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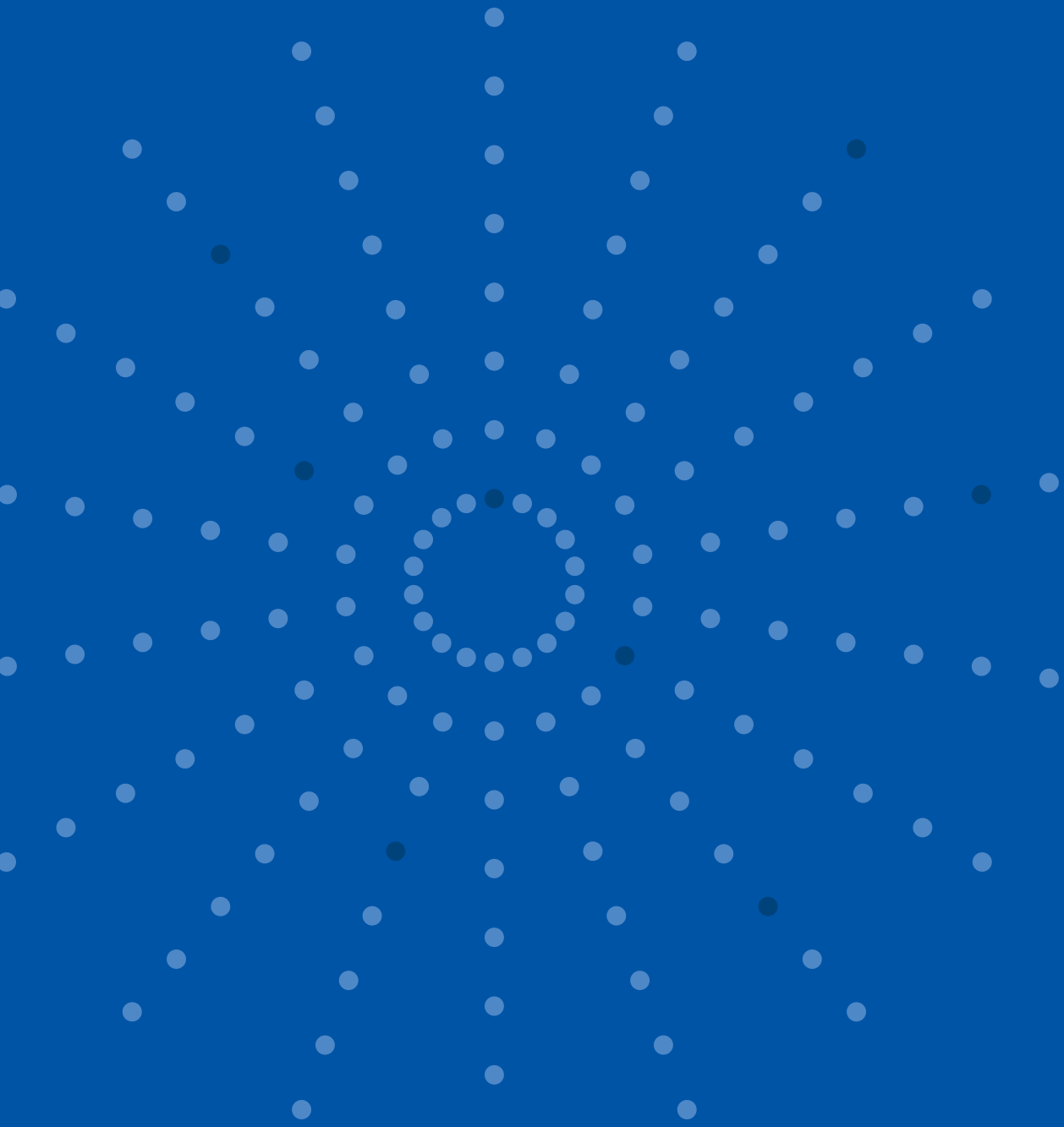
CHALLENGES IN THE DEVELOPMENT OF VARIABLE RENEWABLE ENERGY IN BANGLADESH

SCALING UP RENEWABLE ENERGY (SURE)

JUNE 2020



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Contents

Figures & Tables

List of Acronyms

ADB	Asian Development Bank
BB	Bangladesh Bank
BERC	Bangladesh Energy Regulatory Commission
BEPZA	Bangladesh Export Processing Zones Authority
BOI	Board of Investment
BP	British Petroleum
BPDB	Bangladesh Power Development Board
BREB	Bangladesh Rural Electrification Board
BWDB	Bangladesh Water Development Board
CCIE	Chief Controller of Import and Export
CIFE	Chief Inspector of Factories and Establishments
CO_2	Carbon Dioxide
COP21	21st United Nations Climate Change Conference
CTU	Central Transmission Unit of India
DOE	Department of Environment
EPZ	Export Processing Zone
FERA	Foreign Exchange Regulation Act 1947
GHG	Greenhouse Gas
GOB	Government of Bangladesh
GOI	Government of India
IA	Implementation Agreement
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
LCOE	Levelized Cost of Energy
LNG	Liquified Natural Gas
LoI	Letter of Intent
MNRE	Ministry of New and Renewable Energy
MOC	Ministry of Commerce
MEFCC	Ministry of Environment Forest and Climate Change
MOF (ERD)	Ministry of Finance (Economic Relations Division)
MOF (IRD)	Ministry of Finance (Internal Resources Division)
MOHA	Ministry of Home Affairs
MOL	Ministry of Law
MOU	Memorandum of Understanding
MPEMR	Ministry of Power, Energy and Mineral Resources
NBR	National Board of Revenue
NDCs	Nationally Determined Contributions
NREL	National Renewable Energy Laboratory
OEACEI	Office of the Electrical Adviser and Chief Electric Inspector
PGCB	Power Grid Company of Bangladesh
PPA	Power Purchase Agreement
PSMP	Power System Master Plan
Solar PV	Solar Photovoltaic
RE	Renewable Energy
REN21	Renewable Energy Policy Network for the 21st Century
SECI	Solar Energy Corporation of India
SPP	Small Power Plant
SPPD	Solar Power Park Developer
SREDA	Sustainable and Renewable Energy Development Authority
STU	State Transmission Unit of India
SURE	Scaling Up Renewable Energy
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UP	Local Union Parishad

USA	United States of America
USAID	United States Agency for International Development
VAT	Value-Added Tax
VRE	Variable Renewable Energy
WB	World Bank

List of Unit Measurements

BDT	Bangladesh Taka
GW	Gigawatt
km²	Square Kilometer
kW	Kilowatt
kWh	Kilowatt-hour
m/s	Meter per Second
MW	Megawatt
MWh	Megawatt-hour
TCF	Trillion Cubic Feet
TWh	Terawatt-hour
USD	United States Dollar

Executive Summary

This white paper identifies the most critical challenges hindering the development of grid-connected variable renewable energy in Bangladesh and outlines specific solutions that sector stakeholders can act on in order to spur growth in grid-connected renewables. If implemented, the white paper recommendations will allow the Government of Bangladesh to make meaningful gains in new generation capacity through renewable energy. Realistic and targeted changes to the current support measures offered to the sector will allow the government to reach its renewable energy goals. Targets for renewable energy generation capacity are set out in the 2016 Power Sector Master Plan (PSMP): 2,470 MW by 2021 and 3,864 MW by 2041.[1] With only 311.9 MW of renewables connected to the grid to date, the target set for 2021 will not be achieved, and the target for 2041 will likely be achieved easily in the next 20-year period and does little to encourage any current interventions.

Internationally, new capacity from renewables in 2018 exceeded new installed capacity from conventional and nuclear power combined, and 26.1 percent of the total global electricity production (26,614 TWh) came from renewable energy sources that year.[2] If large hydropower is excluded, other renewables still make up almost 10 percent of global electricity production. The marked increase in worldwide renewable energy capacity has been largely due to falling equipment prices and policy initiatives and targets set by governments. Since 2008, prices for solar photovoltaic (PV) modules have fallen by a factor of about five.[3]

Bangladesh still relies on fossil fuels for most of its electricity supply. Natural gas is currently the main fuel used for electricity generation. Future demand will need to be met by imported gas. With only 11.47 TCF of natural gas reserves remaining, and with annual production of 0.97 TCF in 2018,[4] indigenous gas reserves will only last up to 2026 considering the remaining reserves and yearly production and growth rate. A British Petroleum (BP) report confirmed that natural gas reserves will likely last Bangladesh six more years.[5] The government is currently importing Liquified Natural Gas (LNG) to make up the difference.

According to Bangladesh's PSMP, coal-fired power plants are expected to play an increasing role in the energy mix of installed generation capacity in the next two decades, although much of the coal reserves in Bangladesh are expensive to mine and future coal requirements will have to be met through importation. Bangladesh's current liquid fuels demand for electricity production is about 850 million liters per annum.[6] If demand from transport and industry are also taken into account, the country's local production can only meet 5 percent of the total energy demand. Therefore, Bangladesh's current trajectory with respect to future generation capacity will mean even greater energy security risks for the country.

Bangladesh has significant solar energy potential throughout the country due to its geographical location. A study has shown that the total grid-connected solar PV potential in Bangladesh could be as high as 50 GW.[7] [8] A recent wind assessment study completed by the National Renewable Energy Laboratory (NREL) demonstrated that an area of more than 20,000 km^2 exhibits wind speeds of between 5.75 – 7.75 m/s, with a gross wind potential of over 30 GW.[9] New hydropower opportunities are limited in Bangladesh, with the exception of a few potential micro-hydro sites in the Chittagong Hills area.

1 Government of Bangladesh, *PSMP 2016*.
2 British Petroleum (BP), *Statistical Review of World Energy 2019*.
3 SunShot, "Photovoltaic System Pricing Trends."
4 PETROBANGLA, *Annual Report 2018*.
5 BP, *Statistical Review of World Energy 2019*.
6 BPDB, *Annual Report 2018-19*.
7 Considering the grid availability, only 1.7 percent of land in Bangladesh is assumed to be technically suitable for generating electricity from solar PV.
8 Mondal & Denich, "Assessment of renewable energy resources potential."
9 NREL, "Assessing the Wind Energy Potential in Bangladesh."

To date, large-scale renewable energy development in Bangladesh has been slow due to a number of constraints within the power sector. Renewable energy development challenges have been identified through extensive consultation with key informants from the public, private and academic arenas as well as through a literature review and group discussions from various energy workshops. The key challenges found through this extensive analysis are listed below.

This white paper presents specific solutions and recommendations that can be actioned. These are based on the challenges identified and are listed below:

Policy and Government Support

- Evaluation of renewable energy targets in the PSMP, because the targets set for 2020 and 2021 will not be achieved, and the target set for 2041 does not encourage any current action.
- Creation of an integrated master plan that not only takes into consideration least-cost planning, but also makes adjustments for emissions reduction and energy security.
- An update to the renewable energy policy that addresses targets to 2041 to tie in with the PSMP; the current energy policy only provides an energy target to 2020.
- Bangladesh should consider setting up an IPP procurement agency that is responsible for all procurement activities and communication.
- Review of the roles, responsibilities and activities of government institutions to ensure they are effective in supporting the aims of the government's renewable energy plan with respect to utility-scale renewable energy generation capacity.
- Take steps to ensure policies are practical and implementable and that there is an institution responsible for monitoring policy actions and progress.
- Bangladesh already has excess capacity, and significant capacity payments are made to underutilized plants. BPDB currently requires extensive subsidization to maintain its activities. A review of the use of subsidies in the power sector and how they can be used or redirected to promote clean energy and make tariffs from renewable energy more competitive is required.
- Considering that Bangladesh does not have much experience with utility-scale renewable energy deployment, the government should engage with donors to ensure that knowledge of international best practices and lessons learned in other countries are brought to Bangladesh.

Land for Renewable Energy Development

- The government should consider doing a land study that identifies options for land use for utility scale-renewable energy. The study should include the benefits of using public land, identify land that might have lower agricultural value, and understand any advantages that can be had through designating zones for renewable energy projects.
- In the past, developers have struggled with identifying what land is designated as agricultural. The government needs to assign one agency or institution to deal with assisting developers where it is unclear what the land designation is.
- Having a good, well-thought-out procurement process will attract international developers who are skilled and experienced in negotiations for land leasing and follow international best practices.
- The procurement conditions must stipulate strong community engagement and consultation and could also include requirements for local economic development.
- Bangladesh has eight Export Processing Zones (EPZ) and about 600 industries operate in EPZ areas. One MW and larger rooftop solar PV plants can serve significant demand without requiring any new land or transmission infrastructure.
- Considering that many developers will use land requiring erosion protection, there is a need to create a streamlined process with all agencies involved.

Grid Network

- As a matter of urgency, the government needs to undertake a study to identify those areas of the grid where spare capacity is available for renewable energy plants to tie into.
- Studies conducted by donor partners need to include renewables integration and transmission planning for renewables in their scope.
- If the government pursues an approach where land will be zoned for use by renewable energy projects in the future, techno-economic feasibility studies should be included in the assessment phase.
- Institutions such as the BPDB and the PGCB need to understand what information developers need and can

TABLE 0-1: Key Challenges in Development of Renewable Energy Projects in Bangladesh

	KEY CHALLENGES
Policy and Government Commitment	• Limited effective policy in addressing the challenges of utility-scale renewable energy development • Government is committed, but currently does not have a strategy on how to achieve its commitments and targets • Renewable energy targets in government policy have either expired or look too far ahead (closest target after 2021 is 2041) • Policy guidelines and incentives for the private sector do not always apply to renewable energy projects as they do for conventional fossil fuel projects • The link between carbon reduction commitments and country targets for new renewable energy capacity is absent • Although there are targets in the PSMP, there is limited government planning and guidelines to procure utility-scale renewable energy • Limited coordination and information on procurement because of the absence of a "one-stop" service
Land	• Land availability for projects is limited in Bangladesh because most of the land is designated as agricultural land, which cannot be used for renewable energy projects • Difficult to identify suitable land; no actual definition of agricultural and non-agricultural land • Where land is available, there is often a lack of infrastructure (access roads, nearby grid connection) • Limited support from government to identify suitable land or zone land for projects • Deficit in current data on existing infrastructure such as roads and land surveying data • Land acquisition is a bigger problem than availability: land procurement process is lengthy and complex
Grid Network	• Renewable energy targets and plans are not synchronized with future electricity transmission infrastructure plans, as they are for conventional power plants • Different policies and support for new transmission infrastructure for conventional power plants and renewable energy plants • Limited assessment of potential sites for renewable energy based on transmission capacity • Difficult to access substation or load distribution information. No national grid capacity studies have been conducted • Limited coordination between Bangladesh Power Development Board (BPDB) and Power Grid Company of Bangladesh (PGCB) when negotiating for available grid capacity with developers • Stringent grid-code requirements for renewable energy plants • No standard guidelines for grid integration, or not publicly available • Limited feasibility studies done on grid stability and no integrated study on grid expansion
Solar and Wind Resource Data	• No detailed solar radiation resource assessment has been done to date • Limited renewable energy resource data for solar PV in specific regions, including measurements of seasonal variation • Lack of studies on renewable capacity potential considering land availability and other constraints • Absence of zoning for renewable energy projects where site-specific resource data can be measured

TABLE 0-1: Key Challenges in Development of Renewable Energy Projects in Bangladesh (cont)

	KEY CHALLENGES
Financial	• Local private banks are wary about investing due to a lack of experience in large-scale renewable energy projects • Commercial lenders mostly have experience with "take or pay" power purchase agreements (PPAs) that include capacity charges, which are suited to conventional plants • Government agencies for financing renewable energy currently exclude preferential lending for utility-scale projects • Current financial system concentrates on funding public sector projects, while utility-scale renewables procurement is done through private sector independent power producers (IPPs) • Utility-scale renewable energy projects do not meet current eligibility criteria for financing • Lack of an existing financial market prepared to provide finance, high quoted interest rates from lenders, short loan tenors that do not match the cash flow profiles of large-scale renewable energy plants • Onerous minimum time requirements on equity investors for exiting projects
Procurement and Bidding	• No standardized procurement program • Unrealistically short timeframes for bid submission • More than 40 permits/clearances required from different departments, with long time frames for approval • Gap in coordination between authorities responsible for developing bids and authorizing procurement decisions • Standardized transaction documents such as PPAs for renewable energy-based power projects need to be updated • Limited project implementation time given to developers (12 months)
Institutional Capacity	• Deficit in institutional capacity within public and private organizations and lack of coordination between government institutions • Currently, agencies concentrate more on off-grid renewable energy applications • Limited knowledge of renewable energy technologies and benefits of renewable energy in the energy sector • Lack of experts with experience in large-scale renewable energy projects • Limited experience when it comes to procuring new renewables capacity

better support developers who require connection to the grid.

- The government should investigate and promote renewable projects integrating energy storage facilities.
- Assessment of the effect intermittent power will have on the national grid, how much new intermittent capacity can be accommodated on the grid and equipment, and what infrastructure upgrades are required to deal with variable renewable energy (VRE).
- Bangladesh has included guidelines in its latest Electricity Grid Code 2018 whereby VRE plants need to be capable of supplying 20 percent reactive power in order to contribute to grid stability. An assessment needs to be done as to the practically of such a requirement.
- There needs to be a more formalized interconnection process and clear understanding of the obligations of PGCB with respect to the construction of transmission lines for renewable energy projects.

Renewable Energy Resource Potential

- Conduct resource potential studies that identify zones for renewable energy project development and that also consider other constraints such as land availability, road access, and grid expansion plans. The identified zones can be targeted for resource data collection at the local level.
- Government-led initiatives to increase coordination between international agencies and local universities and research organizations in conducting renewable energy resource studies to improve local capabilities and competency.

