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Problems and Progress towards Sustainable Power

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Executive Summary

Bangladesh is now one of the fastest growing economies in South Asia among five other nations. Over the past years, Bangladesh's economy is growing at an annual rate of around 7%, which is better than the growth rate of many other Asian economies as well as the world. The Vision of the Government of Bangladesh is focusing to achieve the status of a developing country by 2021 and achieve the status of developed country after 2041. It is obvious that electricity plays a vital role in poverty eradication, sustainable economic growth, infrastructure development, industrial boom and security of any country. Thus, Bangladesh will need to mention the impediments to higher growth posed by fewer access to reliable and affordable power, limited availability of serviced land, rapid urbanization, vulnerability to climate change and natural disasters, etc., to achieve its socioeconomic growth targets.

The performance of Bangladesh's power sector in the last five years has been impressive due to the progressive efforts of policymakers, support from developing partners, and effective project implementation by public and private developers. Land and resource is limited, still progress in power sector is remarkable. Number of power station is increased from 27 in 2009 to 138 in 2020 with installed capacity increases from 4,942 MW to 23,548 MW. Per capita electricity generation is also increased from 220 to 512 over this period. Almost 97% of total population have accessed to electricity which was less than half back in 2009. Growth in terms of capacity addition in the last 10 years has been remarkable, from around 4.5 GW in 2007–08 to 12.8 GW in 2016–17. Private sector participation in generation accounts for about 60% of the total installed capacity.

However, further actions need to be taken to match the demand-supply gap of electricity in a sustainable way and thus match the pace of the economic growth of the country. Massive capacity enhancement and expansion projects of the power sector are being undertaken. It has been planned to increase the installed capacity to 24 GW by 2021, and about 8,000 km of new transmission lines and 1,20,000 km of distribution lines have also been planned to be constructed by 2020. More aggressive is required to fulfill the gap between generation capacity and transmission facility.

Despite of serious efforts at all levels to reduce reliance on fossil fuels by promoting renewable energy as its alternative, fossil fuels continue to contribute 73.5% to the worldwide electricity production in 2017. Conversely, renewable sources contributed only 26.5%. In accordance with the recent Power System Master Plan, Bangladesh aims to add 2 GW renewable energy (RE) projects to achieve installed capacity of 2,470 MW by 2021, and 3,864 MW by 2041. Solar and wind will be the key focus areas for future capacity addition, which shall account for about 50% and 40% of the 2,896 MW of RE-based installed capacity by 2021, respectively. Mine mouth coal based power plant will be good choice of energy mix remembering all other factors.

Given the shift in generation mix and advancement in technological interventions that the Bangladesh power sector is witnessing, significant skill upgrade and capacity building of the workforce are required to enable successful transformation. The interventions need to be planned, designed and implemented by factoring in process, technology, information requirements, organization structure, people capabilities, and customer requirements.

This white paper provides our views on the megatrends in the global power sector and how they will impact Bangladesh in its power sector transformation journey. It is important for stakeholders (the government, regulators, utilities, investors and development partners) to assess their strategy and implement the changes they need to make in time or, even better, ahead of time.

The research report provides suggested actions for Bangladesh on thematic areas such as government and regulations, financing and investments, RE, and technology in which disruptions are impacting the country's power sector.

Chapter 01

Introduction

1.1 Background of the Study

Electricity plays a great role wherever people lives and works in industry, agriculture, and transportation etc. The living standard and prosperity of a nation vary directly with increase in use of power. As technology is advancing the consumption of power is steadily rising. Sufficient and reliable source of electricity is a major prerequisite for a sustained and successful economic development effort and poverty reduction.

Modern technology has led to the use of huge amounts of electricity in the present era. It would not be wrong by any means to say that the usage of electricity has become inevitable in every walk of our lives. The time has come when the existing power system requires expansion, improved technology, better security and restructuring to accommodate the ever increasing demand. With the advent of the smart grid, a lot of these concerns will be addressed.

