 2020 Cyclone Amphan caused widespread damage to power infrastructure, leaving millions without electricity for days. Proactive measures, such as climate-resilient infrastructure design and robust disaster risk management strategies, are central to mitigate these risks.

From an economic perspective, the risk of stranded assets and the potential for job losses in the fossil fuel industry during the energy transition must be addressed. Bangladesh's coal mining industry, though relatively small, employs around 120,000 workers who may face displacement as the country shifts toward renewable energy sources. A just transition toward a sustainable energy future requires comprehensive strategies to retrain and reskill workers, create new employment opportunities in the renewable energy sector, and provide adequate social protection measures.

Moreover, the successful implementation of the master plan hinges on the availability of skilled human resources and technical expertise in the renewable energy sector. A complementary policy paper by Harvard Kennedy School Senior Fellow Philip Jordan underscores the importance of capacity building and knowledge transfer initiatives to develop a skilled workforce capable of designing, installing, and maintaining renewable energy systems. The paper outlines the approaches of the US federal government and several state government models to achieve this goal, offering lessons for other nations. In Bangladesh, a shortage of trained personnel in areas such as solar PV installation and maintenance has been identified by SREDA as a significant barrier.[32] Failure to address this risk could result in suboptimal project execution and decreased efficiency.

Regulatory and policy risks also pose significant challenges to the master plan implementation. A lack of a comprehensive and consistent regulatory framework for renewable energy development can discourage private sector investments and hinder project development. For instance, the absence of a clear and streamlined process for obtaining land and environmental clearances has led to delays and cost overruns in several renewable energy projects in Bangladesh. Frequent policy changes, complex bureaucratic processes, and unclear incentive structures can create an uncertain investment environment, deterring potential investors.

Additionally, the integration of large-scale renewable energy sources into the national grid presents technical challenges that must be addressed. In particular, there is a need for grid modernization, energy storage solutions, and robust grid management systems to accommodate the intermittent nature of renewable energy sources. Bangladesh's current transmission and distribution infrastructure is plagued by system losses, estimated at around 11% in 2021 by the BPDB, which could exacerbate the challenges of integrating variable renewable energy sources. Failure to address these technical risks could lead to grid instability, curtailment of renewable energy generation, and inefficient usage of installed capacity.

Sociopolitical risks, such as public opposition to renewable energy projects due to land acquisition issues or perceived environmental impacts, can also impede the implementation of the master plan. In Bangladesh, land acquisition for large-scale renewable energy projects has faced resistance from local communities, particularly in areas with high population density and competing land use priorities.[33]

Policy Recommendations

The disconnect between policy declarations and actual commitments raises uncertainties about the renewable energy strategy and objectives the government of Bangladesh will ultimately adopt. Addressing the risks associated with the master plan implementation requires a multipronged approach that involves financial, economic, technical, regulatory, and social interventions. To realize the ambitious 2041 targets, it is crucial to overcome barriers and revamp the renewable energy policy to be more comprehensive and inclusive. A recent US Agency for International Development white paper made several suggestions to help the government of Bangladesh to navigate these challenges and refine its policies to fulfill its renewable energy commitments and objectives.[34]

On the financial front, the government should explore partnerships with multilateral development banks, international financial institutions, and the private sector to mobilize the necessary investments for renewable energy projects. For instance, the World Bank has committed $185 million to support Bangladesh's renewable energy program, including the construction of the country's first utility-scale solar PV plant.[35] The development of a comprehensive and supportive regulatory framework is crucial to provide clarity and confidence to investors. This framework could include measures such as updated FITs, renewable energy certificates (RECs), and streamlined permitting processes to reduce regulatory barriers and enhance the bankability of projects. Bangladesh has already taken steps in this direction with the introduction of net metering and a renewable energy policy in 2018, but further refinements and implementation are needed. To encourage collaboration and investment, the targets should also be allocated between the public and private sectors, aligning with the recommendations of the United Nations Economic and Social Commission for Asia and the Pacific.

To mitigate supply security risks, the government should prioritize the diversification of the energy mix by promoting a balanced portfolio of renewable energy sources, including solar, wind, and hydropower. This approach can leverage the complementary strengths of different technologies and address the intermittency challenges associated with individual sources. For example, the combination of solar PV and wind power can provide a more consistent energy supply, as wind speeds tend to be higher during the night when solar generation is low. Furthermore, investments in grid modernization, energy storage systems, and advanced grid management technologies are important to facilitate the integration of large-scale renewable energy sources. Bangladesh can also learn from the experiences of other countries that have successfully integrated high shares of renewable energy into their grids. For instance, Germany has implemented a range of measures, including grid reinforcements, demand-side management, and the deployment of large-scale battery storage systems, to accommodate its rapidly growing renewable energy capacity. Collaboration with international organizations, research institutions, and technology providers can provide access to cutting-edge solutions and best practices in this domain.