Renewable Energy Finance

- A formal sector-wide engagement with the lending community, including working with international lenders to understand their requirements for lending and how key risks that affect project bankability can be addressed.
- The government needs to understand what credit enhancement mechanisms it can extend to project sponsors of renewable energy, such as sovereign guarantees, which are already available for conventional IPPs in Bangladesh.
- Acceptable exit strategies for equity investors and ability to transfer equity.

Procurement

- Well-thought-out bidding process with transparent and fair evaluation of bids needs to be prioritized.
- Standardized and high-quality transaction documents such as PPAs and implementation agreements (IAs) will significantly help balance risks for developers.
- Realistic timelines for submission of bids considering the realities on the ground for developers to collect all relevant information, as well as realistic project development and construction timelines.
- A stepwise procurement methodology with clearly advertised bidding windows.
- Government support agreements need to be done after careful consultation with all government agencies with a clear understanding of the risks the government is able to bear.
- Reverse auctions based on allocated capacity per technology have proven to be the best model in many countries for attracting competitive tariffs.
- Support developers by listing all approvals needed and, with commitments from approval agencies and authorities, provide indications of timelines for the approval process.
- Clear guidelines on tax and VAT exemptions and relaxation of import duties.

Capacity Development

- The government (through SREDA) should institute a working plan to improve the knowledge and institutional capacity within public utilities, specifically for utility-scale renewable energy. The workplan should focus on developing capacity in:

  (i) energy security,
  (ii) global trends in energy generation, including energy storage,
  (iii) energy resource assessment,
  (iv) renewable energy project design and development,
  (v) renewable energy procurement, and
  (vi) energy modeling, grid stability and VRE integration.

- SREDA should launch a "One-Stop-Service" for the private sector to obtain useful renewable energy project information, requirements, and resource data that enables developers to produce better quality bids in a timely manner.
- SREDA should also take responsibility for minimizing coordination gaps between entities for renewable energy project development and work to reduce permitting time and accelerate the implementation of projects.
- Consideration should be given to extend the mandate of IDCOL to include financing for large-scale renewable energy.
- As regards grid operation with increasing levels of VRE, there needs to be a comprehensive training for grid operators to manage the power system with increased variances due to intermittency.
- Few academic institutions in Bangladesh have renewable energy research facilities. Renewable energy research facilities will help to strengthen this sector and improve local capabilities and technical know-how. Renewable energy-related fields of study and curricula need to be included in academic institutions.

Credit: Rama George/The World Bank Group

CHAPTER 1.

INTRODUCTION

Bangladesh is experiencing phenomenal economic growth and was one of the countries with the highest GDP growth worldwide in 2019. This has created a need for additional power generation capacity. The Power Sector Master Plan (PSMP) 2016 expects the total new installation capacity to reach 55,138 MW by 2041. This means that roughly 2,100 MW will be needed every year for the next 20 years to meet projected demand by 2041.[10]

Bangladesh has made commitments[11] under the Paris Agreement to mitigate greenhouse gas (GHG) emissions by 5 percent less than the "business as usual" level by 2030, or 15 percent less if international support is provided.[12]

Bangladesh relies predominantly on fossil fuel-based power plants to meet its electricity demand. In 2019, natural gas accounted for about 57 percent of installed capacity,[13] with another 32 percent of capacity comprising liquid fuels, mainly furnace oil and diesel. Current grid-connected capacity from renewable sources makes up less than 2 percent: a 230 MW hydropower plant, 80 MW of solar PV and less than 1 MW of wind power.[14] Bangladesh also relies on imported power, which makes up the equivalent of 6.1 percent of total generation capacity, to meet roughly 9.6 percent of total electricity demand.[15]

In Bangladesh, the power sector alone contributes over 52 percent of the carbon dioxide (CO_2) emissions in the country,[16] and Bangladesh's share of CO_2 emissions from fossil fuel power plants is expected to increase due to the projected increase in fossil fuel plants. Fuel imports are also expected to increase as the size of the country's generation capacity increases in the next two decades. This poses an increasing and significant threat to Bangladesh's future energy security.

Expansion of fossil fuel-based generation is a relatively easier approach to meeting projected demand. One way to meet demand and increase energy security is to utilize indigenous renewable energy resources and reduce dependency on imported fuels.

Bangladesh's indigenous fossil fuel reserves are also limited; dwindling natural gas reserves mean that there are only enough reserves to last up to 2026, considering the current production of 0.97 TCF in 2018, the growth rate and available remaining reserves of 11.47 TCF.[17] A 2019 BP report also confirmed that Bangladesh gas reserves will last only a further six years.

Based on certain scenarios in the PSMP 2016, coal could potentially be the main fuel source for electricity generation in Bangladesh by 2041. Despite the adverse environmental

10 These numbers will likely be adjusted in the short term in light of the worldwide COVID-19 pandemic.
11 Bangladesh Nationally Determined Contributions (NDCs) under the United Nations Framework Convention on Climate Change (UNFCCC).
12 MOEF, "Intended Nationally Determined Contributions."
13 BPDB *Annual Report 2018-19*.
14 SREDA, "Renewable Energy Present Status."
15 BPDB, *Annual Report 2018-19*.
16 World Bank, *World Development Indicators 2015*.
17 PETROBANGLA, *Annual Report 2018*.

impacts of coal, the PSMP projects that for a 35 percent share of the generation capacity, coal imports totaling 60 million tons per annum will be required by 2041, in addition to 10 million tons of locally mined coal for power generation. Imported power is also expected to continue with a share of 5 percent of power generation capacity through to 2041.[18]

Bangladesh is also one of the countries that stands to lose significantly if international efforts to mitigate climate change are not successful. The country consists mostly of low and flat land; only about 10 percent of the country lies more than one meter above mean sea level.[19] It is estimated that rising sea levels, increased river flow from India, extreme weather events and massive tidal surges all caused by climate change could submerge a large part of the country and lead to tens of millions of people being displaced and without land for food production. Increasing the use of fossil fuels to meet growing electricity demand undermines the country's climate action efforts and has a localized negative environmental impact that affects the health of its people.

Bangladesh has much to gain from increasing the share of renewable energy in its energy generation capacity and has already made progress in the off-grid renewables sector. It has been less successful in increasing the share of grid-connected renewables and will now need to focus on interventions that can remove the current constraints affecting renewable energy development. Increasing the amount of electricity generated from renewable energy helps achieve the following:

- Meet projected future increase in demand,
- Meet commitments made under international GHG emissions reductions pledges,
- Mitigate reduced availability of indigenous natural gas resources,
- Improve energy security through displacing imported fossil fuels, and
- Achieve 100 percent electrification and access to modern energy for all.

However, to date, large utility-scale renewable energy has been slow to take off. Bangladesh lags behind severely when compared to many of its South Asian peer countries or other comparable developing countries around the globe with respect to efforts to increase the share of renewables.

This white paper identifies the challenges faced by the sector in scaling up grid-connected renewable energy power. The paper identifies challenges that restrict the potential for scaling up renewable energy by presenting the prevailing views of researchers, think tanks and agencies, as well as informed persons in the sector.[20] The report provides specific recommendations that address the most pressing issues, providing a roadmap for the Government of Bangladesh to act on and benefit from increased clean electricity production.

18 Government of Bangladesh, *PSMP 2016*.
19 USAID, *Bangladesh Climate Vulnerability Profile*.
20 Detailed interviews were conducted with 17 different stakeholders in the Bangladeshi power sector.

CHAPTER 2.

GLOBAL CONTEXT

2.1 Trends in Renewable Energy

Renewable energy has been a major source of new global generation capacity in recent years. Installed capacity has grown rapidly in the last decade and increased from 1,223 GW in 2010 to 2,356 GW by 2018.[21] This trend is expected to continue; in 2018, a total of 175 GW renewable energy-based capacity was installed worldwide,[22] and new capacity from renewables exceeded new installed capacity from both conventional and nuclear power combined. Global installed capacity gains in renewable energy are presented in Table 2-1.[23]

Major gains have been made in solar and wind power. Global solar PV capacity increased from 40 GW in 2010 to 505 GW in 2018, which represents a twelve-fold increase during that period. Global annual additions and cumulative solar PV installed capacity between 2010 to 2018 are presented in Table 2-2.[24] Wind power capacity also significantly increased in that period, growing from 180 GW in 2010 to 564 GW by 2018. Growth trends for bioenergy and geothermal energy are comparatively smaller due to resource potential, specific project risks and higher investment costs.

In 2018, 26.1 percent of the of the total global electricity production (26,614 TWh) came from renewable energy sources.[25] If large hydropower is omitted, renewables still contributed about 9.3 percent to global electricity production. Most of these gains have been made in the last ten years. Figure 2-1 presents the share of global electricity generation at the end of 2018.[26]

The marked increase in worldwide renewable energy capacity has been largely due to reductions in capital costs and policy initiatives such as targets set by governments of many developed and developing countries. These policy signals are paramount in attracting investment in the renewable energy sector.

Renewable energy development trends in the Asia region are significant when compared to other regions. About 43 percent of total global renewable capacity exists in Asia. Capacity development trends for selected key Asian countries and technologies are presented in Figure 2-2.

2.2 Capital Cost Trends in Renewable Energy

Technology and manufacturing gains as well as policy incentives by governments have significantly driven down the cost of renewables.[27] Since 2008, prices for solar PV modules have fallen by a factor of about five.[28] Gains in wind generation technologies have not been as dramatic but have been rapid nevertheless. With these advances, the economics of renewable energy are changing. These reduced investment costs of generation are directly reflected in the levelized cost

21 IRENA, *Renewable Capacity Statistics 2019*.
22 Ibid.
23 IRENA, *Renewable Capacity Statistics 2019*; REN21, *Renewables 2019: Global Status Report.*
24 REN21, *Renewables 2019: Global Status Report.*
25 BP, *Statistical Review of World Energy 2019*.
26 IRENA, *Renewable Capacity Statistics 2019*; REN21, *Renewables 2019: Global Status Report.*
27 Chandler, "Explaining the plummeting cost of solar power."
28 SunShot, "Photovoltaic System Pricing Trends."

TABLE 2-1: Global Renewable Energy Capacity Additions from 2010 - 2018

YEAR	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hydro	1,025	1,056	1,089	1,135	1,173	1,209	1,243	1,271	1,292
Onshore Wind	177	216	261	292	340	404	452	495	540
Offshore Wind	3	3	5	7	8	11	14	18	23
Solar PV	40	71	101	138	177	229	305	405	505
CSP	1	1	2.6	3	4	4	4	5	5
Bio Energy	66	73	77	84	90	96	104	110	115
Geothermal	10	10	10	10	11	11	12	12	13

TABLE 2-2: World Solar PV Capacity Additions, 2010 - 2018

GW	2010	2011	2012	2013	2014	2015	2016	2017	2018
Year-wise Addition	17	31	30	37	39	51	76	99	100
Previous Year's Capacity	23	40	71	101	138	178	229	306	405
Total Capacity	40	71	101	138	177	229	305	405	505

FIGURE 2-1: Sources of Global Electricity Generation (2018)

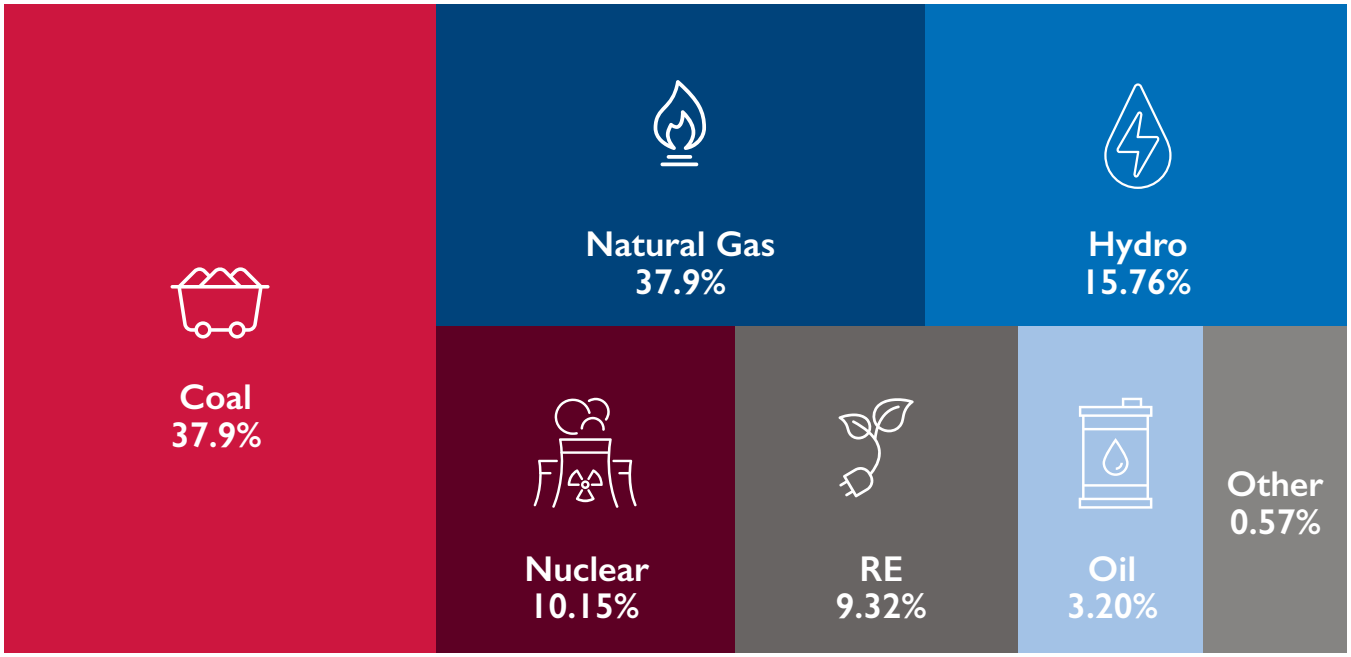


FIGURE 2-2: RE Capacity (MW) Development Trends for Selected Asian Countries

HYDRO

	2010	2011	2012	2013	2014	2015	2016	2017	2018
China	216,057	232,980	249,470	280,440	304,860	319,530	332,070	343,775	352,261
India	40,651	42,417	43,035	44,173	45,407	47,103	47,613	49,520	50,066
Indonesia	3,741	3,953	4,156	5,177	5,242	5,275	5,397	5,451	5,548
Malaysia	2,130	3,116	3,444	4,524	4,762	5,743	6,108	6,108	6,128
Pakistan	6,734	6,737	6,777	7,088	7,218	7,248	7,400	9,900	
Thailand	3,488	3,500	3,508	3,524	3,500	3,573	3,575	3,575	3,603

WIND

	2010	2011	2012	2013	2014	2015	2016	2017	2018
China	29,533	46,145	61,306	76,314	96,379	130,489	147,037	161,604	180,108
India	13,184	16,179	17,300	18,420	22,465	25,088	28,700	32,848	35,288
Japan	2,269	2,394	2,537	2,595	2,703	2,755	3,186	3,327	3,588
Korea Rep	382	425	459	571	602	837	1,027	1,098	1,265
Pakistan	6	6	6	56	106	206	308	591	1,186
Thailand	6	7	112	223	225	234	507	628	1,018

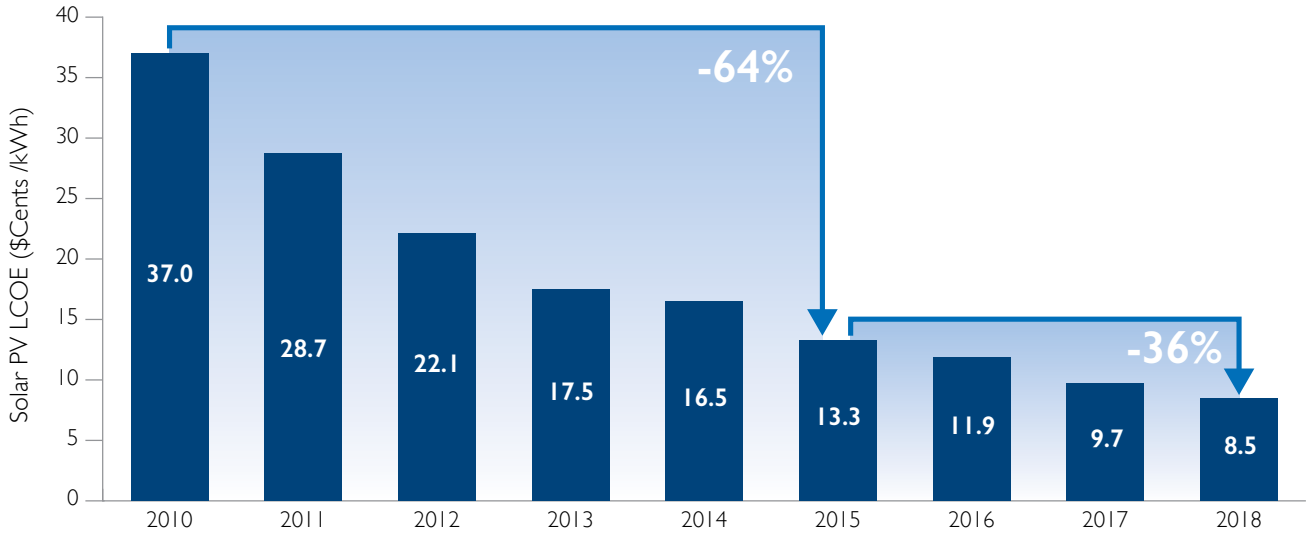
SOLAR PV

	2010	2011	2012	2013	2014	2015	2016	2017	2018
China	1,022	3,108	6,718	17,748	28,388	43,538	77,788	130,802	175,018
India	65	563	923	1,283	3,290	5,168	9,418	17,644	26,869
Japan	3,618	4,914	6,632	13,599	23,339	34,150	42,040	49,040	55,500
Pakistan	9	19	46	101	165	230	410	742	1,568
Thailand	49	79	377	824	1,299	1,420	2,447	2,697	2,720

BIOMASS

	2010	2011	2012	2013	2014	2015	2016	2017	2018
China	3,446	3,808	4,617	6,089	6,653	7,977	9,269	11,234	13,235
India	3,214	3,751	4,014	4,276	5,138	5,605	9,009	9,513	10,252
Japan	1,956	2,147	1,514	1,547	1,708	1,955	1,955	2,214	2,272
Malaysia	670	783	776	1,054	1,440	1,596	1,552	1,574	1,592
Thailand	1,767	1,975	2,196	2,634	2,829	3,231	3,395	3,824	4,095

FIGURE 2-3: Global Average LCOE for Solar PV



of energy (LCOE), which provides a good measurement when comparing different technologies.