Technology is changing day by day. Generation capacity is increasing all over the world. More people is coming in the light of electricity in this decade. Question is now arising whether energy security will be ensured in the coming days. As more people continues to glow, more concern about affordability of electricity is creeping. To ensure energy security reliable uninterrupted supply of electricity with affordable price and easy access to all is to be insured first.

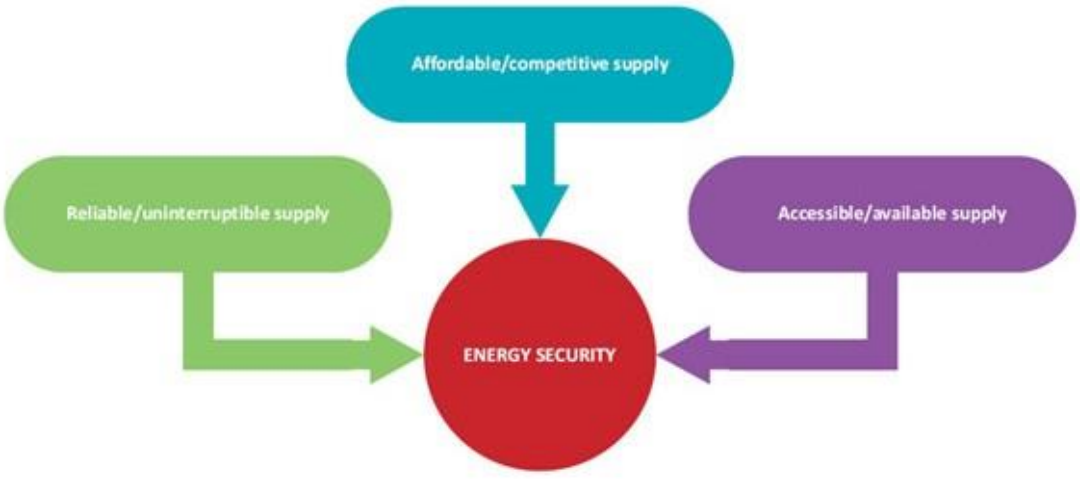


Fig 1.1: Key to achieve sustainable power with energy security

Bangladesh is a small developing country with a huge potential but with limited natural resource. It is facing daunting energy challenges that are merely likely to deteriorate industrialization. Increase of availability and accessibility of quality electricity at an affordable price is a key precondition for the socio-economic development of a country.

Electrification of the capital city Dhaka began in 1901, only 19 years after New York and 13 years after London, by the then Nawab Khwaja Ahsanullah. Later, an Electricity Directorate was established in East Pakistan in 1948. There were few Steam Turbines in Siddhirganj (maximum size 10MW), Chittagong and Khulna area at that time. In 1962, 40 MW Kaptai hydro-electric project was installed a 132kV transmission line between Dhaka and Chittagong was commissioned. In 1971, after the independence of Bangladesh only 3% of the population had access to electricity. It has been increased to 59.6% in 2012 and 97% in 2020. However, 79 % percent of the connected consumers suffer from load-shedding, and 60% of the consumers face low voltage supply. Problems in Bangladesh's electric power sector include high system losses, delays in completion of new plants, low plant efficiency, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance. [Source: Sustainable Energy for All (SE4ALL) database from World Bank, World Bank].

Now in Bangladesh, electricity is the most widely used form of energy. So, future economic growth significantly depends on the availability of electricity. Bangladesh Government should ensure affordable and environmentally friendly source of electrical energy for the people. However, since its independence from Pakistan in 1971, the country has struggled to generate adequate electricity to meet the demand. The state-owned electricity utilities suffer from large energy shortages. Moreover, due to poor pricing policies and other bottlenecks, the energy sector has also failed to attract adequate private investments in power business. This shortage of investment is a contributing factor toward energy crisis. The government of Bangladesh set vision to be a middle income country by 2030 and developed country by 2041. To reach the vision, it must emphasize on power sector. A calculation also made that the capacity of power generation should be as 1.5 times of its GDP growth [1]. As GDP growth of Bangladesh is around 7% in last decade, electricity growth rate is said to be around 10% each year. Government took Power system master plan PSMP-2016 which determines the forecasted maximum electricity demand and generation plan up to 2041. Now in this country generation is surplus. Still there is some technical and general problems in electricity service like low voltage, fluctuation of frequency, harmonics. Generally consumers receive power