Mitigating the sociopolitical risks requires proactive stakeholder engagement and community involvement strategies. The government should establish transparent communication channels, provide adequate compensation and resettlement support for affected communities, and promote the creation of local employment opportunities in the renewable energy sector. Bangladesh can draw lessons from India's experience with the Jawaharlal Nehru National Solar Mission, where dedicated land acquisition policies and community engagement programs were implemented to facilitate the deployment of large-scale solar projects.[36] Capacity building and knowledge transfer initiatives are vital to develop a skilled workforce capable of supporting the renewable energy transition. This can be achieved through partnerships with academic institutions, vocational training programs, and international organizations, leveraging their expertise and resources. For example, the United Nations Industrial Development Organization has implemented a project in Bangladesh to provide technical training and capacity building for solar PV technicians and entrepreneurs.[37]

Moreover, the government should prioritize the development of a comprehensive climate change adaptation and disaster risk management strategy to ensure the resilience of renewable energy infrastructure. This strategy should incorporate climate-resilient design principles, such as elevating critical components above flood levels and using wind-resistant structures, as well as early warning systems and contingency plans to minimize disruptions and potential damages. Bangladesh can draw inspiration from the experiences of other climate-vulnerable countries, such as the Maldives, which has implemented a Climate Change Policy Framework to guide its adaptation and mitigation efforts.[38]

The government must also address the growing pressure from environmental, social, and governance (ESG) regulations and stakeholder expectations, which are increasingly influencing investment decisions in the energy sector. International financial institutions and development banks are placing greater emphasis on ESG criteria when evaluating project proposals, and failure to comply with these standards may limit access to financing. Bangladesh should proactively align its renewable energy policies and practices with global ESG standards to attract sustainable investments and maintain its competitiveness in the global market.

By implementing a comprehensive risk mitigation strategy that addresses financial, economic, technical, regulatory, social, and environmental risks, Bangladesh can enhance the likelihood of successfully implementing its master plan for renewable energy expansion. A proactive and multifaceted approach, involving collaboration among various stakeholders, international organizations, and development partners, will be better able to overcome the challenges and unlock the country's potential for a sustainable and secure energy future.

Bangladesh has set ambitious goals for solar power generation, including the short-term target of 4 GW by 2030 and the medium-term target of achieving 40% renewable energy by 2041. Nevertheless, the country faces several challenges that hinder the widespread adoption of solar energy. The following are a set of policy recommendations and interventions to overcome these challenges and accelerate the deployment of solar energy in Bangladesh.

1. Establish Clear and Achievable Renewable Energy Targets

To create a conducive environment for solar energy deployment, it is important to set a clear, realistic, and achievable national renewable energy target framework. These targets should be based on comprehensive resource availability assessments, techno-economic evaluations, and stakeholder consultations. They should encompass short-term (5 years), medium-term (10–15 years), and long-term (up to 2050) goals, expressed in terms of electricity generation capacity (GWh) or as a percentage of total demand. India has set graduated renewable energy targets, aiming to achieve 450 GW of installed capacity by 2030.[39]

To effectively incorporate information on land usage, rooftop solar, grid stability, and agro-solar systems into Bangladesh's renewable energy action plan, several concrete steps should be taken. First, a national geospatial data infrastructure for renewable energy should be established. This would involve creating a centralized geospatial database that integrates data on land use, land cover, topography, solar irradiation, and other relevant parameters. Collaboration with international organizations, such as the United Nations Food and Agriculture Organization and the International Renewable Energy Agency (IRENA), would enable access high-resolution satellite imagery and geospatial data. Additionally, developing a user-friendly web-based platform would allow stakeholders, including policymakers, researchers, and project developers, to access and analyze the geospatial data for renewable energy planning and decision-making.

Second, a comprehensive assessment of rooftop solar potential should be conducted. This would involve using high-resolution satellite imagery and LiDAR (Light Detection and Ranging) technology to create a detailed 3D map of urban and rural settlements in Bangladesh. An automated algorithm should be developed to identify suitable rooftops for solar PV installation, considering factors such as roof area, orientation, shading, and structural stability. The model could also estimate the total rooftop solar potential in Bangladesh and create a prioritized list of locations for rooftop solar deployment based on energy demand, grid connectivity, and socioeconomic factors.

Third, a grid stability monitoring and management system can be implemented that would involve installing advanced metering infrastructure (AMI) and smart grid technologies to monitor real-time power generation, transmission, and distribution data. Developing a grid stability assessment framework could include the integration of renewable energy sources, particularly solar PV and wind, into the existing grid infrastructure. Identifying grid strengthening and modernization requirements, such as energy storage systems, dynamic voltage regulators, and grid automation technologies, would ensure stable and reliable grid operation with high penetration of renewable energy.

Fourth, agro-solar systems could be best promoted through a targeted policy framework. This would involve conducting a detailed assessment of agricultural land suitability for agro-solar systems using satellite imagery, GIS technology, and ground-based surveys. Developing a plot-by-plot analysis framework, similar to the Integrated Rice Advisory System, could deploy landscaping technologies and geospatial data to optimize solar panel placement and orientation based on crop type, irrigation requirements, and solar irradiation levels. Taken together, a comprehensive policy framework would then support the adoption of agro-solar systems, including financial incentives (e.g., subsidies, low-interest loans), technical assistance, and capacity-building programs for farmers and rural communities.

Importantly, research and innovation in renewable energy geospatial analysis should be fostered. This would involve establishing a dedicated research grant program to support innovative projects that integrate geospatial data, remote sensing, and machine learning techniques for renewable energy planning and optimization. Collaboration with leading universities, research institutions, and technology companies could enable the development of cutting-edge tools and methodologies for geospatial analysis of renewable energy potential, grid stability, and agro-solar systems. Organizing regular workshops, conferences, and knowledge-sharing events would then disseminate best practices and foster a community of practice in renewable energy geospatial analysis.