Utility-scale solar PV and wind power have become increasingly competitive with fossil fuel-based technologies, to the extent that solar and wind were the two lowest-cost unsubsidized generation technologies in the United States in a 2019 analysis of LCOE.[29] Global average LCOE values for utility scale solar PV between 2010 to 2018 are presented in Figure 2-3.

The average worldwide LCOE for utility-scale solar PV stood at 8.5 cents per kWh in 2018, down from 37 cents per kWh in 2010.[30] The global average LCOE for onshore wind also decreased from 8.4 cents per kWh in 2010 to 5.5 cents per kWh in 2018.[31]

Global investments in renewable energy technologies for power generation (excluding large hydro power) and renewable fuels totaled approximately $289 billion in 2018.[32] This was about 11 percent less than the corresponding investment made in 2017: $326 billion. 2018 was the ninth consecutive year surpassing an investment value of $230 billion. In 2018, total investments in renewable energy resources were three times higher than those in coal and gas-based power generation.[33] China is currently the biggest investor in renewable energy, followed by the United States, Japan and India.

2.3 Global Climate Action

At the 21st session of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP21) held in Paris, member nations agreed to take action to limit the increase in global average temperatures to less than 2 degrees Celsius (2° C) and ideally 1.5° C by the end of this century, relative to pre-industrial temperature levels. By the end of 2019, national governments pledged their Nationally Determined Contributions (NDCs) to reduce GHG emissions. However, these commitments are not accompanied by the ability to meet the Paris Agreement goal.

To meet the targets of the Paris Agreement, many national governments committed to additional measures at the United Nations Climate Action Summit held in 2019 to further reduce GHG emissions. A total of 70 countries committed to increase the targets in their action plans by 2020 and 65 countries also committed to achieve net-zero emissions by 2050. Most of the UNFCCC parties have recognized the importance of integrating renewable energy technologies in electricity generation in order to mitigate GHG emissions.

29 Lazard, "Levelized Cost of Energy."
30 IRENA, *Renewable Power Generation Costs in 2018.*
31 Ibid.
32 REN21, *Renewables 2019: Global Status Report.*
33 Ibid.

CHAPTER 3.

BANGLADESH CONTEXT

3.1 Bangladesh Power Sector Overview

Bangladesh aspires to become a developed country by the year 2041. Under its Vison 2041 policy, Bangladesh developed the Power Sector Master Plan 2016, which provides a roadmap for future power sector development and new generation capacity targets until 2041. Since 2011, the government has made a significant effort within the power sector to ensure that there is sufficient electricity supply to meet demand, and has been able to more than double generation capacity, progressing from an installed capacity of 7,264 MW in 2011 to 18,961 MW by 2019.[34] This has allowed the Government to successfully increase the electrification rate from 55% to 95% in a 10-year period, taking it closer to its goal of 100% access to modern energy.

The current generation capacity in Bangladesh is dominated by natural gas and other liquid fuels. However, current grid-connected capacity from renewable energy is only 311.9 MW (excluding a further 314 MW from off-grid capacity) or less than 2 percent of the total installed capacity.[35] A large part of the grid-connected capacity is due to a 230 MW hydropower plant, with the rest coming from various small grid-connected solar and wind plants. Figure 3-1 shows the mix of installed power generation capacity in Bangladesh (2019).

Ownership of installed capacity is roughly divided between the public (50 percent) and private sectors (44 percent), with some imported power from India (6 percent). The total capacity includes 6,503 MW from independent power producers (IPPs), 1,540 MW of short-term rental power and 251 MW grid-connected non-conventional power under the Bangladesh Rural Electrification Board (BREB). An additional 314 MW of off-grid power capacity also exists in Bangladesh.

To meet the additional projected future demand, new installed capacity will need to increase to 55,138 MW in 2041.[36]

Five scenarios for the likely mix of power generation capacity by 2041 were modeled in the PSMP 2016; Figure 3-2 shows the current energy capacity mix and the five different scenarios. The variance between the scenarios is brought about by different expected capacity from coal and gas-based generation.

In most of the scenarios modeled, generation from gas and other liquid fuels could be supplemented with an increase in new generation coming from coal. Increases in the capacity share of renewables and imported power as well as the introduction of nuclear energy make up the rest of the expected changes in the installed power generation mix. If scenario three of the PSMP 2016 is followed through, the expected installed capacity by the year 2041 will be as follows:

- Natural gas and LNG, 35 percent;
- Coal, 35 percent;
- Renewable energy and imported energy, 15 percent;
- Nuclear power, 10 percent; and
- Liquid fuels and hydropower, 5 percent.

34 BPDB *Annual Report 2018-19*; BPDB; *Annual Report 2010-2011*.
35 SREDA, "Renewable Energy Present Status."
36 Government of Bangladesh, *PSMP 2016*.

FIGURE 3-1: Energy Mix of Installed Power Generation Capacity[37]

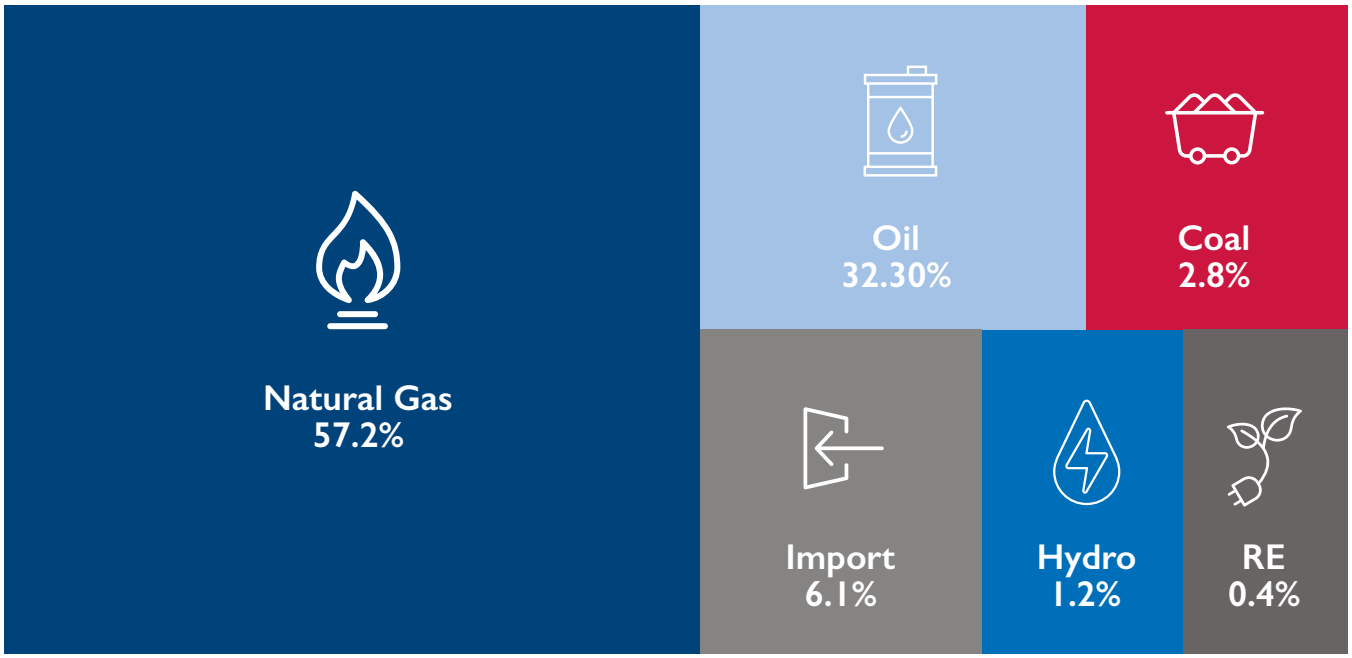
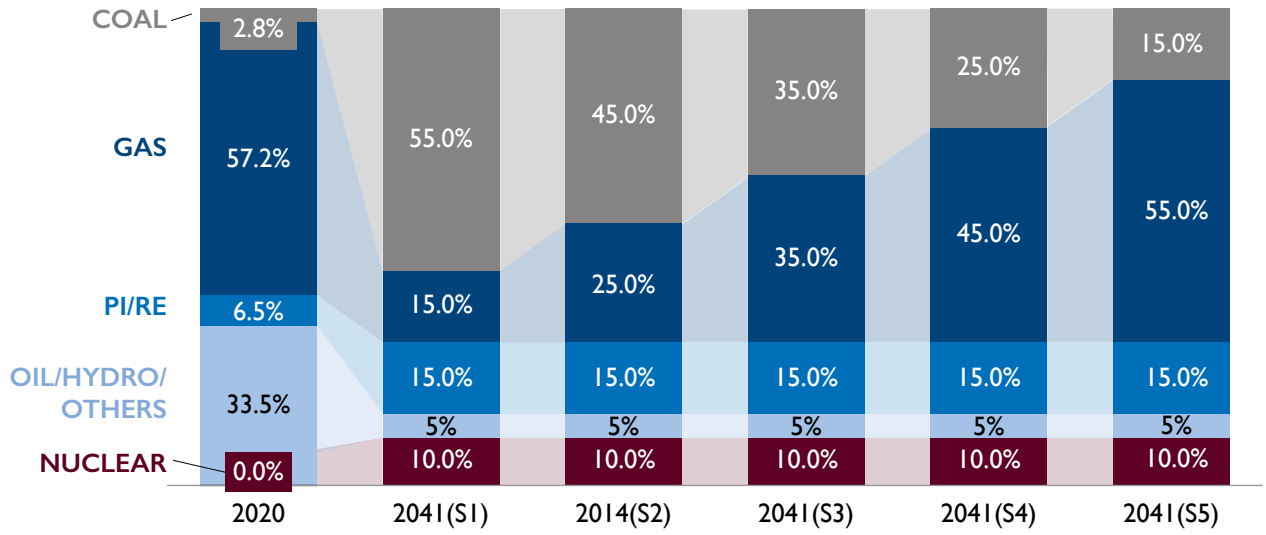


FIGURE 3-2: Generation Installed Capacity (2020) and 2041 PSMP Future Scenarios (1-5)[38]



Based on certain scenarios in the PSMP 2016, coal could potentially be the main fuel source for electricity generation in Bangladesh by 2041. Despite the adverse environmental impacts of coal, the PSMP projects that for a 35 percent share of the generation capacity, coal imports totaling 60 million tons per annum will be required by 2041, in addition to 10 million tons of locally mined coal for power generation. Imported power is also expected to continue

37 BPDB *Annual Report 2018-19*; SREDA, "Renewable Energy Present Status."
38 Government of Bangladesh, *PSMP 2016*; BPDB, *Annual Repot 2018-19*; SREDA, "Renewable Energy Present Status."

TABLE 3-1: Renewable Energy Installed Capacity as of February 2020[40]

TECHNOLOGY	ON-GRID (MW)	OFF-GRID (MW)
Solar	81	312
Wind	0.9	2
Hydro	230	0
Biogas to Power	0	0.6
Biomass to Power	0	0.4
Total	**311.9**	**315**

with a share of 5 percent of power generation capacity through to 2041.[39]

Bangladesh's grid network infrastructure consists of a total of 11,650 km of transmission lines across the country, in voltages of 400 kV, 230 kV and 132 kV. The network also includes 30 substations with a capacity of 18,005 megavolt-amperes. Distribution infrastructure in the country is significant, with over 500,000 km of lines and 132 distribution substations.[40]

3.2 Renewable Energy Achievements to Date and Future Targets

The growth of renewable energy in Bangladesh to date has primarily been through off-grid systems, mainly in rural areas where grid extension is difficult and not economical. 314.8 MW of capacity is present through off-grid systems.[41] Grid-connected renewables account for 311.9 MW. Table 3-1 shows the current installed generation mix of renewable generation. A large proportion of the current capacity is made up of one 230 MW hydropower plant and 81 MW of grid-connected solar PV.

Currently, there are only four solar and two wind power projects that are grid-connected. A total of 10 solar projects and two wind projects have also been approved and are under implementation. These will add an additional 614.8 MW of solar and 70 MW wind to the installed power generation capacity.

According to the PSMP 2016 target, the total cumulative grid-connected renewable energy installed capacity ought to have been 1,728 MW by 2019. It is well short, with only 311.9 MW having been achieved to date, mostly as a result of a 230 MW large hydro plant. The target for 2021 was 2,470 MW, and a target of 3,864 MW of renewables is expected by 2041, which is a total additional capacity target of only 1,394 MW in the 20-year period from 2021 to 2041. The government's Sustainable and Renewable Energy Development Authority (SREDA) also lists a 2021 generation target plan[43] with expected yearly increases projected from 2016. SREDA's target to 2021 is larger than the PSMP target to the same timeline and is shown in Table 3-2.

In order to try and meet some of the targets set in the PSMP, the government has approved the development of various new projects (see Appendix A). Many of these projects originally had a commercial operation deadline of the end of 2019, although none have reached commercial operation to date. In the interim, the government has

39 Government of Bangladesh, *PSMP 2016*.
40 BPDB, *Annual Report 2018-19*.
41 SREDA, "Renewable Energy Present Status."
42 SREDA, "Renewable Energy Present Status."
43 SREDA, *Annual Report 2016-2017*.

TABLE 3-2: SREDA Targets for Yearly Renewable Energy Capacity Additions to 2021

TECHNOLOGY	2016	2017	2018	2019	2020	2021	TOTAL MW
Solar (MW)	200	120	350	250	300	250	1,470
Wind (MW)	2.9	50	150	350	300	300	1,152.9
Biomass (MW)	0	6	6	6	6	6	30
Biogas (MW)	5	0	0.5	0.5	0.5	0.5	7
Hydro (MW)	230	0	1	1	2	2	236
Total (MW)	437	176	507.5	607.5	608.5	558.5	2,895.9

stopped any new procurement of power through unsolicited bids and intends to identify and solve the issues with the current projects first. What is clear is that at the current trajectory, Bangladesh will not meet its renewable energy targets in the short term and does not have an ambitious enough target in the long term (2041).

3.3 Renewable Energy Commitments and Existing Policy

Bangladesh has committed to increase its share of renewable energy electricity generation to 3,864 MW by 2041.[44] Bangladesh has also committed[45] under the Paris Agreement that by 2030, it will mitigate GHG emissions by 5 percent without any additional international support, or 15 percent with additional international financial and technical support, compared to the "business as usual" reference case for GHG emissions.[46] It is unclear how the anticipated future installed generation capacity mix scenarios of the PSMP 2016 will enable Bangladesh to meet these commitments, as they are not linked.

Energy policy in Bangladesh consists of key policy, regulations, guidelines and national action plans that aim to support energy development goals (See Appendix B). Bangladesh has implemented policy mechanisms to promote the uptake of grid-connected renewables, although limited policy effectiveness is one of the key barriers in the development of renewable energy in the country (a problem faced in renewable energy development by many countries around the world). The Government of Bangladesh launched its first policy regarding renewable energy in 1996. Considering the rapid changes that have occurred in the sector globally, the energy policy was again updated in 2004.

The Government of Bangladesh then introduced a national renewable energy policy in 2008, with the intention of encouraging and facilitating public and private sector investment in renewable energy projects.

Selected policy actions from the 2008 Energy Policy are listed below:

- An incentivized tariff may be considered for electricity generated from renewable energy sources; the tariff may be 10 percent higher than the highest purchase price of electricity by the utility from private generators.[47]
- Renewable energy project investors in both the public and private sectors shall be exempted from corporate income tax for a period of five years.

44 Government of Bangladesh, *PSMP 2016*.
45 Bangladesh NDCs under the UNFCCC.
46 MOEF, "Intended Nationally Determined Contributions."
47 Tariff-related data is not published and is not currently publicly available.

- All renewable energy equipment and related raw materials used in manufacturing renewable energy equipment will be exempted from the applicable 15 percent VAT rate.

