

# RENEWABLE AND SUSTAINABLE ENERGY TECHNOLOGIES FOR THE LAST MILE CONNECTIVITY

## BANGLADESH'S PERSPECTIVES

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### Abstract

Energy is the key ingredient to alleviate poverty and to improve the socio-economic development and uplift human life style. The vision of the Government of Bangladesh (GOB) is to make electricity available for all by 2021. In order to fulfill the vision, the GOB has prepared short-, medium-, and long-term power generation plans using gas, coal, dual fuel, nuclear and renewable energy (RE) resources. RE will play a vital role in meeting the demand of electricity in future especially in the off-grid areas of the country. Realizing this fact, the government has set a target to generate 5% of the total electricity from RE resources by 2015 and 10% by 2020. To achieve this goal, electricity generation from renewable sources should be 800 MW by the year 2015 and 2,000 MW by the year 2020. To remove the barriers and to extend incentives, revision of Renewable Policy is under process. In order to achieve the target, the government has taken up different RE development programs.

### Introduction

Bangladesh is a country of 147,570 sq. km. with a population of 153 million. The country has shown tremendous growth in recent years. Bangladesh has attained an average GDP growth rate of 6%. A booming economic growth, rapid urbanization and increased industrialization and development have increased the country's demand for electricity. It is recognized that energy is a key ingredient to alleviate poverty and improve the socio-economic development and uplift human life style. Realizing this important fact, the Government of Bangladesh (GOB) has set a vision to make electricity available for all by the year 2021, the Golden Jubilee Year of Independence of Bangladesh.

Bangladesh had been suffering from a mismatch between supply and demand of electricity before 2009. To overcome electricity crisis, the ruling government has given top most priority to power sector.

Recognizing the importance of electricity, the GOB has diversified the fuel mix for power generation. In order to fulfill the vision and commitment of the government, immediate-, short-, medium-, and long-term power generation plan using natural gas, coal, liquid fuel, dual fuel, nuclear and renewable energy (RE) resources has been prepared. GOB has been implementing power projects under both public and private sectors.

### Present electricity situation

Because of the relentless efforts of the government, commendable achievement has been made in the power sector in the recent past. The government has been able to reduce the gap between supply and demand of electricity. Currently, 68% of the population has come under electricity coverage which was 47% before 2009 and the per capita generation has been raised to 348 kWh from 220 kWh. The Table 1 shows the present electricity situation of the country.

**Table 1: Present electricity situation in Bangladesh**

Item	January 2015
No. of power plants	92
Power generation capacity	11,265 MW
Transmission line	9,536 circuit km
Grid sub-station	23,000 MVA
Distribution line	3.03 million km
Access to electricity	68%
Per capita power generation	348 kWh
Number of consumers	10.62 million
Average system loss	14.13%

### Future planning

In order to reach the target of 2021, the government has prepared power generation master plan (PSMP 2010). Under the generation expansion plan, the government has diversified the fuel mix. Under this electricity generation program, additional 16,645 MW of electricity generation capacity will be added between 2015 and 2021.

The PSMP 2010 (which is presently under revision) sets the desired goals (Table 2):

**Table 2: Goals set by the Power Generation Master Plan (PSMP 2010)**

Year	MW
2016	16,000
2021	24,000
2030	40,000

### Emphasis on RE

Considering the country's future energy security, the government has given due importance on RE. To expedite the process of integration of the RE technology in the country, the government has approved the Renewable Energy Policy in 2008 which became effective since January 2009. The objectives of the policy are to harness the potential of RE resources and disseminate it to the people and enable, encourage, and facilitate both public and private sector investments. In this policy, government has set a target to generate 5% of the total electricity from RE resources by 2015 and 10% by 2020. To achieve this goal, electricity generation from renewable sources should be 800 MW by the year 2015 and 2000 MW by the year 2020. To remove the barriers and to extend incentives, revision of renewable policy is under process.