Last, institutional capacity and coordination should be strengthened. This would involve establishing a dedicated renewable energy geospatial analysis unit within the MoPEMR to coordinate the collection, analysis, and dissemination of geospatial data for renewable energy planning. The unit could also provide training and capacity-building programs for government officials, researchers, and project developers on the use of geospatial data and tools for renewable energy planning and decision-making. Fostering cross-sectoral collaboration and data-sharing among relevant government agencies—such as the Ministry of Agriculture, the Ministry of Environment, Forest and Climate Change, and the Bangladesh Space Research and Remote Sensing Organization—would ensure a coordinated and integrated approach to renewable energy planning.

By implementing these concrete steps, Bangladesh can effectively incorporate geospatial data and analysis into its renewable energy action plan, enabling a diversified and optimized approach to renewable energy deployment. This will support the integration of solar PV systems into agricultural practices, enhance grid stability, and promote the adoption of rooftop solar and agro-solar systems, ultimately contributing to the country's sustainable energy transition.

2. Implement RPOs

To stimulate the growth of renewable energy in Bangladesh, policymakers could introduce RPOs and takxe the following concrete steps. First, they should set ambitious but achievable RPO targets. These targets, based on existing comprehensive assessments of the country's renewable energy potential, should be gradually increased over time to allow for a smooth transition and provide a stable and predictable demand for renewable energy. Additionally, to create a consistent demand for renewable energy, policymakers should expand RPO coverage to include existing consumers with over 50 kW demand. This will ensure that a larger portion of the electricity market is subject to RPO requirements, driving the growth of renewable energy.

Policymakers should also obligate utilities and fossil fuel electricity generation companies to purchase a certain percentage of their electricity from renewable sources. This will help address potential resistance from these companies and ensure they are actively contributing to the country's renewable energy targets. For instance, utilities could be required to purchase 20% of their electricity from renewable sources by 2030, while fossil fuel companies could be mandated to source 15% of their electricity from renewables by the same year.

These reforms would be greatly strengthened with drafting, designing, and eventually implementing a REC system. To support the implementation of RPOs, policymakers should establish a REC system managed by the National Load Dispatch Center. This system should issue and RECs for power generation, distribution companies, and end users, with each REC representing 1 megawatt-hour (MWh) of electricity generated from renewable sources. This will enhance transparency and accountability in the renewable energy sector and ensure that RPO targets are being met.

Policymakers should also develop a transparent and efficient trading platform for RECs, allowing market participants to buy and sell RECs to meet their RPO obligations. This platform should be accessible to all stakeholders, including power generation companies, distribution utilities, and end users. It should also provide real-time information on REC prices and volumes traded, promoting market transparency and liquidity. To ensure compliance with RPO targets, policymakers should also introduce penalties for noncompliance that are significant enough to discourage it and encourage market participants to meet their RPO obligations. For example, a penalty of 1.5 times the average REC price for each MWh of shortfall could be imposed on entities failing to meet their RPO targets.

Finally, policymakers should consider providing incentives for market participants who exceed their RPO targets, including tax benefits, preferential access to financing, or reduced transmission and wheeling charges. For instance, entities achieving 150% of their RPO targets could be eligible for a 5% reduction in transmission charges for the excess renewable energy purchased. Policymakers should also establish a robust monitoring and review framework to assess the implementation and effectiveness of the RPO policy. This should involve regular data collection and analysis on RPO compliance, REC trading, and the impact on renewable energy growth. The findings should be used to make necessary adjustments to the RPO targets, incentives, and penalties to ensure the policy remains effective and relevant.

3. Expand Net Metering and FITs

Net metering policies can significantly promote solar power in Bangladesh. The government could begin with two policies that would provide the foundation of growth. First, policymakers should amend the existing net metering guidelines by revising the current regulations to remove the 10 MW capacity limit on individual installations and allow net metering installations up to 70% of the sanctioned load. This will ensure that the grid can accommodate the increased penetration of distributed solar PV systems. This policy change would also require a detailed grid impact assessment to identify any necessary grid upgrades or reinforcements, which will be crucial to ensure stable and reliable grid operation with higher levels of net metering.

In addition, policymakers should introduce a comprehensive FIT policy that provides guaranteed, long-term payments to renewable energy generators based on the generation cost. The FIT rates should be differentiated based on project size, type of renewable source (e.g., solar PV, wind, biomass), and location to encourage a diverse technology mix and regional development. For example, offering higher FIT rates for small-scale rooftop solar PV systems (e.g., <10 kW) will incentivize household adoption while providing lower rates for larger-scale commercial and industrial installations. Malaysia has successfully implemented an FIT program to promote solar energy deployment by providing guaranteed payments to solar project developers for the electricity they generate, based on a fixed rate set above the market price.[40] The program has been successful in attracting private investment in solar projects and has helped Malaysia achieve its renewable energy targets. Bangladesh can consider implementing a similar FIT program, along with other financial incentives, to provide long-term revenue certainty for solar project developers and attract private investment.

Such FIT systems must be critically supported well through the establishment of a transparent and efficient FIT administration system. This involves setting up a dedicated FIT administration body within the MoPEMR to oversee the implementation and management of the FIT policy. Developing clear guidelines and procedures for FIT application, approval, and payment processes will ensure transparency and efficiency. Additionally, implementing an online platform for FIT administration will allow renewable energy generators to easily apply for and track the status of their FIT payments.

Securing long-term funding for FIT payments is also important to policy reform success. Policymakers should identify sustainable funding sources for FIT payments, such as a small surcharge on electricity bills, a carbon tax, or a dedicated renewable energy fund. Collaborating with international development banks and climate finance institutions to access low-cost financing and grants for FIT programs will be beneficial. Ensuring that the FIT funding mechanism is transparent, predictable, and stable over the long term will also help build investor confidence and attract private sector investment.