Other policy initiatives include:

- **Private Sector Power Generation Policy Revised, 2004**: Key Fiscal incentives for IPPs to exempt them from corporate income tax and some import duties.
- **Statutory Regulatory Order (SRO) 2004: Import Duty Exemptions for Solar and Wind**:[48] An exemption in import duties for certain renewable energy products, in particular, photovoltaic cells.
- **Policy Guideline for Enhancement of Private Participation, 2008**: Allow the private sector to set up commercial power plants, use transmission and distribution lines, rehabilitate old power plants, and develop joint ventures with public sector power utilities.
- **Bangladesh Climate Change Strategy and Action Plan, 2009**: One objective of this plan is to maximize the use of renewable energy sources to lower GHG emissions and to ensure energy security.
- **Sustainable and Renewable Energy Development Authority Act, 2012**: SREDA is authorized to maintain coordination among private and public sector organizations to promote, facilitate and disseminate sustainable energy and to ensure the energy security of the country.
- **Guidelines for the Implementation of Solar Power Development Program, 2013:** Promote environment-friendly power generation. Considering the potential of solar energy, enhance and improve solar technology and attract donor organizations and private investors to reduce the use of fossil fuels by using the potential of solar energy. Create public awareness and decrease the dependency on imported liquid fuel through solar-powered irrigation pumps.
- **Bangladesh Delta Plan 2100**: Combination of long-term strategies and subsequent interventions for ensuring long-term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges.
- **Net Metering Guideline, 2018**:[49] To utilize roof space because of land scarcity, increase the contribution of renewable energy and reduce dependency on grid-connected electricity.

A full list of policies and guidelines is given in Appendix B: Policy Frameworks.

3.4 Energy Security

Bangladesh is heavily reliant on imported fuels to meet its energy demand: 9.62 percent of its power demand is met through imported electricity from India. Imports, whether of fuels for power generation or of cross-border electricity, pose significant risks to Bangladesh's energy security. Currently, Bangladesh has access to about 1,160 MW of capacity for its imports, with an additional 1,496 MW planned by 2022.[50] Current imports occur through India, although Bangladesh intends to sign agreements with countries such as Bhutan and Nepal in the future, due to their large hydropower potential.

Natural gas is currently the main fuel used for electricity generation in Bangladesh. However, of the total recoverable gas reserves that once stood at 27.81 TCF, 16.44 TCF were used by 2018 with only 11.47 TCF remaining.[51] Local production was only about 0.97 TCF in 2018. Considering current requirements and yearly production rate, the remaining reserves of 11.47 TCF will probably last until 2026. Gas demand in Bangladesh is expected to increase significantly in the future and will need to be met by imported gas such as LNG. The government is currently importing LNG to make up for gas shortfalls. A 2019 BP report also estimates that indigenous gas reserves will only last Bangladesh a further six years.

Coal reserves in the country are estimated at about 3.5 billion tons,[52] although much of the coal reserves in Bangladesh are expensive to mine for use in power generation. However, the country plans to produce an increasing amount of electricity in the future from coal-based

48 NBR, "Import Duty Exemptions for Solar and Wind."
49 MPEMR, *Net Metering Guidelines*.
50 BPDB, *Annual Report 2018-19*.
51 PETROBANGLA, *Annual Report 2018*.
52 Ibid.

power plants,[53] displacing gas and liquid fuels. The majority of future coal requirements will have to be met through importation. Current local coal production only reached 0.92 million tons per annum in 2017–2018. It is estimated that with 35 percent coal in the generation capacity mix, future demand would require 70 million tons per year, of which 60 million tons per year will need to be imported and 10 million mined locally.[54]

Bangladesh's current liquid fuel demand for electricity production is about 850 million liters per annum.[55] If demand from transport and industry are also taken into account, the country's local production can only meet 5 percent of the total demand. It is projected in the PSMP 2016 that total liquid fuel demand will be six times higher in 2041 than in 2016.

This current trajectory clearly demonstrates that Bangladesh will continue to rely on imported oil and liquid fuels, further increasing energy security risks and increasing outside dependency in order to meet its future energy demand. The current renewable energy target of 3,864 MW by 2041 will not improve the country's energy security and will leave the country reliant on imports of fuel and electricity.

3.5 Renewable Energy Potential

Bangladesh has significant solar energy potential throughout the country due to its geographical location. It has a daily average Global Horizontal Irradiance (GHI) of 5 kWh/m² for more than 300 days per annum, with daylight hours averaging between seven to ten hours.[56] A study has shown that the total grid-connected solar PV potential in Bangladesh could be as high as 50 GW.[5758]

Wind power potential is located along the 700 km coastline as well as on some of the many islands in the Bay of Bengal.[59] A recent wind assessment study completed by the National Renewable Energy Laboratory (NREL) demonstrated that an area of more than 20,000 km² exhibits wind speeds of between 5.75 – 7.75 m/s, with a gross wind potential of over 30 GW.[60]

Bangladesh's economy relies heavily on agriculture and almost 64 percent of total land is used for this purpose. Therefore, the country has a vast amount of biomass resources as well as livestock waste and municipality solid waste, which can all be used for electricity generation. One study notes that the biomass-to-power potential in 2013 was as high as 373.7 TWh per annum.[61] However, realistically, the technical potential is limited in Bangladesh as most of the biomass resources are already used for other important agricultural and household uses.

New hydropower potential is limited in Bangladesh, with the exception of some identified micro-hydro potential in the Chittagong Hills area. The only existing hydropower plant in Bangladesh is a 230 MW plant located in Kaptai. There are future plans to install an additional 100 MW unit to better utilize the extra flow during the rainy season. Several surveys have been conducted in the past and identified only a few potential sites, and although they are technically and economically viable, the need for large-scale resettlement do not make them suitable for development.[62]

53 According to the revised PSMP 2016 scenarios for 2041, power generation capacity from coal could make up 15 to 55 percent of the generation mix.
54 Government of Bangladesh, *PSMP 2016*.
55 As estimated by the Bangladesh Power Development Board in 2019.
56 Hossain, "Achieving Sustainable Energy Targets in Bangladesh."
57 Considering the grid availability, only 1.7 percent of the land in Bangladesh is assumed technically suitable for generating electricity from solar PV.
58 Mondal & Denich, "Assessment of renewable energy resources potential."
59 Hossain, "Achieving Sustainable Energy Targets in Bangladesh."
60 NREL, "Assessing the Wind Energy Potential in Bangladesh."
61 Halder, Joardder, and Sarker, "Energy Scarcity and Potential of RE in Bangladesh."
62 MPEMR, "Assessment of Barriers to Implement RE Projects."

CHAPTER 4.

CHALLENGES IN DEVELOPING RENEWABLE ENERGY IN BANGLADESH

To date, renewable energy development in Bangladesh has been slow due to several constraints specific to the power sector. It was imperative that these constraints be identified, in order to find measures and actions that will allow the country to fully realize its renewable energy potential and set a new course forward for this sector.

This section presents renewable energy development challenges in Bangladesh identified through extensive consultations with both government and private sector stakeholders, expert interviews, and group discussions as well as a literature review. A list of stakeholders who participated in the consultation for this study is provided with the references to this paper.

4.1 Policy Issues

While the government does have policies in place to promote the uptake of grid-connected renewable energy, these have not been effective in achieving the targets set out in the PSMP 2016 or the Energy Policy 2008. Some key policy interventions, such as tax and VAT incentives and the promotion of private participation in the energy sector are useful, but the majority of its policy and guidelines are vague and hold no tangible bearing for developers and investors. The targets outlined in the PSMP 2016 and in the Energy Policy 2008 have either expired or will not be achieved in the short term. It is also unclear if the current targets are appropriate for Bangladesh, considering its global GHG reduction commitments and its worsening energy security outlook. The government has, however, been successful in the last 15 years in minimizing the supply-demand gap that existed in the country through progressive policy interventions and will need to do the same to scale up the utility-scale renewable energy sector. Policy guidelines such as the enhancement of private participation in the power sector, revised policy guidelines for small power plants in the private sector, and the private sector power generation policy have all proved useful in spurring private participation in the energy sector.

Large-scale, grid-connected renewable energy projects are new in Bangladesh. To promote any new technology in a market, attractive incentives (or at least clear guidelines) for the private sector need to be provided in order to allow new technologies to compete with existing technologies.

Current government policies for renewable energy promotion have not been effective in creating meaningful incentives for accelerating the development of renewable energy projects, and incentives offered for conventional power plants do not always apply to renewable energy projects. Some examples include:

- Private power companies for conventional power plants are exempt from corporate income tax for a period

Credit: Dominic Chavez/World Bank

of 15 years, whereas renewable energy plants are only exempt for a period of five years.

- There are many incentives mentioned in the Private Sector Power Generation Policy[63] that appear to have thus far been used for conventional power plants, and these are absent in the Renewable Energy Policy, 2008.

Project developers are also faced with no or limited guidance on acceptable tariffs when they approach the government with proposals, and there is a lack of transparency in the process. They are also required to acquire over 40 permits (refer to Appendix F) and approvals[64] from different organizations in order to be able to start constructing these projects. Fossil fuel subsidies, such as extremely low gas prices to power generators, also distort the market's perception of the true cost of electricity production, making it difficult for decision makers to compare with tariffs offered by private developers for renewable energy projects.

Even in the presence of ambitious targets, a lack of grid-connected renewable energy uptake highlights that although policy incentives and political will are present in Bangladesh, these currently do not address the main challenges that market participants face. This is an issue faced by many governments across the world. It is also the case that some incentives given thus far have not proven useful due to lack of awareness within government agencies and other government institutions that developers need to engage with in order to reach financial closure of their projects.

A more holistic approach to policy is required in order to address the major bottlenecks along the entire project development process.

4.2 Land for Renewable Energy Development

4.2.1 Land Availability and Land Designation

Bangladesh is a densely populated country with agriculture as the dominant economy activity. More than 70 percent of the total population lives in rural areas and about 87 percent

63 The documents are available at: Private Sector Power Generation Policy: http://lib.pmo.gov.bd/legalms/pdf/power-policy-2004.pdf and Renewable Energy Policy: http://www.sreda.gov.bd/d3pbs_uploads/files/policy_1_rep_english.pdf

64 Model Contract Document for Solar IPP Projects. See Appendix F.

of rural households depend on agricultural activities for their income.[65] Land in Bangladesh is designated as either agricultural land or non-agricultural land, and land scarcity is a major challenge. Agricultural land includes cropland, forest, mangrove forest, rivers, lakes, beel and haor,[66] land used for aquaculture, tea estates and saltpans. Non-agricultural land consists of rural settlements, urban and industrial areas and accreted[67] land. The proportion of agricultural land in Bangladesh decreased from 91.83 percent in 1976 to 70.63 percent in 2016, with a rapid decrease in agricultural land during the period 2000–2016.[68]

Agricultural land is restricted in use and can only be used for food production[69] in order to improve food security. Therefore, the current policy is that renewable energy projects can only be sited on non-agricultural land. This creates uncertainty for developers, as there appears to be no clear government definition of what is considered agricultural land. However, one of the main advantages of wind energy projects is their ability to co-locate on agricultural land with minimal disturbance to agricultural activities. Large utility-scale wind projects require large amounts of land area per MW of installed capacity, but only 1 percent or less[70] of this total area is occupied by roads, turbine foundations and other installations; the remainder is still available for agricultural use. Thus, agriculture and wind power can be sited on the same land successfully.

Solar power plants require about three to four acres of land per MW of plant. Therefore, to develop a 50 MW power plant, 150 to 200 acres of non-agriculture land will be required in a single location. This will be a difficult undertaking for any developer given the context. Land usage requirements for wind projects vary but are likely to need an area of between 0.5 to 1.3 acres of land per MW,[71] a much smaller footprint relative to solar. Where land is available, it tends to be situated far from the national grid and is generally in undeveloped areas with limited access and infrastructure. Available land is mainly along riverbanks in the northwestern region of the country, khas land[72] and coastal areas, including islands in the southern part of Bangladesh. These areas are far from the national grid network or have limited grid capacity for tie-in of new plants. Thus, suitable land in Bangladesh is one of the single most limiting factors in renewable energy development.

This challenge has occurred in many other countries around the world, where interventions such as zoning of land for project development as well as the use of public land have been successfully used.

4.2.2 Land Acquisition

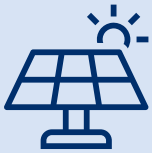
Renewable energy projects, depending on whether they are public or private, unsolicited or awarded through a procurement process and depending on the laws of the country, can use both public or private lands. The use of private land for infrastructure projects is seen as an issue of national importance in Bangladesh, primarily due to concerns over land rights. According to the Constitution of Bangladesh, the government has the right to acquire land and property for important public uses. Land is considered as an asset in Bangladeshi culture, not only as a means of livelihood but also in terms of social status. Therefore, experience has shown that in almost all cases, landowners are generally against the sale or leasing of their land.

It has proved challenging for developers to purchase or lease land from several hundred landowners. In many cases, the landowner's legal documents that are required to transfer ownership are not present. In other cases, land prices sharply increase when landowners know that there is a project being planned for the area. These challenges are not unique to Bangladesh; land acquisition and leasing pose major challenges for governments and private developers around the world. These can be effectively dealt with as has been done in many countries already.

In Bangladesh, the government's responsibility should be to support the private sector, especially during the early stages of land leasing for projects, as well as assisting developers

65 World Bank, *Bangladesh: Growing the Economy through Advances in Agriculture*.
66 Beel and haor are natural low-lying areas that typically fill up during the monsoon period to form shallow inland lakes.
67 Accreted land refers to the increase of riparian land by the gradual deposit of solid material by water, whether mud, sand, or sediment on land previously covered by water.
68 Miah et al., *Agricultural Land Availability in Bangladesh*.
69 Land Use Policy 2001
70 Mark D. Jacobson (Senior Project Leader, Integrated Applications Center, NREL), interview by author.
71 Denholm et al., "Land-Use Requirements of Modern Wind Power Plants."
72 Land that is deemed to be owned by the government and available for allocation according to government priorities.

Bangladesh's first public solar power plant, the 7.4 MW solar PV grid-connected power generation plant at Kaptai and developed by the Bangladesh Power Development Board (BPDB) is situated in the area of Kaptai in the southeastern part of the country. The project was funded by the Asian Development Bank (ADB). The project is situated on 22 acres of land, of which five acres were backfilled. Erosion protection work increased the total project cost by 15 percent and added six extra months to the construction timeline.



who face difficulties with specific landowners. Overall, land acquisition through leasing is lengthy (refer to Appendix D for the land procurement process), costly and complex in Bangladesh and many other countries and is often considered a bigger issue than land availability. Without government support in addressing these land acquisition issues, large-scale renewable energy projects are unlikely to scale up in Bangladesh.

4.2.3 Land Development and Erosion Protection

Bangladesh is one of the most vulnerable countries in the world with respect to the anticipated effects of climate change. A study shows that most of the coastal area in Bangladesh will be underwater due to rising seas if there is a future temperature increase of 2°C.[73] Bangladesh is a low-lying country with many areas that are prone to flooding. Every year during the rainy season, a large portion of cropland and floodplains in the north and south of the country become flooded. Most of the non-agricultural land available for solar PV and wind power projects are located on the floodplains of rivers and coastal areas, which will have to be backfilled and require some form of erosion protection. A large amount of backfilling and erosion protection work increases project development costs as well as project construction timelines.

These processes also need a significant number of official clearances and permissions. Permission is required from the Bangladesh Water Development Board (BWDB) and Land Ministry for dredging of sand from rivers and backfilling. A complete social impact assessment from the Department of Environment is also required. If a project is located near an environmentally sensitive area, special permission will be required from the Ministry of Environment, Forest and Climate Change (MEFCC). According to the Bangladesh National River Protection Commission Act of 2013, there should be no impediments constructed that obstruct the natural flow of the river.[74] Therefore, if a developer is required to conduct erosion protection, they need approval from the BWDB, which is responsible for water management in Bangladesh. Solutions for land access for wind power could potentially be different to that of solar PV, as wind power can be co-situated on agricultural land while still allowing for significant agricultural activity to continue.

4.3 Grid Network

4.3.1 Grid Capacity

The revised PSMP covering the period 2016-2021 identifies the increase in new generation capacity expected per year, where those plants will be located, and the transmission infrastructure that will be required to evacuate the power. Included in this are yearly expected generation capacity increases from renewable energy. However, the renewable energy component is not synchronized with the electricity transmission infrastructure plans, as is the case for new capacity from conventional technologies. As most of the future solar and wind projects are expected to be located far from the national grid, the current capacity of the transmission network will generally only be able to

73 World Bank, "Warming Climate to Hit Bangladesh."
74 Ministry of Shipping, *National River Protection Commission Act*


Credit: Johannes Plenio/Pexels

accommodate smaller renewable energy projects. Other estimates, however, have indicated that there are potential sites on the grid where up to 300 MW of solar PV can be accommodated.[75] While this is mainly for reasons of grid stability, studies will need to be completed to ascertain with more certainty whether the grid can accommodate variable renewable energy above this threshold.[76] Solar park implementation guidelines also allow up to 20 MW to be connected directly to the distribution substations (11 kV–33 kV), with plants larger than 20 MW needing to be connected directly to transmission stations.

There is also a lack of information and no national grid capacity studies to help project developers understand the requirements of connecting at specific locations on the network. Developers have found that information on transmission line capacity from the BPDB and Power Grid Company of Bangladesh (PGCB) is not readily available to developers who need to confirm grid capacity at specific locations. Some donor organizations such as the World Bank (WB), Asian Development Bank (ADB) and KfW are currently involved in technical studies, mostly on studies for grid network development or transmission line expansion projects in specific locations.

4.3.2 Grid Stability

Countries that have started to add variable generation have faced some challenges with the integration of VRE and maintaining system stability. Grid integration strategies have been successfully implemented in other countries and studies will need to be undertaken in Bangladesh to achieve the same. Grid stability is defined as an available grid with stable voltage and frequency and relying on grid operators managing supply, demand and events on the network that require intervention to maintain stability. Renewable energy resources are intermittent energy sources whose output can vary widely within short time frames, depending on whether the wind is blowing or the sun is shining. Voltage and frequency are two major components for grid stability but are difficult to manage from renewable sources because of this intermittency. Countries also need to consider the availability of spinning reserve and the condition of the grid network.