### Acts, rules, policies, and guidelines for the development of RE

Apart from approving the Renewable Energy Policy, some acts, policies, and regulations have been formulated to support the promotion of RE in Bangladesh. The following acts, rules, policies, and guidelines have been enacted or are under different stages of preparation:

- Electricity Act 1910; New Electricity Act 2015 under process of approval: Due importance has been given on RE.
- National Energy Policy (Revised – Draft Final): RE resources has been identified as one of the important and sustainable fuels.
- Sustainable and Renewable Energy Development Authority (SREDA) Act 2012 has been enacted to create a nodal agency to promote, develop and co-ordinate RE, energy efficiency and energy conservation programs.
- Private Sector Power Generation Policy of Bangladesh to attract private investment.
- Renewable Energy Policy 2008 (Revised – Draft Final): declaration of fiscal incentives and other benefits for RE projects.

- Emergency Energy and Power Supply Special Act, 2010: to expedite implementation and support unsolicited potential projects.
- Renewable Energy Rule (Draft) under SREDA Act: to formulate rules in details under the act.
- 500 MW Solar Program.
- Solar Program Implementation Guidelines.

### Institutional framework for RE development (creation of SREDA)

The SREDA Act has been enacted in December 2012. The objectives of SREDA is to promote, develop, and co-ordinate RE and energy efficiency programs in the country. SREDA will prepare short-, medium-, and long-term plans to meet the targets set by the government through policy. SREDA will monitor all RE programs and activities implemented by the public as well as private entities. SREDA will innovate new financing and incentive mechanism for RE projects. RE rules have already been drafted under SREDA Act. Separate RE directorates have also been set up under Bangladesh Power Development Board and Bangladesh Rural Electrification Board (BREB) to carry forward research and development of RE technologies and to implement RE projects.

### RE resources of Bangladesh

The prospect of RE in Bangladesh has a bright prospect. However, in the present scenario RE will remain as a supplement to conventional energy situation. RE will still play an important role to reach the consumers who are outside the national grid or where grid connection will be delayed. Major sources of RE in Bangladesh are as follows:

- solar energy;
- mini and micro hydro;
- wind energy; and
- biomass.

### Solar energy

Bangladesh has bright prospect for consumer-based solar projects. However, Bangladesh is a land constraint country

and cannot afford many large solar power projects. About 1 hectare (2.47 acres) of land is required for 1 MW (DC) solar power. Several RE projects are in operation mostly in consumers' base as well as community base. However, some grid tied projects are also under process of implementation.

### Mini hydro & micro hydro project

Bangladesh is a flat terrain stretching from north extremity to south of the sea (Bay of Bengal) except some hilly area in Chittagong hill tracts. Hence, the gradient is not significant to offer prospect of hydro-electricity except Chittagong hill tracts. Only one hydropower plant (230 MW) exists in Kaptai in this area. Some small plants can be envisaged in this area only.

### Wind energy

Bangladesh has a long coastal region. Data from earlier measurements and analysis of upper air data show that wind energy resource of Bangladesh is <7 m/s. At present, several wind resource assessment programs are ongoing in the country. Small wind turbines can be installed in the coastal regions of the country. Several organizations have installed low capacity wind turbines in the coastal region of Bangladesh. However, progress in the wind energy sector of Bangladesh is not impressive.

### Biomass

Energy from biomass has prospect in the rural as well as urban areas. Apart from cow dung, other biomasses such as wood, forest residue, municipal solid waste, poultry litter, and cow dung are the popular wastes to be used as source of biomass energy. Institute of Fuel Research and Development of the Bangladesh Council for Scientific and Industrial Research (BCSIR) is carrying out different pilot projects in biomass since 1973.

Different government organizations such as Local Government and Engineering Department (LGED), Department of Public Health Engineering, Department of Livestock Services, Bangladesh Agricultural Extension Department, and NGOs are also working in this field. A project under LGED is in progress for installation of 10,000 biogas plants, of which 2,000 biogas plants are community based.

## Achievement in RE sector

Commendable achievement has been made in the RE sector in the last few years. At present about 404 MW is being generated from RE sources. Solar Home System (SHS) is a success story of Bangladesh. It has been hugely popular in the rural areas of Bangladesh especially in the off-grid regions of Bangladesh. Table 3 shows the achievement made so far in the RE sector of Bangladesh.