Finally, a nationwide public awareness campaign could be developed to educate households, businesses, and communities about the benefits of net metering and FIT policies, and how they can participate in the program. Developing user-friendly guides and online resources that provide step-by-step instructions on how to install rooftop solar PV systems, apply for net metering, and access FIT payments will be helpful. Moreover, providing capacity building and training programs for local technicians, installers, and entrepreneurs will enable them to develop the necessary skills and expertise to support the growth of the solar PV market.

4. Integrate Demand-Side Management and TOU Pricing

To mitigate the risks and challenges associated with implementing a TOU pricing scheme in Bangladesh, the country can draw from the experience of these neighboring nations and consider several specific policy initiatives. First, a comprehensive feasibility study to assess the technical, economic, and social implications of the initiative provides baselines for comparison. The study can analyze the current electricity consumption patterns, load profiles, and consumer behavior to identify potential peak demand reduction opportunities and challenges, as well as evaluate the existing metering and billing infrastructure to identify gaps and necessary upgrades to support TOU pricing. This feasibility study will help Bangladesh make informed decisions on the design and implementation of the TOU scheme, minimizing the risk of costly mistakes or unintended consequences.

To minimize the upfront investment risks and test the effectiveness of TOU pricing, reform can begin with pilot projects in selected areas or customer segments, targeting areas with high electricity consumption, such as industrial zones or commercial districts, where the potential benefits of TOU pricing are most significant. These pilots can help gather valuable data and insights on consumer response, load shifting, and peak demand reduction, informing the design and refinement of the TOU scheme. Based on the results of the pilot projects, Bangladesh can gradually scale up the scheme to other areas and customer segments, allowing for a phased and manageable implementation process.

In addition, to enable the successful implementation of TOU pricing, Bangladesh would also need to invest in AMI that can record and communicate real-time electricity consumption data. The country can learn from the Metropolitan Electricity Authority's experience in Thailand and prioritize the deployment of smart meters and communication networks in areas targeted for TOU pricing. Partnering with international financial institutions, such as the World Bank or the ADB, can help secure funding and technical assistance for AMI investments, while exploring PPPs can help share the costs and risks of AMI deployment, leveraging the expertise and resources of private sector players.

Fourth, changing consumer behavior and ensuring widespread adoption of TOU pricing requires effective customer education and awareness campaigns. Bangladesh could launch a comprehensive outreach program to inform and educate consumers about the benefits, functioning, and potential savings of TOU pricing, using various communication channels, such as media advertisements, social media, billboards, and community workshops, to reach diverse consumer segments. Collaborating with local NGOs, community leaders, and consumer advocacy groups can help build trust and credibility, addressing potential concerns or resistance to TOU pricing. The campaign should also provide practical guidance and tips on how consumers can shift their electricity usage to off-peak hours and take advantage of lower tariffs.

To encourage consumer adoption and mitigate the impact of TOU pricing on vulnerable households, Bangladesh can also introduce targeted incentives and assistance programs. For example, offering rebates or subsidies for the purchase of energy-efficient appliances, such as LED lights or smart thermostats, can help consumers reduce their electricity bills under TOU pricing. In Vietnam, the Ministry of Industry and Trade launched a successful energy efficiency campaign, the "Vietnam Energy Efficiency Program," which included public awareness activities and incentives for energy-efficient appliances.[41] These measures help address the information gap and encourage consumers to adopt energy-saving practices and technologies. However, they require significant resources for the design and implementation of effective campaigns, and incentive programs and may have limited impact if not combined with other measures, such as pricing reforms and technological upgrades. Providing low-interest loans or on-bill financing options for the installation of rooftop solar or battery storage systems can enable consumers to generate their own electricity during peak hours and reduce their reliance on the grid. Implementing a lifeline tariff or a progressive TOU pricing structure can ensure that low-income households have access to affordable electricity for their basic needs.

Finally, establishing an accountability framework for utilities is essential to ensure compliance with renewable energy targets and demand-side management initiatives. A time-bound accountability structure should be developed along with performance-based incentives and penalties to encourage utilities to meet their targets. In the Philippines, the Energy Regulatory Commission has implemented a performance-based regulation framework for distribution utilities, which includes incentives and penalties based on their performance in meeting renewable energy targets and demand-side management initiatives.[42] This framework ensures that utilities are committed to the successful implementation of renewable energy policies and provides a mechanism for monitoring progress and addressing any challenges or delays. However, it may face resistance from utilities that are not prepared to adapt to the new requirements and requires strong regulatory oversight and enforcement mechanisms to be effective.

Bangladesh can mitigate the risks and challenges associated with introducing a TOU pricing scheme, drawing from the successful experience of others. A comprehensive approach that includes feasibility studies, pilot projects, targeted investments, customer education, incentives and assistance programs, and continuous monitoring and evaluation can help Bangladesh navigate the complexities of TOU pricing and realize its potential benefits in terms of peak demand reduction, energy efficiency, and consumer empowerment. With careful design and implementation, the country can create a more sustainable, resilient, and inclusive electricity sector that supports its long-term development goals.