75 World Bank WPS 8517 - Integrating Variable Renewable Energy in the Bangladesh Power System - A Planning Analysis.
76 As of May 2020, the largest grid-connected variable renewable plant in Bangladesh was the 28 MW Teknaf solar PV plant.

Bangladesh's national grid is not robust or reliable enough to manage intermittent electricity beyond a certain capacity. Currently, there is very little available transmission capacity. In addition, a lack of nationally recognized technical standards and operating standards further create a difficult environment in which to tie in a utility-scale renewable energy plant to the grid. A 2018 World Bank study using a least-cost planning approach assessed the volume of solar and wind power that can technically and economically be integrated in the power system, accounting for spinning reserve generation capacity requirements and adequacy of transmission capacity.[77]

One issue for grid operators is the lack of reliable reactive power from solar and wind, which can provide voltage support and is needed for voltage stability in the transmission system. To date, there have been no studies done in Bangladesh on grid stability due to the integration of large-scale renewable energy-based power plants or any training done among grid operators on how to manage intermittent power on the grid. Bangladesh has included guidelines in its latest Electricity Grid Code 2018[78] whereby VRE plants need to be capable of supplying 20 percent reactive power in order to contribute to grid stability.[79] Technically, this might prove challenging in an environment where there is minimal experience in managing variable power generators.

4.3.3 Construction of New Transmission Lines

The PGCB is currently solely responsible for power transmission infrastructure in Bangladesh, including the development and expansion of transmission lines and power evacuation from power plants. However, due to a lack of experience with renewable-based power, the PGCB is generally not familiar with renewable energy-based power plants, and experience from previous procurement rounds has shown that for renewable energy projects, developers are expected to take responsibility for grid connection infrastructure.[80] Under guidelines for conventional power plants, the PGCB constructs transmission lines and thereafter imposes a wheeling tariff of around BDT 0.23 per kWh of electricity, although the applicable rate is determined by the Bangladesh Energy Regulatory Commission (BERC). This is in contrast to more recent government procurement documents for renewable energy capacity, which have noted that developers will be required to build required transmission infrastructure. Distribution entities such as the BPDB, BREB, Dhaka Power Distribution Company Ltd (DPDC), and Dhaka Electric Supply Company Limited require a clearance certificate from the PGCB for new transmission lines. However, there are currently no guidelines on the process of applying to the PGCB to attain such a clearance certificate.

Limited coordination between the BPDB and PGCB also hinders developers in trying to get permission for transmission planning, which has also led to developers including transmission infrastructure in their project responsibilities. This increases project risk and has a material impact on the tariff that can be offered, making them appear even more expensive in comparison to conventional power plants, which under normal circumstances are not required to cover transmission infrastructure. For conventional IPPs, the PGCB builds transmission lines because most of these power plants are located close to existing grid substations, which makes it is easier for the PGCB to cover transmission costs.

4.3.4 Power Evacuation

Most industry experts in Bangladesh are of the opinion that although land may have been identified for projects, it may not be suitable for developing large-scale renewable energy power plants, primarily due to transmission capacity. As is common in many countries, developers in Bangladesh are responsible for feasibility studies for power evacuation at prospective sites. However, there is a lack of publicly available substation information in general throughout Bangladesh and developers need to make significant assumptions that inadvertently increase project risks, which leads to developers calculating higher tariffs to offer to the government.

4.4 Solar and Wind Resource Data

Currently, some efforts have been made to map the renewable energy resource potential in Bangladesh. A handful of local organizations and academic institutes have measured solar radiation and wind speed data in Dhaka and a few other cities for academic purposes, although this data is generally not publicly available. Apart from this, a few international

77 Bankuti, Chattopadhyay, and Song, "Integrating Variable Renewable Energy."
78 BERC, Electricity Grid Code 2018.
79 Ibid.
80 This has been the experience of some IPP developers.

organizations have created wind and solar data using satellite models. NREL has developed a renewable energy data explorer, a geospatial tool that can be used to inform renewable energy investment and deployment decisions and can be useful in siting wind projects in Bangladesh. The NREL wind assessment study demonstrated that an area of more than 20,000 km² exhibits wind speeds of between 5.75–7.75 m/s, with a gross wind potential of over 30 GW.[81] However, this estimation may be reduced when one considers the current non-availability of agricultural land for wind power projects, although this large potential can easily support the country's renewable energy targets.[82]

There is currently no thorough assessment of the solar PV potential in different areas of Bangladesh, although the United Nations Development Program (UNDP) is supporting the country to develop a solar resource assessment.

Key challenges related to renewable energy resource assessment are:

- Lack of renewable energy resource data for solar PV in specific regions, including measurements of seasonal variation, and lack of assessment of the real potential for renewable energy after land availability is considered;
- Lack of mapping or zoning for renewable energy projects where site-specific resource data can be measured; and
- The fact that wind resources are best in the southern coastal region, which is also an area prone to cyclones.

4.5 Financial and Project Cost

To date, the majority of financing for renewable energy projects in Bangladesh comes from government bodies such as the Infrastructure Development Company Limited (IDCOL), although this has been for solar home systems and other off-grid applications as well as mini grids. Other development banks have also been involved the financing of renewable energy. Commercial banks are the main source of finance for private projects, including renewable energy projects. Due to a lack of experience in renewable energy project financing and not understanding the associated risks involved, commercial banks in Bangladesh are wary of investing in renewable energy projects.

Some of the key issues identified in financing renewable energy projects in Bangladesh include the lack of an existing financial market to provide finance, high quoted interest rates from lenders, short loan tenors that do not match the cash flow profiles of large-scale projects, and minimal government support[83] offered through policy or government commitments such as credit enhancement mechanisms.

Renewable energy power plants, especially solar and wind, have much lower capacity factors than conventional plants. The result is that payback periods to lenders tend to be longer for these types of plants. During the last few years, investment in Bangladesh's conventional fossil fuel-based energy sector has been remarkable, and large amounts of capital have already been deployed by the commercial banking system. Therefore, many banks have reached their credit limits for investment in the power sector. Where money is available, interest rates are high with loan tenors too short to be suitable for renewable energy projects. In previous procurement rounds, standard IAs have stipulated that equity shareholders cannot exit projects before six years have passed.[84] Due to lack of experience with large-scale renewable energy projects, financial institutions ask for PPA provisions comparable to conventional power plants with guarantees on certain cash flows.

4.6 Procurement and Bidding

In Bangladesh, government utilities (generally power generation companies, including the BPDB) receive project proposals from developers in two ways: through a formal procurement procedure (solicited) and through unsolicited proposals (refer to Appendix E). To date, for government-driven procurements, lack of information on resource assessments for public sites, site conditions and access and grid availability has made it difficult for developers to submit any bid with confidence. Lack of information in bidding documents translates into additional risks for the developer, who must bear full responsibility for any consequences from missing or erroneous information.

So far, Bangladeshi government entities have only provided a short timeframe to submit proposals for solicited bids, in

81 NREL, "Assessing the Wind Energy Potential in Bangladesh."
82 NREL, "Assessing the Wind Energy Potential in Bangladesh."
83 Certain VAT and tax exemptions for renewable energy projects are present in government policy.
84 IA clause on the Restriction on Transfer of Shares.

some cases as short as 45 days. This does not allow bidders much time to complete feasibility studies properly or on time, and these bidders either then don't submit a bid or price in any uncertainties which result in overall higher tariffs being bid. Local companies have been engaging with more experienced international developers to submit joint bids, and although some extensions have been given in previous procurement rounds, these have not proven useful to local companies who require time to engage with potential international partners.

In previous bids, PPAs have been signed, with tariffs offered ranging from 11.95 cents per kWh to 18.99 cents per kWh for solar and 12 cents per kWh for wind. The Government of Bangladesh considers these tariffs high when compared to average international prices and many letters of intent do not subsequently get converted into PPAs, and when developers have received PPAs, some have expired.

Developers have also noted that project implementation timelines as stipulated in the PPAs are unrealistic. After a PPA agreement has been signed, a project sponsor needs to start the long and onerous process of getting approvals and clearances from different government agencies. Most of the clearances are given by authorities who might not be aware of the project and its permitting requirements, which increases the time it takes to get clearances and permits, causing developers to miss agreed implementation timelines. Developers must obtain more than 40 permits and clearances to complete projects and start commercial operations (refer to Appendix G). For unsolicited bids, the experience has been that there is no set time limit for authorities to approve permits and clearances, with some taking up to two years to get.

According to government policy and the procurement guidelines provided by the Ministry of Power, Energy and Mineral Resources (MPEMR), VAT and tax are exempted for any imported equipment or materials that are related to power generation from renewable energy projects in Bangladesh. However, developers have experienced that the National Board of Revenue (NBR) is not aware of details related to VAT and tax exemptions for RE projects, creating uncertainty in their calculations for bid prices.

There are also no guidelines for tariffs on renewable energy projects and in most cases the agreed-upon tariffs are based on direct negotiations with the government through unsolicited offers. Developers offering projects directly through negotiation abandon their potential projects if the tariff negotiation is not feasible. With the government not having a fair guideline on tariffs to help them negotiate, projects that would otherwise have been beneficial to the country are shelved due to unrealistic tariff expectations by the government, especially when they are directly compared to tariffs from other fossil fuel IPPs, or when the factors that contribute to the tariff offered are not fully understood.

4.7 Institutional Capacity

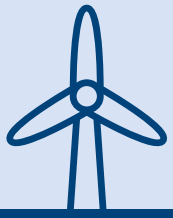
Progress in the renewable energy sector in Bangladesh has slowed due to a lack of institutional capacity within public and private organizations and lack of coordination between government institutions. To date, only four small-to-medium sized solar power projects have been realized; one is owned by a public institution, with the other three owned by different IPPs. Such a small number of projects has not allowed time for people within the sector, government institutions and commercial banks to become familiar with the requirements of RE project realization.

SREDA and IDCOL are two government organizations playing a major role in bridging the technical and financial knowledge gap in Bangladesh. SREDA is the institution responsible for promoting and disseminating information on sustainable energy, covering both renewable energy and energy efficiency. It falls under the auspices of the Power Division of MPEMR as a coordination body for the development of the renewable energy in the country. Although SREDA was set up for this purpose, to date, most renewable energy projects have been awarded on an unsolicited basis and tariffs have been determined through negotiations directly between the BPDB and IPPs. SREDA's achievements have been mostly in the off-grid space or around energy efficiency. For utility-scale renewable energy, most of its work has been on resource assessments with development partners. SREDA does not appear to have played an active role in the wind and solar IPP procurement that has already occurred in Bangladesh.

IDCOL is a non-bank financial institute of the Government of Bangladesh and plays a major role in bridging the financing gap for developing off-grid and mini-grid renewable energy projects in Bangladesh. IDCOL's work has focused mostly

Bangladesh's first renewable energy IPP bid attempt

A PPA and IA were signed in 2014 for the country's first utility-scale (60 MW) wind power project at Cox's Bazar, with a ten-month timeline for commercial operation of the plant from the date of the IA being signed. However, due to a lack of institutional capacity on wind power development, the project has not been completed yet. Agreements were signed without full knowledge of the requirements for wind power development and timelines. There was also no wind resource data available for the developer to select appropriate wind turbines for the site. The project was delayed until site-specific wind data was collected and all project development issues were resolved.



Note: As of May 2020, this project has not yet been completed or reached commercial operation.

on financing solar home systems, off-grid systems, microgrids, biogas and biomass systems and other renewable energy industrial applications. It does not appear that any preferential financing is available for utility-scale projects.[85]

BPDB is the single buyer of electricity from IPPs in Bangladesh, as well as being responsible for procuring electricity from rental power plants and other publicly owned power plants for both conventional and renewable energy. A lack of experience with power purchase from renewable energy IPPs has led to issues in negotiating terms and tariffs. Therefore, most renewable energy projects already awarded in Bangladesh have not moved forward with implementation.

Some of these challenges have also been identified in recent studies and workshops by MPEMR, IDCOL, SREDA, UNDP and USAID. These are summarized in Appendix G.

4.8 Overall Findings on Renewable Energy Development Challenges

Table 4-2 summarizes the main challenges identified in this study. Identified challenges are listed based on their perceived impact on development of renewable energy projects in Bangladesh, with lack of clarity in government policy being perceived as the highest risk. Policy risk contributes to other challenges such as land availability, procurement and financing. Many of the challenges listed here can be mitigated through specific government support and intervention.

Many other developing countries have faced similar challenges to Bangladesh and have had to implement country-specific interventions in order to kick-start the large-scale renewables sector. India stands out as a country where political will and support allowed the development of a huge renewable energy sector. Various targeted interventions created a market for competitive large-scale renewable energy, and substantially drove down the tariffs from new capacity. A full case study is presented in Appendix C.

85 IDCOL does not list commercial utility-scale projects under its categories for eligible renewable energy projects.

TABLE 4-1: Summary of Renewable Energy Development Challenges in Bangladesh

	KEY CHALLENGES
Policy and Government Commitment	• Limited effective policy in addressing the challenges of utility-scale renewable energy development • Government is committed, but currently does not have a strategy on how to achieve its commitments and targets • Renewable energy targets in government policy have either expired or look too far ahead (closest target after 2021 is 2041) • Policy guidelines and incentives for the private sector do not always apply to renewable energy projects as they do for conventional fossil fuel projects • The link between carbon reduction commitments and country targets for new renewable energy capacity is absent • Although there are targets in the PSMP, there is limited government planning and guidelines to procure utility-scale renewable energy • Limited coordination and information on procurement because of the absence of a "one-stop" service
Land	• Land availability for projects is limited in Bangladesh because most of the land is designated as agricultural land, which cannot be used for renewable energy projects • Difficult to identify suitable land; no actual definition of agricultural and non-agricultural land • Where land is available, there is often a lack of infrastructure (access roads, nearby grid connection) • Limited support from government to identify suitable land or zone land for projects • Deficit in current data on existing infrastructure such as roads and land surveying data • Land acquisition is a bigger problem than availability: land procurement process is lengthy and complex
Grid Network	• Renewable energy targets and plans are not synchronized with future electricity transmission infrastructure plans, as they are for conventional power plants • Different policies and support for new transmission infrastructure for conventional power plants and renewable energy plants • Limited assessment of potential sites for renewable energy based on transmission capacity • Difficult to access substation or load distribution information. No national grid capacity studies have been conducted • Limited coordination between BPDB and PGCB when negotiating for available grid capacity with developers • Stringent grid-code requirements for renewable energy plants • No standard guidelines for grid integration, or not publicly available • Limited feasibility studies done on grid stability and no integrated study on grid expansion
Solar and Wind Resource Data	• No detailed solar radiation resource assessment has been done to date • Limited renewable energy resource data for solar PV in specific regions, including measurements of seasonal variation • Lack of studies on renewable capacity potential considering land availability and other constraints • Absence of zoning for renewable energy projects where site-specific resource data can be measured

KEY CHALLENGES	
Financial	• Local private banks are wary about investing due to a lack of experience in large-scale renewable energy projects • Commercial lenders mostly have experience with "take or pay" PPAs that include capacity charges, which are suited to conventional plants • Government agencies for financing renewable energy currently exclude preferential lending for utility-scale projects • Current financial system concentrates on funding public sector projects, while utility-scale renewables procurement is done through private sector independent power producers (IPPs) • Utility-scale renewable energy projects do not meet current eligibility criteria for financing • Lack of an existing financial market prepared to provide finance, high quoted interest rates from lenders, short loan tenors that do not match the cash flow profiles of large-scale renewable energy plants • Onerous minimum time requirements on equity investors for exiting projects
Procurement and Bidding	• No standardized procurement program • Unrealistically short timeframes for bid submission • More than 40 permits/clearances required from different departments, with long time frames for approval • Gap in coordination between authorities responsible for developing bids and authorizing procurement decisions • Standardized transaction documents such as PPAs for renewable energy-based power projects need to be updated • Limited project implementation time given to developers (12 months)
Institutional Capacity	• Deficit in institutional capacity within public and private organizations and lack of coordination between government institutions • Currently, agencies concentrate more on off-grid renewable energy applications • Limited knowledge of renewable energy technologies and benefits of renewable energy in the energy sector • Lack of experts with experience in large-scale renewable energy projects • Limited experience when it comes to procuring new renewables capacity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CHAPTER 5.

RECOMMENDATIONS TO ADDRESS KEY CHALLENGES

Bangladesh has laid the foundation for scaling up grid-connected renewable energy but will now need to provide focused support to this nascent industry. This white paper aims to highlight to stakeholders the current challenges within the sector and provides suggestions to address these major bottlenecks. Based on feedback from industry stakeholders, academic experts and international best practice, the following key solutions are presented to address the challenges of utility-scale grid-connected renewable energy.

5.1 Policy and Government Support

The Government of Bangladesh has shown the commitment required to scale up renewable energy, although to date, its policy interventions have not been able to attract much private sector participation. Most of the previous bids have received a lukewarm response from the market. Some key policy interventions are useful, such as tax and VAT incentives and the promotion of private participation in the energy sector, but the majority of its policies and guidelines will still need to be thoughtfully formulated if they are to have any benefits for developers and investors. The targets outlined in the PSMP 2016 and in the Energy Policy 2008 have either expired or will not be achieved in the short term and need to be revisited.