**Table 3: RE sector achievements in Bangladesh**

Methods	Capacity (MW)
Installation of SHS (3.5 million)	150
Installation of roof-top PV s at government/semi-government offices	3.00
Installation of roof-top PVs in commercial buildings and shopping malls	1.00
Installation of PVs by the consumer during new electricity connections	11.00
Installation of wind-based power plants	2.00
Installation of biomass-based power plants	1.00
Installation of biogas-based power plants	5.00
Installation of solar irrigation (93 numbers)	1.00
Hydro	230.00
<b>Total (MW)</b>	<b>404.00</b>

## RE development program

### Power generation targets from RE

In line with the government's Renewable Energy Policy targets, the government has a plan to develop at least 800 MW power from RE by 2015 as stated earlier.

**Table 4: Expected RE generation in Bangladesh**

Resources	Capacity (MW)
Solar	500
Wind	200
Others	100
<b>Total</b>	<b>800</b>

Expected generation from RE under public and private sector initiatives is presented in Table 4.

### 500 MW Solar Program

To materialize the RE target, GOB has taken the "500 MW Solar Program". Considering project financing, implementation approach and modus operandi projects are categorized into two types: commercial projects and social sector projects. Commercial projects will be implemented by the private sector, whereas social projects will be implemented by the different ministries and agencies as a part of social responsibilities of the government. Commercial projects are (a) solar park (grid connected), (b) solar irrigation, (c) solar mini-grid/micro-grid, (d) solar rooftop; and social projects are (a) rural health centers, (b) remote educational institutes, (c) Union e-Centers, (d) remote religious establishments, (e) off-grid railway stations, (f) government and semi-government offices in the off-grid areas. Share of commercial and social projects is given in Table 5:

**Table 5: Share of commercial and social solar power projects in Bangladesh**

Types of projects	Capacity (MW)
Commercial solar power projects	340
Social sector solar power projects	160
<b>Total (MW)</b>	<b>500</b>

### Wind resources mapping programs

Bangladesh has potential of wind energy, mainly in the coastal areas and offshore islands. Government has a plan to generate electricity from wind power under public and private initiatives. However, private investors will not feel encouraged without reliable and complete wind resources data (bankable wind data). For that reason, wind resource mapping project has been taken up by the government.

### SHS program

Infrastructure Development Co. Ltd. (IDCOL) promotes and disseminates SHS

program in remote rural areas through its solar energy program with the financial support from the World Bank, Global Environment Facility, KfW, GIZ, Asian Development Bank, and Islamic Development Bank. IDCOL started the program in January 2003 and till February 2015 it could successfully finance almost 3.6 million SHSs with a capacity of ~150 MW. They are installing about 80,000 SHSs per month through their partner organizations (POs). SHSs are popular among the off-grid area people where grid electricity expansion is expensive. IDCOL aims to finance 6 million SHSs by the end of 2016. Apart from IDCOL, BREB is also operating SHS program with the help of Palli Bidyut Samity (PBS). BREB started this program since 1996 and so far they have supported 15,250 SHSs of 0.9 MWp installed capacity.

### Solar roof-top program in government/semi-government office

To meet the increasing demand of electricity, government and semi-government offices have also started to install roof-top solar system to meet their light and fan loads. So far they have installed roof-top solar of 3 MW capacities while installing another 1 MW system.

### Solar PV installation by the new consumers

To promote renewable energy, power division has issued an executive order in 2010 addressing the new consumers to set up roof-top solar system on voluntary basis at specific percentage of total sanction load. Through this executive order and by the co-operation of the new consumers, almost 11 MW solar systems have been installed by the 24,050 consumers.

### Solar irrigation

Bangladesh is predominantly an agrarian country having 14.76 million hectares of total land of which 7.56 million hectares are irrigable land. Plenty of water is needed for irrigation in Boro (dry) season (January–April). Country's agricultural sector has long tradition of being dependent on rain water for irrigation. However, mechanized irrigation took ground during early 70s with a view to increase agricul-

tural productivity. According to the survey conducted by the Bangladesh Agricultural Development Corporation (BADC) about 1.42 million diesel operated irrigation pumps require about 1 million MT imported diesel per year. On the other hand electricity demands for 0.33 million electric operated irrigation pumps are about 1700 MW. Considering the energy crisis of the country and increasing price of petroleum products across the world, it is important to explore alternative energy sources for irrigation to ensure food and energy security as well as climate change mitigation. In this context the application of solar irrigation pump has tremendous potential.