5. Streamline Land Acquisition Processes

To address the significant barrier of land acquisition for large-scale solar project development in Bangladesh, the government can learn from the experiences of other Asian countries and adapt their best practices. One concrete step Bangladesh should take is to establish a centralized land bank for solar project development, similar to India's Solar Park Program. India has established a dedicated agency, Solar Energy Corporation of India (SECI), which is responsible for identifying and acquiring land for solar parks across the country.[43] SECI works closely with state governments to identify suitable land parcels, considering factors such as solar irradiation, grid connectivity, and land use patterns. By centralizing the land acquisition process, SECI has been able to streamline the development of solar parks and reduce the burden on individual project developers. Bangladesh could follow a similar model, creating a centralized agency or taskforce within the MoPEMR to identify and acquire land for solar projects. This agency could work with local government bodies and landowners to identify suitable land parcels, negotiate land lease or purchase agreements, and facilitate the necessary approvals and permits.

Another important step Bangladesh should take is to conduct a comprehensive land assessment using satellite imagery and GIS technology, following the example of China, which has been at the forefront of using advanced remote sensing and GIS tools to identify suitable land for solar project development. The Chinese government has collaborated with research institutions and technology companies to develop sophisticated algorithms and models that analyze satellite imagery and GIS data to identify areas with high solar potential, suitable land use patterns, and proximity to transmission infrastructure. This has enabled the country to rapidly scale up its solar energy capacity, with over 253 GW of installed capacity as of 2020, accounting for nearly one-third of the global total.[44] Bangladesh could partner with international organizations, such as the World Bank or the ADB, to access advanced satellite imagery and GIS technology. The government could also collaborate with local research institutions and technology companies to develop customized tools and models for land assessment, accounting for the specific geographical and socioeconomic context of Bangladesh.

Developing comprehensive land acquisition guidelines could also draw productively from the experience of Vietnam, which has established a fairly robust legal framework for land acquisition, including clear provisions for fair compensation, resettlement assistance, and public consultation.[45] The Vietnamese government has developed detailed guidelines for calculating compensation rates based on factors such as land type, location, and market value. The guidelines also require project developers to provide adequate resettlement assistance to affected households, including housing, employment opportunities, and access to public services. Moreover, the legal framework mandates public consultation and participation throughout the land acquisition process, ensuring that local communities have a say in the decision-making process. Bangladesh could develop similar guidelines, tailored to its specific context, to ensure that land acquisition for solar projects is conducted in a fair, transparent, and inclusive manner. These guidelines could be developed through a consultative process involving relevant government agencies, project developers, civil society organizations, and local communities.

Establishing a single-window clearance system for land acquisition is another important step Bangladesh could take, learning from the experience of the Philippines. The Philippines has implemented an innovative online platform called the Energy Virtual One-Stop Shop (EVOSS), which enables renewable energy project developers to apply for and obtain all necessary permits and approvals through a single portal.[46] The EVOSS platform integrates the processes of multiple government agencies involved in the permitting and approval of renewable energy projects, including land acquisition. Project developers can submit their applications, track the status of their applications, and receive approvals online, significantly reducing the time and cost of the permitting process. Bangladesh could develop a similar online platform, integrating the processes of the centralized land bank, land assessment tools, and land acquisition guidelines. This would provide a streamlined and transparent process for project developers to acquire land for solar projects, reducing administrative barriers and accelerating project implementation.

Bangladesh should establish a robust monitoring and evaluation framework for the land acquisition process, learning from the experience of South Korea. South Korea has implemented a comprehensive monitoring and evaluation system for its renewable energy projects, including solar projects.[47] This system tracks a range of indicators related to land acquisition, such as the number of land parcels acquired, total land area acquired, compensation rates provided, and number of affected households resettled. It also includes indicators related to project implementation, such as installed capacity, energy generation, and greenhouse gas emissions reduction. Moreover, the system includes indicators related to the social and environmental impacts of the projects, such as job creation, local economic development, and biodiversity conservation. The data collected from this system is used to identify areas for improvement and inform policy and planning decisions.

Bangladesh could develop a similar monitoring and evaluation framework, tailored to its specific context and priorities. This framework could be integrated into the centralized land bank and online permitting platform, enabling real-time monitoring and evaluation of the land acquisition process. The data collected could be used to identify bottlenecks and challenges, assess the effectiveness of land acquisition guidelines and procedures, and inform policy and planning decisions to improve the efficiency and sustainability of solar project development in Bangladesh.

In conclusion, Bangladesh can learn from the experiences of other Asian countries to address the critical issue of land acquisition for large-scale solar project development.

By establishing a centralized land bank, conducting comprehensive land assessments, developing clear guidelines, engaging with local communities, and monitoring and evaluating the land acquisition process, the country can streamline the process and reduce barriers to solar project development. However, implementing these steps will require strong political will, institutional capacity, and financial resources. By taking a proactive and strategic approach to land acquisition, Bangladesh can unlock the vast potential of solar energy and accelerate its transition to a low-carbon, sustainable energy future.

6. Enhance Financing Mechanisms

To mitigate the high upfront costs and limited access to financing that hinder solar energy deployment, the government of Bangladesh should further strengthen several concrete policies and financial incentives. These policies can include innovative financing mechanisms, such as green bonds and concessional loans, and direct financial incentives, such as subsidies, tax exemptions, and grants. Moreover, the government can establish government-backed guarantees and standardized PPAs to enhance the bankability of solar projects and attract private investment.