The government should provide clarity on long-term renewable energy development planning. This must align with national commitments made on mitigating GHG emissions and the need to ensure energy security by reducing dependence on fossil fuels. The government should consider producing an energy roadmap that focuses on procurement and infrastructure development for power evacuation. The PSMP 2016 future development plans to 2041 are based on high-capacity shares of coal and gas, both of which have limited local reserves, while the generation capacity shares of other technologies are kept relatively constant in the five scenarios for the period 2016–2041. It should be the aim of a long-term development plan to target the optimal use of available indigenous resources, minimize import dependency and mitigate GHG emissions from the power sector using a least-cost methodology. The Government of Bangladesh should consider revising the PSMP or investigate long-term least-cost technology options to meet its national NDC targets, sustainable development goals and projected electricity demand.

Improved coordination between government agencies will go a long way in providing clarity on policy and easing the many onerous processes and approvals for renewable energy projects. Bangladesh needs a more holistic approach to policy that will be able to address the major bottlenecks along the entire project development process.

The following steps are recommended:

- Evaluate renewable energy targets in the PSMP, as the targets set for 2020 and 2021 will not be achieved, and the target set for 2041 is too far in the future and does not encourage any current action. Targets will also need to take into consideration the commitments made by Bangladesh under the Paris Agreement.

- Create an integrated master plan that not only takes into consideration least-cost planning, but also makes adjustments for emissions reduction and energy security. The plan needs to provide achievable yearly renewable energy targets considering the limited natural gas and coal reserves in the country; it also needs to minimize imported fossil fuels and imported power to meet the projected electricity demand in the country.
- Update the renewable energy policy that addresses targets to 2041 to align with the PSMP; the current energy policy only provides an energy target to 2020. An updated policy will need to provide a clearly laid-out framework of how the government will support future procurement of utility-scale renewables. Interventions must be comprehensive and able to be realistically actioned.
- Consider setting up an IPP procurement agency that is responsible for all procurement activities and communication. It can be the point of coordination between all government agencies and institutions and provide developers and investors with all the required information such as bidding documents, guidance on applicable laws and permitting requirements, and timely communication of all bidding activities.
- Review the roles, responsibilities and activities of government institutions to ensure they are effective in supporting the aims of the government's renewable energy plan with respect to utility-scale renewable energy generation capacity.
- Take steps to ensure policy is practical and implementable and that there is an institution responsible for monitoring policy actions and progress.
- Review the use of subsidies in the power sector. Bangladesh already has excess capacity, and significant capacity payments are made to underutilized plants. Overall power capacity utilization in Bangladesh for 2018–2019 was just 43 percent, while capacity payments to idle plants reached $1.1 billion. Before the COVID-19 pandemic, the BPDB had expected that the subsidy required in 2019–2019 would rise again. A review of these subsidies and how they can be used or redirected to promote clean energy and make tariffs from renewable energy more competitive is required.

Considering that Bangladesh does not have much experience with utility-scale renewable energy deployment, the government should engage with donors to ensure that knowledge of international best practices and lessons learned in other countries are brought to Bangladesh, and that these donor programs support government-championed interventions and initiatives.

5.2 Land for Renewable Energy Development

Bangladesh is a moderately sized, densely populated country whose people rely heavily on the land for agriculture. Land scarcity is a reality and land availability has proven to be one of the biggest constraints in the development of utility-scale renewable energy. The Government of Bangladesh needs to carefully consider how it can support private developers, especially in the initial phases of new generation capacity procurement. The government can initially support the sector by identifying and zoning of suitable available public land. The government's position on land use also needs to take into consideration that wind and solar power use land very differently, with wind power being perfect for co-location on agricultural land.

- The government needs to consider the idea of doing a land study that identifies options for land use for utility-scale renewable energy. The study should include the benefits of using public land, identifying land that might have lower agricultural value, and understand any advantages of designating zones for renewable energy projects.
- Developers have struggled to identify what land is designated as agricultural. The government needs to assign one agency or institution to assist developers when a land designation is unclear or consider a study that identifies all non-agricultural land that is available and best suited for renewable energy.
- Having a good, well-thought-out procurement process will attract international developers who are skilled and experienced in negotiations for land leasing and follow international best practices.
- The procurement conditions must stipulate strong community engagement and consultation and could also include requirements for local economic development.
- Bangladesh has eight EPZs[86] and about 600 industries operate in EPZ areas. As these industries mostly operate during the daytime, solar PV plants can serve significant demand for these industries during daytime hours. The

86 BEPZA, *Annual Report 2017-2018*.

Bangladesh Export Processing Zones Authority (BEPZA) can produce electricity locally from solar plants of 1 MW and larger by using rooftops of factories and unused spaces in the EPZ areas and distribute electricity through their existing distribution system. There will be no additional land and transmission line construction costs. Other industries outside of EPZ areas can also develop solar PV projects on rooftops and on unused areas. As reserves of local natural gas may only last for six more years, the Bangladesh Economic Zones Authority, BEPZA, the Bangladesh Garment Manufacturers and Exporters Association, the Dhaka Chamber of Commerce & Industry and the Federation of Bangladesh Chambers of Commerce and Industries should consider this option for reliable and secure energy supply. A government guideline to generate electricity from renewable energy in Bangladesh's economic zones and EPZs is necessary.

Most of the non-agricultural land in Bangladesh is situated on the floodplains of rivers and in coastal areas, with the experience of solar PV developers being that erosion protection is often necessary. Currently, approval for erosion protection measures is required from multiple government agencies, including the BWDB, the Department of Environment (DOE) and the MEFCC.

- Considering that many developers will use land requiring erosion protection, there is a need to create a streamlined process with all agencies involved. Currently, the timelines for these various permits are shown to substantially increase project duration and costs. The process needs to be coordinated as one function involving all agencies that ensures that permits are provided in a timely manner.

5.3 Grid Network

Bangladesh's grid network currently has a limited amount of spare grid capacity, although no current studies have determined the exact amount of grid capacity available. In addition, future grid transmission plans outlined in the PSMP 2016 are not synchronized with any future renewable energy generation capacity increases, as they are for future fossil fuel generation increases.

Most of the future renewable energy plants are expected to be situated far from the existing grid transmission network. Developers have found it difficult to get technical information from the BPDB and the PGCB on grid capacity and local grid conditions.

- As a matter of urgency, the government needs to undertake a study to identify those areas of the grid where spare capacity is available for renewable energy plants to tie into. The study should extend its scope to cover what network upgrades can be done to easily unlock further free capacity. In the short term, this represents the quickest path to maximizing the use of the existing grid system. It will also provide valuable insight into the optimum capacity of the renewable energy plants the government should be pursuing and can be overlaid onto any future land studies.
- Studies conducted by donor partners need to include renewables integration and transmission planning for renewables in their scope. Donor organizations such as the WB, ADB and KfW are mostly involved in studies for grid network development or transmission line expansion projects in specific areas.
- If the government pursues an approach where land will be zoned for use in the future by renewable energy projects, techno-economic feasibility studies should be included in the assessment phase to understand the costs of new transmission lines and system upgrades.
- Institutions such as the BPDB and the PGCB must understand what information developers need so they can can better support developers who need to connect to the grid. They can also support studies on renewables integration, expansion of transmission infrastructure and construction of substations close to renewable energy designated zones.
- Timing of such studies and planning of infrastructure upgrades needs to happen before future procurement rounds. The government should investigate and promote renewable projects integrating energy storage facilities. Storage will significantly help to meet peak electricity demand and improve grid stability. High-priced peaking power plants can be replaced with renewable hybrid plants (renewable and storage) to minimize the system costs, reduce capacity payments of idle plants and decrease imported fossil fuel dependency.

Countries that have started to add variable generation have faced some challenges with the integration of VRE and maintaining system stability. The same issues are important in the Bangladeshi context.

- The government should assess the effect that intermittent power will have on the national grid, how much new intermittent capacity can be accommodated on the grid and equipment and what infrastructure upgrades are required to deal with VRE. System studies should cover effective ways to handle changes in system frequency and voltage and should also assess the required levels of spinning reserves for various VRE capacity increase scenarios.
- Bangladesh has included guidelines in its latest Electricity Grid Code 2018 whereby VRE plants need to be capable of supplying 20 percent reactive power in order to contribute to grid stability. An assessment needs to be done as to the practicality of such a requirement, taking into consideration the nature of Bangladesh's grid system and operation.

The PGCB is currently solely responsible for power transmission infrastructure in Bangladesh, including the development and expansion of transmission lines and power evacuation from power plants. To date, some developers have found that the PGCB has been reluctant to commit to extending power lines to the point of delivery/metering, and that this responsibility has been passed on to developers.

- There needs to be a more formalized interconnection process and clear understanding of the PGCB's obligations with respect to the construction of transmission lines for renewable energy projects.

5.4 Renewable Energy Resources and Potential

Currently, some effort has been made to map the renewable energy resource potential in Bangladesh. NREL's wind energy assessment tool as well as the ongoing UNDP-supported solar PV potential assessment are important developments if utility-scale projects are to become a reality. Further work needs to be done in this area with the involvement of international agencies and potentially in collaboration with research units at local universities where such a partnership can increase capacity-building.

- Conduct resource potential studies that identify zones for renewable energy project development and that also consider other constraints such as land availability, road access and grid expansion plans. The identified zones can be targeted for resource data collection at the local level.
- Government-led initiatives should increase coordination between international agencies, local universities and research organizations in conducting renewable energy resource studies to improve local capabilities and competency.

5.5 Renewable Energy Finance

Financing for private utility-scale renewable energy projects has come from commercial banks as well as development banks. Lacking experience in renewable energy project financing and not understanding the risks involved, commercial banks in Bangladesh are wary of investing in renewable energy projects and generally offer short loan tenures and high interest rates.

Extending sovereign guarantees to renewable energy projects and establishing special long-tenor funds through financial institutions will help bring down the cost of financing. Additionally, reducing subsidies on fossil fuels should be considered to avoid the risk of investments in conventional power projects hindering development of renewable energy in Bangladesh.

- Bangladesh should hold a formal sector-wide engagement with the lending community, including international lenders, to understand their requirements for lending and how key risks that affect project bankability can be addressed.
- The government needs to understand what credit enhancement mechanisms it can extend to project sponsors of renewable energy, such as sovereign guarantees, which are already available for conventional IPPs in Bangladesh.
- The government should establish acceptable exit strategies for equity investors and the ability to transfer equity.

5.6 Procurement

In Bangladesh, the government receives project proposals through a formal procurement procedure and through unsolicited proposals. Government-driven procurements, lack of information on resource assessments for public sites, site conditions and access, and grid availability have made it difficult for developers to submit bids with competitive prices. Tariffs offered by IPPs have ranged from 11.95 cents per kWh to 18.99 cents per kWh for solar and 12 cents per kWh for wind. The government considers these to be higher than the international benchmark.

In the 2018–2019 fiscal year, the government subsidy required to compensate BPDB for selling power below cost and to avoid a major cash flow shortfall rose again to reach $936 million. Before the COVID-19 pandemic, the BPDB had expected that the subsidy required in the 2019–2020 financial year would rise again to $1.1 billion. This will now likely need to be even greater.

It is only by providing a well-laid-out procurement process and by minimizing project risks best handled by the government that developers will be in a position to lower the tariffs they bid. This has been the experience of many countries procuring renewable energy through the IPP model.

- The government should prioritize a well-thought-out bidding process with transparent and fair evaluation of bids, and formalize the bidding process as unsolicited proposals tend to produce higher bid prices.
- The government should develop standardized and high-quality transaction documents such as PPAs and IAs, which will significantly help balance risks for developers and can address key issues in Bangladesh. Documents needs to be easily accessible.
- A procurement process should include realistic timelines for submission of bids considering the time it takes for developers to collect all relevant information, as well as realistic project development and construction timelines.
- A stepwise procurement methodology needs clearly advertised bidding windows. The procurement structure needs to be designed to attract long-term interest from international developers.
- Government support agreements need to be signed after careful consultation with all government agencies with a clear understanding of the risks the government is able to bear.
- Reverse auctions based on allocated capacity per technology have proven to be the best model for attracting competitive tariffs in many countries. They force the market to do proper due diligence on each bid and drive down bid prices.
- The government should support developers by listing all approvals needed and indicate the timelines for any approvals needed from agencies and authorities.
- The government should provide clear guidelines on tax and VAT exemptions and relax import duties. Developers have found that the NBR is not aware of details related to VAT and tax exemptions for RE projects, creating uncertainty in their calculations for bid prices.

5.7 Capacity Development

Progress in the renewable energy sector in Bangladesh has slowed due to a lack of institutional capacity within public and private organizations and lack of coordination between government institutions. Bangladeshi institutions also lack experience on renewable energy project development, as only four utility-scale projects have reached commercial operation.

- The government (through SREDA) should institute a workplan to improve the knowledge and institutional capacity within public utilities, specifically for utility-scale renewable energy. The workplan should focus on developing capacity in: (i) energy security; (ii) global trends in energy generation, including energy storage; (iii) energy resource assessment; (iv) renewable energy project design and development; (v) renewable energy procurement; and (vi) energy modeling, grid stability and VRE integration. SREDA can be tasked do this with the help of technical research organizations such as the World Bank, KfW, ADB and NREL.
- SREDA should launch a one-stop service for the private sector to obtain useful renewable energy project information, requirements, and resource data, which will enable developers to produce better quality bids in a timely manner.
- SREDA should also take responsibility for minimizing coordination gaps between entities for renewable energy project development, for reducing permitting time, and for accelerating project implementation.
- Consideration should be given to extend the mandate of IDCOL to include financing for large-scale renewable energy.
- As grid operation features increasing levels of VRE, there needs to be a comprehensive training for grid operators to manage the power system with increased variances due to intermittency.
- Few academic institutions in Bangladesh have renewable energy research facilities. Renewable energy research facilities will help to strengthen this sector and improve local capabilities and technical know-how. Renewable energy-related fields of study and curricula need to be included in academic institutions.

Credit: Rama George/The World Bank Group

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List of Key Informants and Subject Matter Experts Interviewed

- Mr. Siddique Zubair, Ex-Member (Additional Secretary), Sustainable and Renewable Energy Development Authority (SREDA)
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- Mr. Tarique Hyder, Business Advisor, Scatec Solar
- Mr. Rafiqul Alam, Procurement and Logistics Manager, Scatec Solar
- Ahmed Jahid Khan, Director, Renewable Energy, Bangladesh Power Development Board (BPDB)
- Engr. Mohammed Sherajul Islam, Deputy Director, IPP Cell-3, BPDB
- Taibur Rahman, Project Manager, Development of Sustainable Renewable Energy Power Generation Project (SREPGen), United Developed Nations Program (UNDP)
- Mr. Sheikh Rahman, Managing Partner, Enertech International Inc.
- Mr. Shahriar Ahmed Chowdhury, Assistant Professor, Department of Electrical and Electronic Engineering, United International University, Dhaka
- Mrs. Salima Jahan, Member (Joint Secretary), SREDA
- Engr. Rashedul Alam, Assistant Director, SREDA
- Engr. Ibrahim Ahmad Shafi Al Mohtad, Superintending Engineer (P&D), Electricity Generation Company of Bangladesh Limited (EGCB)
- Engr. Mr. Monowar Hasan Khan, Senior Advisor, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Dhaka, Bangladesh
- Engr. Q.M Shafiqul Islam, Chief Engineer (A/C) & Project Director, Power Grid Company of Bangladesh Limited (PGCB)
- Mr. Sheikh Reaz, Executive Director (F), PGCB and Former Director, SREDA
- Engr. Mukit Alam Khan, Manager (Project and Planning), Cox's Bazar 60 MW Wind Power Plant Project, US-DK Green Energy (BD), Limited
- Md. Sobhan Miah, Director (Renewable Energy), Bangladesh Rural Electrification Board (BREB)
- Engr. Md. Faruque Ahmed, Project Director, 7.4 MW Solar PV Grid-Connected Power Generation Plant, Kaptai, and Superintending Engineer, BPDB
- A group consultation meeting with Md. Enamul Karim Pavel (Head of Renewable Energy), Farzana Rahman (Executive Vice President and Unit Head, Renewable Energy), Syeeda Yeasmeen Meer (Manager, Investment), and Engr. Hassan Aziz (Manager), Infrastructure Development Company Limited (IDCOL)
- Mohammad Alauddin, Additional Secretary (Policy and Renewable Energy), Power Division, Ministry of Power, Energy and Mineral Resources
- Dr. Md. Abdur Razzak, Professor, Department of Electrical and Electronic Engineering, Independent University, Bangladesh
- Engr. Md. Mohaimenul Islam, Superintending Engineer and Project Director (Sirajganj 7.6 MWp Grid-Connected Solar Photovoltaic Power Plant), North-West Power Generation Company Limited (NWPGCL)

APPENDICES

Appendix A: Solar and Wind Ongoing/Completed Project List

Completed Solar Projects

- 7.4 MWp Grid-Connected Solar PV Power Plant at Kaptai Hydro Power Station compound under BPDB in Rangamati. Public; financed by the Asian Development Bank.
- 28 MWp (20MW AC) Solar Park at Cox's Bazar by Joules Power Limited (IPP Unsolicited). Debt finance by Standard Chartered Bank (Bangladesh and UK) and One Bank (Bangladesh) and GuarantCo credit guarantee for over 50 percent of the project debt.
- 8 MW (AC) Solar Park at Majhipara, Tetulia, Panchagarh by JV of Paragon Poultry Ltd. & Parasol Energy Ltd., Bangladesh and Symbior Solar Siam Ltd., Hongkong (IPP Unsolicited). Finance By IDCOL.
- 3 MW Grid-Connected PV Power Plant at Sharishabari, Jamalpur.