from distribution end. So to ensure sustainable quality service it should ensure quality in every organ (generation, transmission and distribution) of power sector. Moreover, pricing of electricity is a major concern. Big challenge to achieve sustainability is the huge amount of capital investment. Raising fund from both public and private entities is a major concern. Efficient choice of primary fuel with minimal impact on environment will ensure energy security in the long run.

1.2 Problem Statement

Bangladesh is a country of 147,570 sqkm with a population of over 163 million [2]. The country has shown tremendous growth in recent years, and has attained an average gross domestic product growth rate of 7-8 per cent [3]. Booming economic growth, rapid urbanization, and expanding industrialization and development have increased the country's demand for electricity. It is recognized that energy is the prime ingredient to improve the socioeconomic condition of the people of Bangladesh. The vision of Government is to make electricity available for all by 2021 [3]. To keep pace with the blustering economic growth and elevate access to electricity, government has taken many projects in the last decade. Mega projects are on the way to come in the national grid. Nuclear power is knocking at the door. Generation of electricity is adequate at this moment but transmission and distribution networks are lacking behind. So far, grid in not stable which will be a big challenge to operate larger plants like nuclear power plant.

The country's sustainable development activities are focused around UN Sustainable Development Goals (SDG). It also provides a Policy Matrix showing major goals and actions that need to be taken. The policy of the government was to develop its potentially large natural gas resources however it is already ascertain that natural gas in this region will not ensure sustainability in energy sector for long.

Because of geographical position, Bangladesh is very much susceptible to climate change. Land scarcity is also a concern. Policy makers have to consider these circumstances in order to choose efficient fuel mix. So cross border power trade will be effective in this area. However it will be interesting to see how regional organizations will act in the upcoming days. There is a huge scope of coal mine in this country but existing policy and technology do not permit to harness this coal efficiently. Measure is needed in this aspect as well as policy

amendment. Investment in power sector is very much return oriented. This is why this sector is very much dependable on loans from various organizations. Government had taken some small and medium scale visions in 2009 and latterly new goals were set up for 2041 to achieve energy security and sustainable power. One of the main challenges to meet up this goal is ensuring continuous supply of primary energy along with investment in power sector.

Energy efficiency and energy saving policies also play vital roles in the way of energy sustainability. 'Energy Efficiency and Conservation master plan up to 2030' implemented by SREDA, has some targets regarding power generation, transmission and conservation of electricity in the utility ends. Taking into account the country's future energy security, it is a question how Government will give due consideration to renewable energy along with other primary resources. In this study, different challenges regarding attaining energy security and sustainability are thoroughly identified along with progress and future steps to ensure sustainable energy to all.

1.3 Research Objectives

1. To determine the main problems towards sustainable power.
2. To determine the challenges of achieving sustainable power and how power sector has improved over the last decade.
3. To analyze how Bangladesh in moving to achieve power security using limited resources.

1.4 Research Questions

1. What are the main problems towards sustainable power?
2. What are the main challenges of achieving sustainable power?
3. What percentage Bangladesh has improved in power sector over the last decade?
4. Is existing power system master plan adequate enough for energy security?
5. Which primary resource government should focus to ensure energy security?
6. Does renewable energy become one of the key components of achieving sustainable power?