The first key policy measure is the development of innovative financing mechanisms, such as green bonds and concessional loans. Green bonds are financial instruments that raise funds specifically for environmentally friendly projects, including renewable energy projects like solar power. PRAN Agro Limited (PAL), a major Bangladeshi conglomerate, issued the country's first sustainability-linked green bond in 2021, marking a significant milestone in the country's corporate finance and sustainability efforts. The BDT1.5 billion (over USD13.60 million) bond, structured by Standard Chartered Bangladesh, financed PAL's green initiatives, including agro-recycling, organic farming support, and environmental improvements in manufacturing operations. The bond incentivized both the issuer and investors, addressing the attractiveness of green bonds in a market dominated by government bonds and zero-coupon corporate bonds. It also linked funding costs to PAL's impact on various United Nations SDGs, including poverty alleviation, zero hunger, and climate action. The deal's success, despite challenging market conditions, demonstrated the potential for sustainability-linked products to unlock capital in Bangladesh's developing bond market. This groundbreaking issuance marks a departure from the norm of zero-coupon bonds, presenting the first coupon-bearing bond for a local corporate linked to sustainability initiatives.

By issuing and supporting a wider range and larger volume of green bonds, the government can attract domestic and international investors who are looking to support sustainable development initiatives. Moreover, it can work with multilateral development banks, such as the World Bank and the ADB, to secure concessional loans with lower interest rates and longer repayment periods for solar projects.[48] These concessional loans can help reduce the overall cost of financing and make solar projects more financially viable.

Another important policy measure is the provision of financial incentives, including subsidies, tax exemptions, and grants, to reduce the capital costs of solar projects. The government can introduce direct subsidies for the purchase and installation of solar panels, inverters, and other essential components, making them more affordable for households, businesses, and project developers.[49] Additionally, it can offer tax exemptions, such as import duty waivers and value-added tax reductions, on solar equipment and materials, further reducing the upfront costs of solar projects. Moreover, the government can provide grants and other forms of direct financial support to solar project developers, especially for large-scale projects, to help cover the initial capital costs. These financial incentives can be targeted toward specific segments, such as rooftop solar for households and commercial buildings, and ground-mounted solar parks for utility-scale projects.

To implement these policies effectively, the government of Bangladesh can learn from the experiences of other countries in the region. For example, India has been successful in promoting solar energy deployment through a combination of financial incentives and innovative financing mechanisms. The Indian government has introduced a range of subsidies and tax exemptions for solar projects, including capital subsidies, interest rate subsidies, and accelerated depreciation benefits.[50] Moreover, the country has developed a robust green bond market, with the Indian Renewable Energy Development Agency (IREDA) and other government-backed institutions issuing green bonds to finance solar and other renewable energy projects. Bangladesh can draw lessons from India's experience and adapt these policies to its own context, accounting for its specific energy needs, market conditions, and institutional capacities.

7. Encourage PPPs

PPPs can play a pivotal role in mobilizing investments and expertise for solar energy projects. The private sector itself plays a key role in securing foreign direct investment (FDI) and driving economic growth by "actively investing in energy and transport infrastructure development, promoting exports from dedicated zones and enhancing agricultural productivity through research and development."[51] The government has been creating facilitation devices such as "the Bangladesh Export Processing Zones Authority (BEPZA) for enhancing export, the Bangladesh Investment Development Authority (BIDA) for facilitating private sector investment, the Bangladesh Economic Zones Authority (BEZA) for accelerating FDI, SME Foundation to support small business and the Public-Private Partnership (PPP) Authority for promoting private participation in the infrastructure and public service delivery."[52] Furthermore, Bangladesh has one of the leading public-private cooperation markets in South Asia, having supported more than $5.9 billion in the energy sector between 1997 and 2019.[53]

The key prospects of implementing PPPs are raising capital, increasing energy efficiency, and, in Bangladesh's case, reducing pollution.[54] Kirikkaleli, Ali, and Altuntaş (2022) investigate the causal link between PPPs and carbon dioxide emissions, finding that Bangladeshi public-private investments in energy (PPIE) over the short and long term show promise in improving air quality and alternative energy projects. They also find the current level of PPIEs is insufficient due to "low financing in renewable/technological inventions schemes via the public–private partnership in Bangladesh, which causes declines in the sustainability of the atmosphere."[55] From these findings, we recommend private-facing initiatives that foster collaboration with the government ecological financing, while also buttressing the overarching mission of reducing carbon-intensive practices.

Characterized by an increasing shortage of energy and a sharpened effort to incorporate renewable energy into the fuel mix, India provides another example in the region as a proponent of PPIE investment. The dual members of PPIE initiatives, the public/government and private companies, are present in India but have not been considered in parallel for understanding CO_2 emissions reductions, according to Kirikkaleli and Adebayo (2021). Alongside increasing technology development and innovation for end users, India's "PPIE strategy has been strongly promoted by the Government of India in projects such as energy, transport, expenditure, and construction."[56] Previous studies by Khan et al. (2020) in the Chinese context have also "revealed evidence of cointegration amongst the variables. Furthermore, they found that technological innovation causes a detrimental effect on [consumption-based] CO_2, whilst PPIE has a positive impact on CO_2." In their study of the interactions between PPIE and CO_2 emissions in India under a sustainable energy regime, Kirikkaleli et al. (2021) also found that "in general, decentralization of energy generation via the use of PPIE could also affect environmental quality by reducing carbon volume."