Solar powered irrigation system is an innovative, economic, and environment friendly solution for the agro-based economy of Bangladesh. This system mainly consists of solar panels and solar power operated pump. Primarily diesel operated shallow and low lift pumps preferably used in triple crop areas were targeted to get replaced by the solar irrigation pumps. Program has been taken by the government to replace 18,700 diesel-based irrigation pumps by solar irrigation pumps. The project will be implemented by IDCOL. IDCOL will select private entities (called PO) to implement the program. IDCOL will provide grant and concessionary loan and necessary technical and promotional support to the POs for successful implementation of the program. Under this program, about 150 MW of electricity will be generated.

### Solar mini grid

Providing access to electricity to remote villages always lie as a challenge because either grid expansion is not possible there or would be very expensive. Government has prepared a guideline for Remote Area Power Supply System to facilitate electricity access to unprivileged areas. A commercial model has been identified under the guideline to implement the mini grid project through private sector. Each project will be implemented under distributed utility concept integrating solar-based generation and distribution management. However, government will

provide necessary fiscal and financial support. Initially 30 remote Upazillas have been identified for solar mini grid where grid expansion is not planned for next 5–20 years. Total solar power capacity addition from this component will be 25 MW. IDCOL will provide grant and concessionary loan and necessary technical and promotional support to the POs for successful implementation of the program.

### Solar social sector projects

As part of “500 MW Solar Program” social projects will be implemented by the different ministries and agencies as a part of social responsibilities of the government. Social projects are as follows:

- *Solar electrification in health centers:* It is estimated that there are 18,000 rural community clinics in remote villages. Many health units do not have either dependable supply or even electricity access. Electricity is required for operation of health units, surgery, and preservation of vaccinations and medicines.
- *Solar electrification in remote educational institutes:* Government plans to introduce multimedia classroom facility in each school as a part of modernization of education system. However, many remote schools do not have either dependable supply or even electricity access. This project aims to provide solar power systems to selected remote government and non-governmental educational institutions.
- *Solar electrification at union e-centers:* Government has taken a remarkable initiative by setting up about 4,501 information centers at union level to ensure access to information to all citizens of Bangladesh even to a remote villager. Because many of the unions do not have reliable electricity during daytime, it would be sensible to install solar PV systems at the union information centers so that the remote villagers do not suffer for electricity outage. Nearly 1013 e-centers already have solar PV system.

- *Installation of SHS in religious establishments:* Most of the religious establishments such as mosques, temples, and pagodas are operated through government and public support. Those establishments have occasional electricity usage pattern throughout the day depending on prayer times. Many establishments are even in remote areas where there is no grid electricity. Solar electrification of those religious establishments would not only reduce pressure on grid electricity but would also ensure fulfillment of government’s social commitment.
- *Solar electrification at remote railway stations:* Bangladesh railway has so far 450 railway stations. Many stations are at remote locations. Those railway stations do not have either electricity access or reliable supply. Solar PV with battery back-up supply will ensure reliable electricity access to those railway stations.

### Conclusion

The government has taken all efforts to overcome problems in the power sector. It is firmly believed that Bangladesh will be able to meet electricity demand in a sustainable way. Government is pledge bound to provide electricity to all by the year 2021. Bangladesh would like to move forward with the same pace and spirit for the generation of green energy to safe environment. However, still now clean energy is not cost effective. By and large, action-oriented national commitment from all stakeholders, regulatory bodies, and support from the development partners are the key to the success for achieving the government-declared vision of “Electricity for all by 2021”. However, even with the best effort of the government, total area of Bangladesh cannot be brought under national electricity grid connectivity. Approximately 10% of the remote areas of Bangladesh will remain out of national grid. For the last mile connectivity of these areas, Bangladesh will have to depend on RE technology. ■