1.5 Methodology

Our analysis in this thesis is very much narrative in nature. We try to explore the present scenario of Bangladesh regarding the topic. For the purpose of the study, data have been collected mainly from secondary sources. As primary sources, we planned to take interview of experts regarding sustainable power of Bangladesh. But, due to COVID-19 pandemic we did not have the opportunity at that moment. So, we have taken opinion of some graduate professionals of DESCO in virtual medium regarding this matter. Still, we have to depend heavily on secondary data sources. For secondary sources, some data are collected from different reliable websites of power division, SREDA, BPDB PSMP-2016 and other power related websites. PSMP-2016, Energy Efficiency and Conservation Master Plan 2030, Renewable Energy Policy-2008, Power Division Annual Report 2018-19 are thoroughly studied. We have analyzed the secondary data and compared with primary data for developing the thesis.

1.6 Significance of this Study

To keep pace with the booming economic growth, reduce energy deficit, dependency, import, dominance of single fuel and increase the use of renewable energy using limited, minimal energy resources, justified policy making is a must. By identifying the main limitations like shortage of primary energy, impact of natural calamities, uneconomical fuel mix etc. should be minimized immediately to secure sustainable energy. The scarcity of resources can become so critical that in some cases a path contrary to that of sustainable development is followed in some other countries around the globe. But it must be kept in focus that Bangladesh must not derail from current energy policy to assure sustainable power for constant GDP growth. Policy makers should understand the implications of the development path they are pursuing. Capacity building of government agencies therefore is essential in charting a sustainable energy development path.

1.7 Limitations

The main limitation of this report is that it has been prepared in short span of time. Moreover, when this report is prepared the world has been deadlocked by COVID-19 pandemic. Although our country is starting to move on, still safety is the first concern. So, we did not

move to different places in that period. As a result, it was not possible to reach many key informant personnel to collect primary data. Therefore, this paper is mostly based on secondary data.

1.8 Delimitations

Even though this paper is prepared with a very limited scope, it creates some window for further study on other aspect of power scenario in our country. This study tries to focus on the problems and measures taken to achieve energy sustainability. Detail study can be done on sub-regional power trade in South-East Asia. Proper identification of prospect of Renewable Energy in this region should be future concern. This study provides the opportunity for uttermost study regarding primary fuel mix in the context of Bangladesh in future.

Chapter 02

Literature Review

2.1 Present Electricity Situation in Bangladesh

In the power sector, the total electricity consumption is 62,037 MkWh in 2019. Electricity used to feed-up electricity demand in the industrial, residential, agriculture, small general service and others. In this year, the electricity growth is 12% and maximum electricity generation is 12,893 MW. As on August, 2020, installed capacity is 23,548 MW including renewable and captive power [4]. Renewable energy is the key to reduce fossil fuel which caused increasingly of CO_2 emissions. According to government projection, the installed capacity of renewable energy technologies in 2036 will be 19,634 MW [5].