Completed Wind Projects

- 900 kW Grid-Connected Wind Power Plant at Sonagazi, Feni completed by BPDB. Self-financed.
- 2 MW-Capacity Wind Power Plant on turnkey basis at the bank of the River Jamuna adjacent to the existing Sirajganj 150 MW power plant, Sirajganj, Bangladesh. By BPDB, self-financed.

Ongoing Solar IPP projects (614.6 MW)

- 35 MW (AC) Solar Park by Consortium of Spectra Engineers Limited & Shunfeng Investment Limited.
- 50 MW (AC) Solar Park by HETAT-DITROLIC-IFDC Solar Consortium.
- 32 MW (AC) Solar Park by Haor Bangla-Korea Green Energy Ltd.
- 5 MW (AC) Solar Park by Sun Solar Power Plant Ltd.
- 200 MW (AC) Solar Park by Beximco Power Co. Ltd.
- 30MW (AC) Solar Park by Intraco CNG Ltd & Juli New Energy Co. Ltd.
- 200 MW (AC) Solar Park by SunEdison Energy Holding (Singapore) Pvt Ltd.
- Sonagazi 50 MW Solar Power Plant Construction Project, implementation organization Electricity Generation Company of Bangladesh. Financed by the World Bank.
- 5 MW (AC) Solar Power Park by PV Power Patgram Ltd. Patgram, Lalmonirhat. (IPP unsolicited)
- Sirajganj 7.6 MWp Grid-Connected Solar Photovoltaic Power Plant, implementation organization North-West Power Generation Company through self-finance.

Ongoing IPP Wind Project (70 MW)

- 60 MW Wind Power Project at Cox's Bazar by US-DK Green Energy (BD) Ltd, Chakaria Upazila, Cox's Bazar, (IPP unsolicited).
- 10 MW Wind Power Plant, Kalapara Upazila, Patuakhali, implementation organization Rural Power Company Ltd. Financed by the Government of Bangladesh.

Appendix B: Policy Frameworks

This section summarizes the key existing policy, regulations, guidelines and national action plans that support the achievement of energy development goals. Policy inadequacy is one of the key barriers in the development of renewable energy in many countries. The Government of Bangladesh launched its first energy policy regarding renewable energy in 1996. Considering the rapid changes that have occurred in the sector globally, the energy policy was updated in 2004. Table B-1 shows the key policies, regulations and guidelines that are directly related to renewable energy development in Bangladesh.

TABLE B-1: Key Policies, Regulations and Guidelines for RE Development in Bangladesh

POLICY, REGULATIONS AND GUIDELINES	KEY OBJECTIVES
National Energy Policy, 1996 (MPEMR, 1996)	• To provide energy for sustainable economic growth • To ensure optimal development of all indigenous energy resources • To ensure environmentally sound sustainable energy development
National Energy Policy 2004 (MPEMR, 2004a)	This policy has the same objectives as the 1996 policy and added new objectives: • To bring the entire country under electrification by 2020 • To ensure a reliable supply of energy to the people at a reasonable and affordable price • To develop a regional energy market for rational exchange of commercial energy to ensure energy security
Private Sector Power Generation Policy Revised, 2004 (MPEMR, 2004b)	Key fiscal incentives: IPPs are exempt from corporate income tax, and allowed to import plant and equipment and spare parts; foreign lenders are exempt from income tax in Bangladesh; and foreign investors will be free to enter into joint ventures.
Statutory Regulatory Order 2004: Import Duty Exemptions for Solar and Wind (NBR, 2004)	This order creates an exemption in import duties for certain renewable energy products, particularly photovoltaic cells, even if they are assembled into modules or panels and solar powered lantern/lamps having no provision for electrical power.
Renewable Energy Policy, 2008 (MPEMR, 2008c)	• To harness the potential of renewable energy resources and technologies everywhere, encouraging and facilitating both public and private sector investors • To scale up the contribution of renewable energy to power generation • To promote and train efficient and environmentally friendly use at every level of energy usage • To produce 5% of the total electricity demand from renewable energy by 2015 and to increase the portion to 10% by 2020
Policy Guideline for Enhancement of Private Participation, 2008 (MPEMR, 2008b)	• To promote further private participation, harness competition, ensure optimal use and conservation of gas resources • To develop local private sector entrepreneurship to develop power projects The government intends to allow the private sector to 1) set up commercial power plants, 2) use transmission and distribution lines of the PGCB, 3) rehabilitate old and inefficient power plants and 4) develop new joint venture power plants in partnership with public sector power utilities

POLICY, REGULATIONS AND GUIDELINES	KEY OBJECTIVES
Policy Guideline for Small Power Plants (SPP) in Private Sector 2008 (MPEMR, 2008a)	• To allow for fast-track private sector establishment of SPPs for their own electricity needs, and to sell the surplus to others. SPPs are to be developed with a capacity of 10 MW or less (larger plants are possible with government permission) and are to be established on a build-own-operate basis.
Bangladesh Climate Change Strategy and Action Plan, 2009 (MoEF, 2009)	The Government of Bangladesh adopted the Climate Change Strategy and Action Plan, which is built on six pillars and a total of 44 programs. Renewable energy development is listed as the fourth program out of ten programs under the fifth theme titled "Mitigation and Low Carbon Development." The objective of this program is to maximize the use of renewable energy sources to lower GHG emissions and ensure energy security.
Sustainable and Renewable Energy Development Authority Act, 2012 (MPEMR, 2012)	SREDA is authorized to organize the renewable energy sector to maintain coordination among the private and public sector; to promote, facilitate and disseminate sustainable energy; and to ensure the energy security of the country.
Guidelines for the implementation of solar power development program, 2013 (MPEMR, 2013)	Key objectives are: 1) to promote environment-friendly power generation considering the potential of solar energy, 2) to enhance and improve solar technology, 3) to attract donor organizations and private investors to invest in the solar technology as a part of renewable energy, 4) to reduce the use of fossil fuels by using the potentials of solar energy, 5) to achieve "green energy," 6) to create public awareness of rooftop solar systems, and 7) to decrease the dependency on imported liquid fuel via solar-powered irrigation pumps.
Energy Efficiency and Conversation Master Plan up to 2030, 2015 (MPEMR, 2015)	• To improve energy intensity • To save a total of 95 million tons of oil equivalent by 2030 • Energy savings will amount to BDT 768 billion • To decrease the amount of fuel imports for power generation, resulting in a cumulative savings of BDT 2.3 trillion between 2015 and 2030
Power Sector Master Plan 2016 (PSMP, 2016)	Five viewpoints of PSMP 2016: • Enhancement of imported energy infrastructure and its flexible operation • Efficient development and utilization of domestic natural resources • Construction of a robust, high-quality power network • Maximization of green energy and promotion of its introduction • Improvement of human resources and mechanisms related to the stable supply of energy
Net Metering Guideline, 2018 (MPEMR, 2018)	• To utilize rooftop space as a response to land scarcity, increase the contribution of renewable energy and reduce the dependency of grid electricity with additional earnings
Bangladesh Delta Plan 2100 (Planning Commission, 2018b)	The General Economics Division of the Bangladesh Planning Commission formulated the Bangladesh Delta Plan 2100, which as approved by the government in September 2018. It is the first report to combine long-term strategies and subsequent interventions for ensuring long-term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges through robust, adaptive and integrated strategies and equitable water governance. This report is also important for the renewable energy project because it has guidelines for the potential usages of land.

Appendix C: India Case Study

A Case Study: India[87]

India has a total of 23.5 percent renewable energy capacity share (excluding large hydro) in its total installed capacity of 368.98 GW as of February 2020. India is one of the top five countries worldwide for installation of renewable energy for power generation, equivalent to 86.71 GW. India wants to achieve top position globally by installing 175 GW of renewable energy capacity by 2022. The achievement of its current capacity was not easy, as India was also facing the same challenges as Bangladesh does now. The Government of India (GOI) has undertaken massive initiatives to achieve its target, and India has reached 34 GW solar capacity from 2.35 GW within the last 5.5 years. Electricity tariffs have decreased more than 75 percent due to their initiatives in development renewable energy during that period.[88]

The GOI's first initiative toward the development of solar power was the announcement of the Jawaharlal Nehru National Solar Mission under the National Action Plan and Climate Change, which was launched in 2010 with the target of achieving 60 GW large-scale solar power plants. However, the mission did not succeed, and India only achieved 2 GW of large-scale solar installed capacity by 2015.[89]

The second initiative was to develop proper guidelines for the development of solar parks with plant capacity of 500 MW or higher, which were published under the Jawaharlal Nehru National Solar Mission on October 2015.[90] The guidelines aimed to provide easier access to information for local and international solar project developers/investors and to create a single window for the permit and clearance system and any other formalities that delay the progress of the projects. The key guidelines are presented here:[91]

Guidelines Related to Site Selection, Land Acquisition and Facility Development

The state government is responsible for identifying the land for setting up large-scale solar projects, except where an implementing agency has its own land. The land should be government wastage/non-agricultural so that the land acquisition process is easier and inexpensive. If the land is not available in a single location, then multiple locations in the close vicinity can be chosen. The state government is solely responsible for acquiring land, other land-related clearances and all infrastructure development such as approach and internal road, water and drainage facilities, electricity supply, internal transmission system and arrangement for power evacuation with grid, land leveling and development, which are required for solar plants. As per the guidelines, the state government nominates solar power park developers (SPPD) under the large solar park scheme. The SPPD will be responsible for the operation and maintenance of the plant for 25 years after setting up the solar park.

Financial Support

The Solar Energy Corporation of India (SECI) will receive the project proposal and application to set up a solar park from an SPPD and forward it to the Ministry of New and Renewable Energy (MNRE) with their recommendations. The MNRE will release a grant of Rs.25 Lakh to the SPPD to prepare a detailed project report including project costs, and SECI will ensure that the SPPD completes these works within 60 days after funds have been released. After that, the MNRE will release another grant to the SPPD through SECI, the value of which is Rs.20 Lakh per MW or 30 percent of the total project cost including grid connectivity, whichever is lower. This is used for land acquisition and other infrastructure development works.

87 Developed mainly from data and information from the Ministry of New and Renewable Energy website (https://mnre.gov.in/) and the Guidelines for Development of Solar Park, Government of India.
88 MNRE website, 2020.
89 Rathore et al., "Solar Power Utility Sector in India."
90 MNRE, *Guidelines for Development of Solar Park.*
91 Ibid.

Financial Structure

The SPPD estimates the total project cost including operation and maintenance costs and formulates a recovery model to ensure sustainability of solar park project. Normally, SPPDs will not require high equity investment or loans, as most of the costs will be covered by the MNRE grant, state government and other grants. The SPPD will recover its investment by selling or leasing the land to the prospective solar project developers. SPPDs are state government-designated agencies, joint ventures between a state government-designated agency and SECI, or joint ventures between a state government-designated agency and a private agency or fully private agency. The project developers are free to set up projects under any GOI or state government scheme or for third-party sale.

Power Transmission and Evacuation

The park developer (SPPD) is responsible for developing the pooling substation inside the solar park and the solar project developer is responsible for the interconnection of each plant by 66 kV or other suitable voltage through underground or overhead lines. The responsibility of setting-up a substation nearby the solar park to take power from the pooling station by the Central Transmission Unit (CTU) or State Transmission Unit (STU) depends on the conditions of power purchase. If the state government is willing to consume more than 50 percent of the power generated, then the STU will set up the substation; otherwise, CTU will be responsible. To set up this transmission line and evacuation facilities, CTU may prepare a separate project to be funded from the National Clean Energy Fund, external funds, or Green Corridor Projects.

Institutional Arrangement and Coordination

The SPPD is the designated nodal agency of the state government, which is solely responsible for making arrangements to set up the solar park. The solar park will be developed by local and international developers/ investors in collaboration with the state government and its agencies. SECI is the nodal agency of MNRE on behalf of the GOI, and is responsible for handling funds available under the GOI scheme. SECI will coordinate with the SPPD for the development work and provide support so that work is completed as per the detailed project report and within the agreed timeline. SECI will also coordinate with the Power Grid Corporation of India for the construction of transmission lines and a power evacuation substation near the solar park so that the project will not be delayed due to the power transmission lines not being complete on time. SECI will develop an online project progress tracker where the SPPD and project developer can log progress and photographs of the solar park.

Appendix D: Process of Land Procurement for Private Project

Appendix E: Unsolicited Proposal Approval Process

UNSOLICITED SOLAR POWER PROJECT	
Proposal Submission	• To be submitted to the Power Division of the Ministry of Power, Energy & Mineral Resources • A copy must be submitted to the Secretary of the Bangladesh Power Development Board
Evaluation of Proposal	• Power Division's Renewable Energy Wing sends proposal to the Technical Evaluation Committee • Committee comprises members of BPDB, PGCB and other relevant government entities
BPDB & PGCB Opinon	• Renewable Energy Wing seeks opinion from BPDB, PGCB, and local government
Land Inspection Committee Approval	• Land Inspection Committee conducts physical land inspection • Committee comprises representatives from BPDB, PGCB, and local government
Approval from Prime Minister	• Renewable Energy Wing prepares a summary (combination of all reports) • Power Minister (Honorable Prime Minister) gives in-principle consent
Tariff Negotiation	• Sponsors are called in to negotiate the tariff with a Special Processing Committee • Committee is headed by the Power Secretary and comprises representatives of the Ministry, the Prime Minister's Office, the NBR, BPDB, PGCB and other relevant entities
Purchase Committee Approval	• The proposal, including negotiated tariff, is sent to the Cabinet Committee for Government Purchase, headed by the Finance Minister
Issuance of LoI	• Once the Purchase Committee approves the proposal, a letter of intent (LoI) is issued • $5,000/MW security deposit must be made within one (1) week of LoI acceptance
Signing of PPA	• LoI signatory signs the Power Purchase Agreement • $18,000/MW performance security deposit must be made prior to PPA signing

Appendix F: List of Required Permits from Different Authorities[92]

SL. NO.	GOVERNMENT AUTHORIZATION	RELEVANT AUTHORITY
PART 1: GOVERNMENT AUTHORIZATIONS REQUIRED BEFORE FINANCIAL CLOSING		
SUB-PART A: CRITICAL GOVERNMENT AUTHORIZATIONS		
1.	No objection certificates for the Project and consents for Site clearance and Environmental Clearance Certificate. In particular:	
(a).	As per the Local Government (Union Parishads) Ordinance, 1983 and with reference to Circular No. 159/UP/047, dated 16 June 1993.	Local union parishad (UP)
(b).	As per Local Government (Thana Parishads and Thana Administration, Reorganization) Ordinance, 1982 (Order No. LIX of 1982) as amended up to 1992.	Thana authority of the district
(c).	Government Authorization granting permission to commence civil works on the basis of the "Initial Environmental Examination Report."	DOE
(d).	Government Authorization approving the Project for environmental and social impact ("Environmental Impact Assessment Approval") on the basis of the "Environmental Impact Assessment Report."	DOE
2.	Government Authorization for the execution of the Financing Documents, including approval of the term sheets for the Company's Foreign Currency loans.	Ministry of Finance (MOF) (ERD)/Board of Investment (BOI)
3.	Registration of the executed Financing Documents	BOI
4.	License for the term of the Power Purchase Agreement permitting the Company to generate and supply electricity under the Power Purchase Agreement.	MPEMR/ Office of the Electrical Adviser and Chief Electric Inspector (OEACEI)/BERC
SUB-PART B: OTHER GOVERNMENT AUTHORIZATIONS		
1.	Registration of the Company and the O&M Contractor to operate and maintain infrastructure facilities for private power generation projects.	BOI
2.	Government Authorization for the installation, construction and operation of a deep tube well at the site.	Department of Public Health Engineering / Dhaka Water Supply & Sewerage Authority
3.	Work permits for Project personnel including the Company's and Contractors' employees and residence visas.	BOI/Ministry of Home Affairs (MOHA)
4.	National security clearance for expatriate employees of Company and the Construction and O&M Contractor.	MOHA

92 Model contract document for solar IPP projects.

SL. NO.	GOVERNMENT AUTHORIZATION	RELEVANT AUTHORITY
5.	Government Authorization for remittance of up to fifty percent (50%) of salaries and savings by expatriate employees of the Company without restriction.	Bangladesh Bank (BB)
6.	Registration of the Company as a private limited company.	Registrar of Joint Stock Companies and Firms
7(a).	All import permits, certificates, licenses and other required consents allowing the Company and the Contractors to import into Bangladesh all plant, machinery, equipment, spare parts, materials and supplies required for the Project, as expressly provided in Section 7.1 of the Implementation Agreement.	Ministry of Commerce (MOC)/Chief Controller of Import and Export (CCIE)
7(b).	Exempting the Company and the Contractors from payment of fees on import into Bangladesh all plant, machinery, equipment, spare parts, materials and supplies required for the Project, as expressly provided in Section 7.1 of the Implementation Agreement.	MOC/CCIE
7(c).	No objection certificate to obtain export permit to export the imported equipment not forming the permanent part of the Facility as expressly provided in Section 7 of the Implementation Agreement.	BB
8.	Statutory notifications granting exemption from Customs Duties and VAT on the importation of plant and equipment (including spare parts) for incorporation into the Facility and the temporary importation of erection materials, machinery and equipment (subject to re-export), as expressly provided in Section 12.1(b) of the Implementation Agreement.	NBR
9.	Statutory notification granting the Company exemption from taxation on its income including all withholding taxes related directly to the Project, as expressly provided in Section 12.1(a) of the Implementation Agreement.	NBR
10.	Statutory notification granting foreign collaborators, companies and experts exemption from tax or withholding tax on such of their income as is paid as "royalties," "technical assistance fees" and "technical know-how fees" by the Company in connection with the Project, as expressly provided in Section 12.1(d) of the Implementation Agreement.	NBR
11.	Statutory notification granting the Foreign Investors of the Company (if a public limited company) exemption from capital gain tax in respect of any transfer or disposal of shares in the Company, as expressly provided in Section 12.1(d) of the Implementation Agreement.	NBR
12.	Statutory notification granting the Company an exemption from any duty on the sale of electricity to BPDB, as expressly provided in Section 12.4 of the Implementation Agreement.	MPEMR/OEACEI
13.	Statutory notification granting foreign employees of the Company exemptions from taxation on their personal income in Bangladesh, as expressly provided in Section 12.1(d) of the Implementation Agreement.	NBR