8. Ensure a Just Energy Transition

As Bangladesh transitions toward renewable energy, it is critical to ensure a just and equitable transition for workers and communities dependent on fossil fuels. Bhattacharya, Kharas, and McArthur (2023) define a just and green transition in Bangladesh as "tackling both brown and green issues with an approach of equity, addressing both pollution and natural resource degradation in a manner that is socially equitable." A just transition in Bangladesh involves mainly developing reskilling and retraining measures for affected workers, alleviating transition impacts on communities through social protection measures, and promoting new employment opportunities in the expanding green energy sector. Dhaka has developed a plethora of environmental action plans, such as the Mujib Climate Prosperity Plan (2022–41), as well as having acquired the most number of Leadership in Energy and Environmental Design (LEED)–certified clean and green garment factories in the world.[57] A just transition plays a key role in Bangladesh's neighborhood partners, such as India, whose unprecedented economic growth and government measures for environmental transition provide a valuable framework for modeling Dhaka's own growth. Importantly, economic growth has to be balanced in the prism of the necessary social measures to ensure workers safety and training, which India's Jharkhand Just Transition Task Force aims to embody.[58]

With lofty goals of net zero emissions by 2070, India has recognized that burgeoning noncarbon-intensive practices must be complemented with socially responsible programs to best buttress renewable energy efforts. Grounded in a traditionally coal and fossil fuel resource culture, the nation's eastern members, such as Jharkhand, Odisha, and Chhattisgarh, will be the most affected by the nation's green ambitions.[59] The need for a just transition programming in Jharkhand is underscored by "renewable capacity is developing elsewhere in the country, which highlights the need for equity between internal regions as well as internationally."[60] The Jharkhand Just Transition Task Force identifies and seeks to resolve seven themes: livelihood, energy transition, coal transition, electric mobility, industry decarbonization, climate finance and capacity building.[61] It is also supported by corporate interests in worker reskilling and strategic investment in areas such as "health, sanitation, environment and sustainability, education, and livelihood," according to a 2023 report from CSRBOX.[62]

The Jharkhand Just Transition Task Force has produced "three large consultative meetings including national consultative meetings in New Delhi," with "several sub-national, national, and international consultations which include meetings with policymakers, think-tanks, the World Bank, the United Nations Development Programme (UNDP), and the Indian Institute of Technology (IIT), Kanpur."[63] It also held capacity-building events and training in Ahmedabad and Guwahati in 2023,[64] and has already begun advocating serviceable just transition policies in Ranchi, Jharkhand. In a 2024 stakeholder consultative session, various options for electric vehicle (EV)/sustainable mobility and the associated social dimensions of this policy were discussed, such as education of the masses for cycling, gender inclusion in the transportation sector, and proliferation of EV charging infrastructure in the city. "The Ranchi Smart City project has already launched a public bicycle-sharing system, with 60 dock stations and 600 smart bicycles operational currently," with the added benefits of increased jobs, trained labor forces in material refinery, and a greater impetus for recycling compliance by transitioning to a renewable system.[65] As visible in the Jharkhandian case, a just transition's complementary role in renewable energy adaptation and development create social opportunity for workers and affected individuals, incorporating a human element into the process.

Conclusion: Institutionalizing Execution and Accountability

Any success of the reforms discussed in this policy paper will largely depend on institutional coordination and streamlined processes in facilitating renewable energy deployment. Enhancing the role of SREDA as a central organization to promote and support sustainable energy is arguably the most important first step in this regard.[66] A centralization of project-focused processes through an online single-window platform under

SREDA for project developers to submit documentation and obtain necessary approvals can enhance efficiency and transparency.

Elevating Renewable Energy Regulatory Entities

Given that the centrality of effective institutional coordination is crucial for the successful implementation of solar energy projects, the government should seek to

- enhance the role of SREDA as a central body to promote and support sustainable energy;
- establish a renewable energy division within the MoPEMR to provide dedicated focus and resources for renewable energy projects; and
- develop an online single-window platform under SREDA for project developers to submit documentation and obtain necessary approvals.

In particular, the establishment of a renewable energy division within the MoPEMR is a type of strategic institutional change that can provide dedicated focus and resources to support Bangladesh's renewable energy targets, including the COP26 commitments for 2041. There are several successful models of this approach in Asia, three of which are summarized below.

- India's Ministry of New and Renewable Energy (MNRE):
  The MNRE has played a pivotal role in driving India's renewable energy agenda through its comprehensive institutional framework and dedicated divisions. The ministry has established specialized divisions for different renewable energy sources, such as SECI for solar power, the National Institute of Wind Energy for wind power, and the Biogas Development and Training Centres for biogas promotion.[67]

  These dedicated divisions have facilitated focused efforts, resource allocation, and targeted policy interventions tailored to the unique requirements and challenges of each renewable energy source. For instance, SECI has been instrumental in conducting large-scale solar auctions, which have driven down solar tariffs and accelerated the deployment of solar power plants across the country.
- Malaysia's Sustainable Energy Development Authority (SEDA):
  SEDA, established in 2011 as a one-stop center to facilitate the development of renewable energy in Malaysia, serves as a central hub for renewable energy investors, providing information, advice, and streamlined processes for project development. It has implemented various initiatives to attract private sector investments, such as the FIT scheme, which guarantees a fixed tariff for renewable energy producers over a specified period. Additionally, SEDA offers a range of services, including technical advice, project evaluation, and assistance with regulatory approvals, making it easier for investors to navigate the complex landscape of renewable energy project development.

- China's National Energy Administration (NEA):
  The NEA is a powerful government agency that oversees and regulates China's energy sector, including the development and implementation of renewable energy policies and programs. Within the NEA, the Renewable Energy Department plays a crucial role in driving the country's transition toward a more sustainable energy mix (NEA, 2023).
  The Renewable Energy Department has been responsible for setting and revising China's ambitious renewable energy targets, as well as designing and implementing supportive policies such as FITs, renewable portfolio standards, and tax incentives. It also coordinates with local governments and energy companies to facilitate the deployment of renewable energy projects across the country.