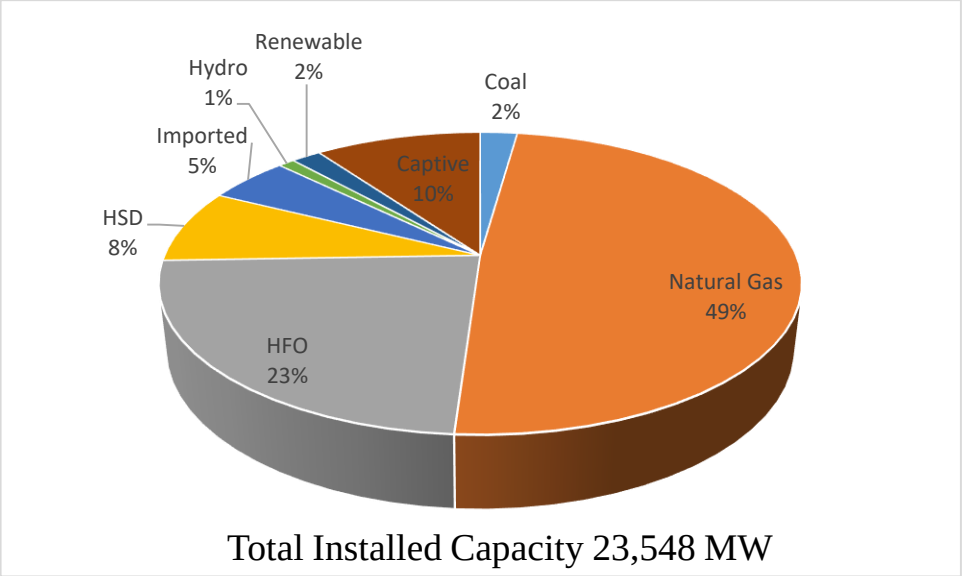


Figure 2.1: Fraction of Energy Sources Used on August, 2020

2.2 Power System Master Plan-2016

The Power System Master Plan (PSMP)-2016 is assembled by Japan International Cooperation Agency (JICA). PSMP-2016 aims at supporting Bangladesh in formulating an extensive energy and power development plan. It inclines to the plan of Bangladesh to become a developed country by 2041. PSMP-2016 covers energy balance, power balance, and tariff strategies. The development of energy and power infrastructure therefore pursues not only the quantity but also the quality to realize the long term economic development.

PSMP-2016 aims to create a well-balanced power generation environment that maximizes the respective advantages of different types of power generation methods, including nuclear power, thermal power, hydropower generation, and power imports from neighboring countries, from the comprehensive perspective of stable supply, or energy security, environmental performance, and economic efficiency. According to PSMP-2016 by 2021 installed power generation capacity will in 24,000MW, by 2030 generation capacity will reach 40,000MW and by 2041 it will go up further to 60,000MW [6]. Domestic renewable energy power generation (cumulative): 2,470MW (by 2021), and 3,864MW (by 2041). Cross border Energy Import will be 3,500~8,500 MW (by 2031) and 9,000 MW (by 2041). Nuclear power will be 7,000 MW (by 2041). Massive infrastructure development will be needed for coal mining, storing, transporting and handling.

Table 2.1: Projection of Primary Energy Supply

Primary Energy Sources		**2014**	**2041**		**Annual growth rate ('14-'41)**
	ktoe	**(share)**	**ktoe**	**(share)**	**(share)**
Natural gas	20,726	(56%)	**50,149**	**(38%)**	**3.3% p.a.**
Oil (Crude oil＋ refined products)	6,263	(17%)	**32,153**	**(25%)**	**6.2% p.a.**
Coal	1,361	(4%)	**26,273**	**(20%)**	**12.7% p.a.**
Nuclear power	-	-	**11,942**	**(9%)**	**-**
Hydro, solar, wind power and others	36	(0%)	**197**	**(0%)**	**6.5% p.a.**
Biofuel and waste	8,449	(23%)	**4,086**	**(3%)**	**-2.7% p.a.**
Power (import)	377	(1%)	**6,027**	**(5%)**	**10.8% p.a.**
Total	**36,888**	**(100%)**	**130,827**	**(100%)**	**4.8% p.a.**

2.3 Energy Security

Energy security has become a vital issue in the energy domain which refers to the availability of sufficient energy supplies at affordable prices and emphasizes on the supply side of the energy domain. At present, Bangladesh government is depending on natural gas for electricity generation which will be in short of reservation in near future. So proper preparation and planning for fuel diversification is needed for ensuring availability of sustainable energy. As Bangladesh is abundant of coal, Bangladesh can rely significantly on coal as a part of fuel diversification and ensure energy security. Coal is cheaper and efficient fuel and Bangladesh has high quality of fuel which contains less sulphur, hence large-scale coal-based power plants can be set up. Bangladesh has approximately 3 billion tons of underutilized coal resources [7]. The government aims to produce energy- 35% by coal, 35% by natural gas,

10% by renewables, 11% by cross-border electricity trading and 6% through nuclear power. Bangladesh is also looking forward to replacing fossil fuel and non-renewable energy with the renewables to meet its local energy demand. Solar energy is regarded as the most efficient and sustainable source of energy which has absolutely no effect on environmental degradation. [Source: Banglapedia-National Encyclopedia of Bangladesh]