SL. NO.	GOVERNMENT AUTHORIZATION	RELEVANT AUTHORITY
14.	Statutory notification that the Lenders will be exempted from taxation on their income in Bangladesh, as expressly provided in Section 12.2 of the Implementation Agreement.	NBR
15(a).	Statutory notification granting exemption from stamp duties in respect of the registration of all deeds, documents and instruments contained in the Financing Documents and deeds recorded in connection with the acquisition of the Site in Bangladesh, as expressly provided in Section 12.1(c) of the Implementation Agreement.	MOF(IRD)/Ministry of Law (MOL)
15(b).	Statutory notification granting exemption from registration fees in respect of the registration of all deeds, documents and instruments contained in the Financing Documents and deeds recorded in connection with the acquisition of the Site in Bangladesh, as expressly provided in Section 12.1(c) of the Implementation Agreement.	MOF(IRD)/MOL
16(a).	Easement or lease agreement and approval for construction of shoreline work, jetty, intake and outfall structures of once through cooling system, use of river water and dredging of river.	Inland Water Transport Authority
16(b).	Approval for construction of shoreline work, jetty, intake and outfall structures of once through cooling system, use of river water and dredging of river.	BWDB
16(c).	Approval for shoreline work such as sheet piling at Site along the canal.	Thana/UP
17.	Government Authorization for payment by the Company to persons outside Bangladesh under Section 5 of the Foreign Exchange Regulations Act, 1947 (Act VII of 1947) ("FERA") in respect of all transactions of the Company necessary to implement the Project, as expressly provided in Section 8.3 of the Implementation Agreement.	BB
18.	Government Authorization for the issuance, export and transfer of securities in Bangladesh or outside Bangladesh under Section 13 of FERA, purchased in Taka or in Foreign Currency.	BB
19.	Government Authorization to lend money to the Company.	BB
20.	Government Authorization for opening and operating on-shore Dollar and off-shore Foreign Currency bank accounts, as expressly provided in Section 8.2 of the Implementation Agreement.	BB
21.	Government Authorization for the purchase of Dollars for Taka through normal commercial banking channels in Bangladesh for the purposes specified in Section 8.3 of the Implementation Agreement, and for the transfer of such Dollars from bank accounts inside Bangladesh into bank accounts outside Bangladesh, as is expressly provided in Sections 8.2 and 8.3 of the Implementation Agreement.	BB
22.	Government Authorization for creation of security interests in favor of the Lenders in the Company's bank accounts.	BB

SL. NO.	GOVERNMENT AUTHORIZATION	RELEVANT AUTHORITY
23.	Government Authorization to make or remit payments in Dollars from bank accounts in Bangladesh or outside Bangladesh, as expressly provided in Section 8.3 of the Implementation Agreement.	BB
24.	Exemption from Section 3D(2) Insurance Act 1938 (Act IV of 1938) to permit the Company to obtain insurance for the Project from companies outside Bangladesh.	MOC/CI
25.	Special Order for the term of the Power Purchase Agreement exempting the Company from the application of Section 30 of the Electricity Act, 1910 (Act IX of 1910), so as to permit the Company to use electricity within the Facility for auxiliaries (other than supply of electricity to the residential area of Facility).	MPEMR/OEACIE/BERC
26.	Special sanction for the term of the Power Purchase Agreement under Section 34 of the Electricity Act, 1910 (Act IX of 1910) permitting the connection of the Facility to the earth by the Company.	MPEMR/OEACEI/BERC
27	No Objection Certificate to build an exhaust stack and bypass stack at the site as part of the plant.	Civil Aviation Authority of Bangladesh
PART 2: GOVERNMENT AUTHORIZATIONS REQUIRED AFTER FINANCIAL CLOSING		
1.	Approval of installations for boilers at the Facility under Sections 6 and 7 of the Boilers Act, 1923 (Act V of 1923).	Department of Explosives/ Chief Inspector of Factories and Establishments (CIFE)
2.	"Certificate of Registration" of Facility under Factories Act, 1965 (Act IV of 1965).	CIFE
3.	License under the Petroleum Act, 1974 (Act LXIX of 1974) for storage of petroleum products at or proximate to the Facility.	Department of Explosives
4.	License for the Company to obtain and have arms for the purposes of the security of the Facility.	MOHA
5.	Permission for transporting chemicals, toxic wastes and hazardous materials on land and water routes.	DOE/Department of Explosives
6.	Government Authorization to commission, start up and operate the Facility based on the implementation of measures identified in the Environmental Impact Assessment ("Environmental Clearance Certificate").	DOE
7.	Approval of the Facility as satisfying the fire safety and protection standards under the Fire Service Ordinance, 1959 (Ord. No. XVII of 1959) and Civil Defence Act 1952 (Act. XXXI of 1952).	Department of Fire Service & Civil Defence

Appendix G: Challenges to Renewable Energy Projects Identified in Recent Literature and Workshops/Assessments

LITERATURE/WORKSHOP/ ASSESSMENTS	CHALLENGES IDENTIFIED
MPEMR. (2019) Bid Document on "Assessment of Barriers to Implement Renewable Energy (RE) Projects and Standardize RE" submitted to Power Cell, Ministry of Power, Energy and Mineral Resources (MPEMR).	• Land availability one of the single most limiting factors for development of renewable energy projects in Bangladesh • Procurement and leasing of land for development is a complex task and approval processes are also lengthy • Increased site development costs, including erosion protection measures, have shown to increase project costs and site preparation timelines • Most of the available land is not situated near existing grid networks and new projects require the construction of long transmission lines • Project developers are faced with no guidance on acceptable tariffs when they approach the government with proposals • Developers require over 40 permits and approvals from different organizations before starting construction of their projects
SREDA. (2015) Scaling Up Renewable Energy in Low Income Countries (SREP): Investment Plan for Bangladesh Sustainable & Renewable Energy Development Authority.	• High development and financing costs: high land prices, lack of renewable energy project financing, high interest rates for short term loans • Lack of incentives, lack of government direction on tariffs • Lack of reliable data and experts on renewable energy
IDCOL. (2018b) "Sunnyside Up: Scaling Up Solar Photovoltaic in Bangladesh," Bangladesh Clean Energy Summit, Infrastructure Development Company Limited.	• Investors are cautious due to limited experience with renewables, and have a perception that renewables carry higher risks • Government does not allow the use of agricultural land for renewable energy projects • Lack of policy incentives • Lack of data (lack of reliable data on resource availability or assessment)
Rahman, M.T. (2019) UNDP supports Climate Mitigation through Renewable Energy: Present Status & Roadmap of Bangladesh.	• Scarcity of suitable land • High land procurement and development costs • Lack of cooperation and coordination between government agencies • Lack of resource data required for project feasibility studies • No clear policy or guideline for purchasing electricity from mini-grids during grid expansion
USAID. (2019) National Renewable Energy Laboratory (NREL) workshop called "Wind Energy Procurement: Best Practices, Considerations and Tools"	• Lack of available sites • Lack of institutional knowledge in Bangladesh of wind power development • High tariff proposals put forward by developers • Lack of data on transmission networks and possible tie in points • Insufficient preparation time for project proposals • Lack of information on legal and regulatory frameworks • Lack of information on existing incentives/taxation

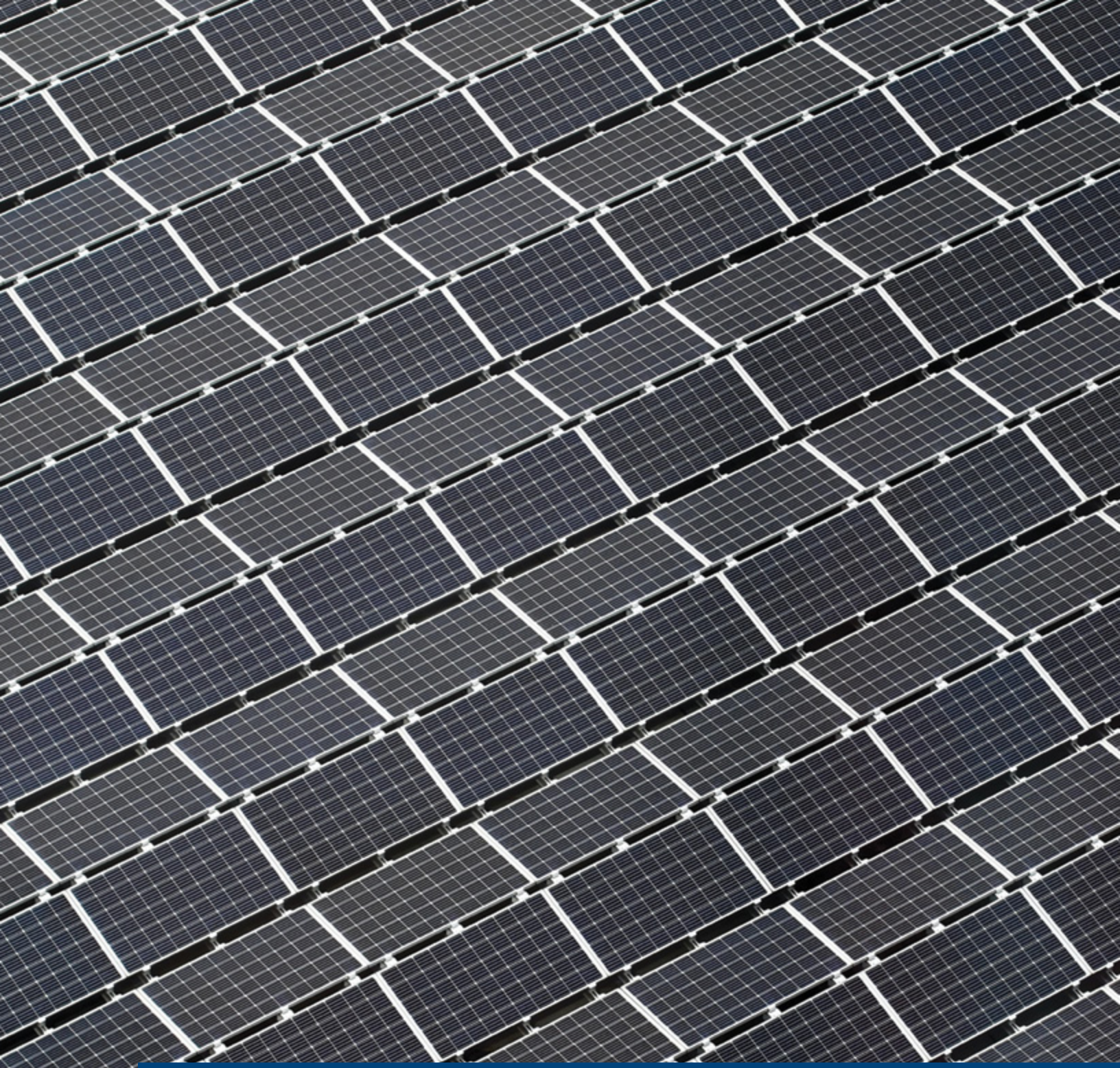
LITERATURE/WORKSHOP/ ASSESSMENTS	CHALLENGES IDENTIFIED
USAID. (2020) Bangladesh Clean Energy Sector Assessment.	• Land availability and lack of zoning or demarcation of land for wind power • Complex and difficult grid connection process • Limited application of existing policies • Lack of clear guidelines for renewable energy development • Lack of planning for implementation of renewable energy projects • Lack of quality data availability or resource assessments • Fossil fuels subsidy • Absence of a standardized PPA and other transaction documents • Sourcing of low-cost financing • Lack of flexibility for investors due to a stringent exit policy
USAID SURE, Assessment of ongoing wind IPP procurements.	• Non-availability of sizable parcels of land, weak land acquisition regulations and tough terrain for siting and transportation • Non- availability of site-specific wind resource data • Inadequate time allowed for submitting bids; developers need at least six months to conduct due-diligence (for land acquisition, etc.) and secure finance • An expensive $250,000 bid bond requirement • Burden on project developer for transmission line development • Absence of a clear procurement and development procedure • Limited knowledge and capacity of local firms in the wind energy sector

Appendix H: Technical Assistance Programs by Donor Organizations

DONOR	PROGRAM/ SUPPORT	DESCRIPTION
World Bank	Bangladesh Scaling-up Renewable Energy Project	The project is designed to contribute to increasing power generation capacity from renewable energy, specifically from solar PV and wind power; to mobilize financing for renewable energy projects; and to improve capacity for renewable energy development in Bangladesh. The project aims to add 300 MW of solar and wind power capacity to improve access to clean energy in Bangladesh. There are three components of this project: • Supports a first-of-its-kind 50 MW pilot phase of a renewable energy park developed by the Electricity Generation Company of Bangladesh; • Establishes a dedicated Renewable Energy Financing Facility, hosted and managed by IDCOL, to provide financing to private sector projects and public-private partnership projects, including joint ventures; and • Supports technical assistance and capacity-building activities to improve the enabling environment to scale up renewable energy and supports development of a project pipeline, in particular for private sector participation by SREDA.
World Bank	Country support	International Development Association investments in gas power generation, strengthening and optimization of power dispatch, strengthening and expansion of transmission and distribution, and rural access to renewable energy. Existing World Bank technical assistance includes analysis of options to increase power generation and integration of renewables.
USAID/NREL	Wind Resource Assessment	Under this program, the NREL has been providing technical assistance to support the Government of Bangladesh's goal of promoting wind development to stimulate private sector investment and rural economic development, and to meet growing energy demand through domestic energy resources. NREL already completed a study assessing Bangladesh's wind energy resource potential, which the Government of Bangladesh has used to transition into the second phase of renewable power planning: engaging private sector interest and investment. Document available at: https://www.nrel.gov/docs/fy18osti/71077.pdf A renewable energy data explorer has also been developed, and wind data for selected sites in Bangladesh can be downloaded from: https://www.re-explorer.org/bangladesh-data.html

DONOR	PROGRAM/ SUPPORT	DESCRIPTION
UNDP	Development of Sustainable Renewable Energy Power Generation (SREPGen) program	The objective of the project is to reduce the annual growth rate of GHG emissions from fossil fuel-based power generation by exploiting Bangladesh's renewable energy resources for electricity generation. The basic approach of the project will be to promote renewable energy in Bangladesh through the recently established SREDA. For Bangladesh to achieve a greater share of RE in its energy mix, the project will support activities that will: • transform SREDA into a strong RE project facilitation center to bring confidence to private RE investors and increase the number of approved RE projects; • increase the capacities of appropriate government agencies to generate, process, obtain and disseminate reliable RE resource information for use by potential project developers and investors; • increase the affordability of photo-voltaic solar lanterns for low-income households by supporting pilot solar lantern diffusion activities; and • increase the share of RE in Bangladesh's power mix by facilitating the financing, implementation and operation of pilot (RE) energy projects using rice husk and solar panels. The lessons learned from the pilot plants will be utilized to scale up the dissemination of PVSLs and investment in on-grid RE projects and RE technologies. The Development of Sustainable Renewable Energy Power Generation (SREPGen) Project has four major components: *Component 1*: Policy support and capacity building to bring confidence to private RE investors; and to increase the number of approved RE projects *Component 2*: Resource Assessment Support Program to increase capacities of relevant government agencies to generate, process, obtain and disseminate reliable RE resource information *Component 3*: To support diffusion of affordable PV power and other RE technology solutions for low-income households and associated livelihood enhancements *Component 4*: Renewable energy investment scale-up to support an increased share of Bangladesh's power generation mix
Asian Development Bank (ADB)	Technical Assistance	The ADB currently supports preliminary assessment studies of potential sites for renewable energy development in conjunction with the Power Cell (government agency). Feasibility studies and new business models for wind and solar parks include: • Site selection and resource assessment study for wind and solar parks, • Feasibility studies and new business models for wind parks, and • Feasibility studies and new business models for solar parks. Other technical assistant projects by ADB include: • Transmission planning, project preparatory study for the PGCB, and • Grid reliability study for integration of renewable energy into the national grid.

DONOR	PROGRAM/ SUPPORT	DESCRIPTION
The German Federal Ministry for Economic Cooperation and Development (BMZ), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Renewable Energy and Energy Efficiency Program (REEEP)	The program is run in conjunction with SREDA. The aims of the program are: • Developing framework conditions for the promotion of renewable energy and energy efficiency through policy advocacy and institutional development; • Developing locally customized technological solutions on sustainable energy delivery and establishing business cases through successful piloting; and • Facilitating market uptake of successful business models through capacity development of service providers, promoting access to finance and leveraging sustainable ownership.



SCALING UP RENEWABLE ENERGY (SURE)

USAID
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