By studying and adapting best practices from these institutional arrangements in India, Malaysia, and China, Bangladesh can strengthen its own institutional framework and enhance the coordination and implementation of its renewable energy policies and programs.

Creating Learning Organizations: Expert Advisory Council

A core challenge of policy evolution in the solar industry is the pace of technological change, particularly related to smart grid integration of intermittent renewables, storage, and, ultimately, system stability. Given the pace of change in these subsectors, a sustained knowledge and learning mechanism such as an expert advisory council should be established. This group, comprising global and local experts from industry, academia, and the public sector, would provide ongoing input and enable a more effective monitoring of developments that could better achieve grid integration, innovation, and multisectoral dialogue. This would align well with the recommendations of the United Nations Economic Commission for Europe, which highlights the importance of inclusive and participatory approaches in developing sustainable energy policies and strategies.

Composition

The expert advisory council should ideally be characterized by a diverse and multidisciplinary composition, drawing experts from various relevant fields to ensure a comprehensive and well-rounded approach. The council composition could align with the following outline:

- National renewable energy experts: Renowned academics, researchers, and industry professionals from Bangladesh's leading universities, research institutions, and industry bodies with expertise in renewable energy technologies, policies, and implementation
- International renewable energy experts: Reputed global experts and practitioners from international organizations (e.g., IRENA, International Energy Agency, UNDP), multilateral development banks, and renowned foreign

universities/institutes with extensive experience in renewable energy deployment and policymaking

- Government representatives: Senior officials from relevant ministries and agencies, such as the MoPEMR, SREDA, the Power Development Board, and the Prime Minister's Office
- Industry and private sector representatives: Executives and experts from leading renewable energy companies, project developers, financiers, and industry associations operating in Bangladesh, the region, the US, and the EU
- Civil society representatives: Representatives from nongovernmental organizations, community-based organizations, and advocacy groups working on energy, environment, and sustainable development issues

Function

The primary function of the expert advisory council would be to provide strategic guidance, technical expertise, and policy recommendations to the government and relevant stakeholders on all aspects of renewable energy development in Bangladesh. Such a council's mandate could include six areas of responsibility:

- Conducting comprehensive resource potential analyses and identifying suitable zones for renewable energy projects, factoring in land availability, road access, grid expansion, and other relevant criteria
- Evaluating and providing recommendations on the country's renewable energy targets, policies, regulations, and implementation strategies to ensure alignment with national development goals and international commitments
- Advising on the development of a comprehensive and inclusive renewable energy action plan, addressing existing barriers, and ensuring stakeholder participation
- Assessing and proposing innovative financing mechanisms, business models, and incentive structures to attract private sector investment and promote the adoption of renewable energy technologies
- Facilitating knowledge exchange, capacity building, and skill development programs in collaboration with local academic institutions, research organizations, and international partners
- Monitoring and evaluating the progress of renewable energy deployment, and providing periodic reports and recommendations for course correction or policy adjustments as needed

Governance

Governance is also critical to the potential value of the expert advisory council, which could be established under SREDA's purview. The council should have a well-defined governance structure, with a chairperson and cochairperson elected from among the council members. It could also be divided into subcommittees or working groups focused on specific areas such as policy and regulations, technology and innovation, finance and business models, and capacity building and stakeholder engagement. These subcommittees would be responsible for conducting in-depth analyses and consultations and developing recommendations within their respective domains.

Deliverables and Reporting

Finally, deliverables and reporting would include the production of regular reports and policy briefs on various aspects of renewable energy development in Bangladesh. These reports could include four types of deliverables:

- Annual renewable energy status report: A comprehensive report assessing the progress made in renewable energy deployment, identifying challenges and bottlenecks, and providing recommendations for addressing them
- Renewable energy policy briefs: Periodic policy briefs on specific issues or emerging trends, such as innovative financing mechanisms, grid integration challenges, or new technological developments
- Renewable energy resource assessments: Detailed reports on renewable energy resource potential assessments, including identification of suitable zones for project development
- Strategic roadmaps and action plans: Long-term strategic roadmaps and action plans for achieving Bangladesh's renewable energy targets, aligned with national development priorities and international commitments

The expert advisory council should present its reports and recommendations to the government, relevant ministries, and stakeholders and facilitate public consultations and discussions to ensure transparency and inclusive decision-making processes. By establishing a well-structured and empowered council, Bangladesh can leverage the collective expertise of national and international experts and develop evidence-based strategies and policies to accelerate its transition toward a sustainable and renewable energy future. Effective implementation of any resulting council recommendations will require collaboration among various stakeholders, including policymakers, regulatory bodies, industry players, academic institutions, and civil society organizations.

In conclusion, the successful implementation of Bangladesh's renewable energy initiatives hinges on robust institutional coordination and streamlined processes. Enhancing SREDA's role as a central organization for promoting sustainable energy is a critical first step, while establishing a dedicated renewable energy division within the MoPEMR represents a strategic institutional change that could provide focused attention and resources to support the country's ambitious renewable energy targets. Additionally, the formation of an expert advisory council is recommended to address the rapid pace of technological change in the renewable energy sector, particularly in areas such as smart grid integration and energy storage. This council, comprising a diverse group of national and international experts from academia, industry, government, and civil society, would provide ongoing strategic guidance and enable more effective monitoring of developments in the field. As Bangladesh navigates the evolving energy landscape and technological advancements, ongoing monitoring, evaluation, and adaptation will be crucial to ensure the relevance and effectiveness of its renewable energy strategies.

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