2.4 Sustainable Development Goals (SDG)

The Sustainable Development Goals are the blueprint to secure a better and more sustainable future for all. Sustainable Development Goals address challenges this world is facing, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. There are 17 goals in SDG which are all interconnected, and in order to leave no one behind, it is important that we achieve them all by 2030 [8]. Electricity plays a vital role to uphold the standard of living. To ensure sustainable development affordable and clean energy for all is a must. Goal 7 of the SDGs aims to correct this enormous imbalance by ensuring everyone has access to affordable, reliable, and modern energy services by the year 2030. To expand energy access, it is crucial to enhance energy efficiency and to invest in renewable energy.

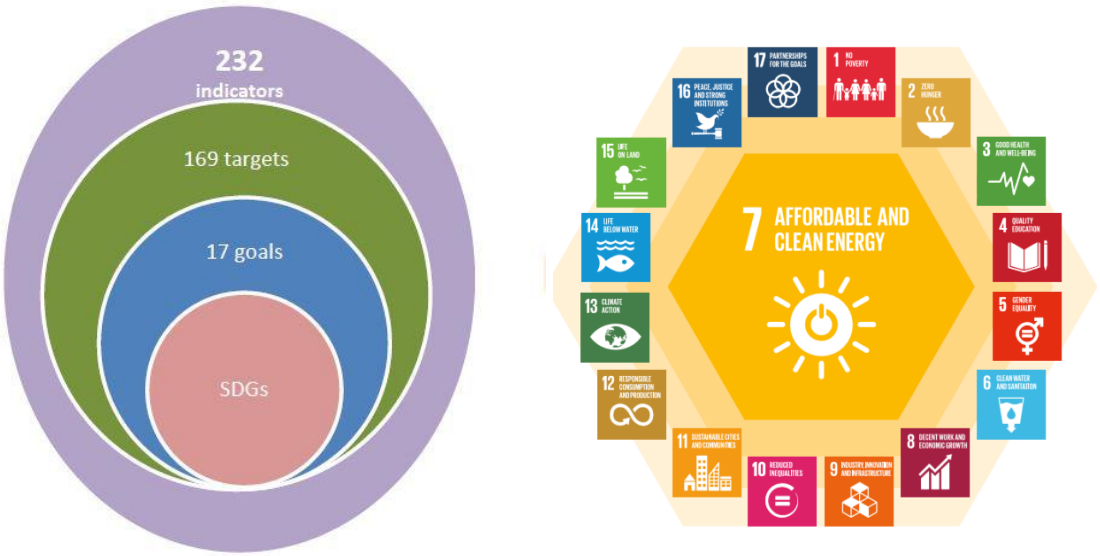


Figure 2.2: United Nations Sustainable Development Goals

2.5 Sustainable and Renewable Energy

Sustainable energy is termed as energy using in a way that meets the necessity of today's world without compromising the future generation. Renewable energy is a good example of sustainable energy which is environment friendly and get replaced by new growth naturally. It is obtained from natural resources, such as sunlight, wind, water, tides, geothermal heat, biomass etc. which are not likely to run out. It is also called 'green energy' as it can generate electricity having less effect on environment. Based on REN21's 2020 report, renewable energy contributed 27.3% to electricity generation. Of this electricity production, 15.9% comes from hydropower, 5.9% from wind power, 2.8% from solar PV, 2.2% bio-power, 0.4% geothermal, CSP and ocean power. According to IRENA, 2020, total installed capacity (renewable energy sources) is 2,360 GW. The world has invested 3 trillion USD in renewables in past 10 years. In 2030, this investment will be more of 10.3 trillion USD. According to the Renewable Energy Policy 2020, 10% of the total electricity generated by 2020, i.e. 2000 MW will have to be generated from renewable energy sources [9].

2.6 Renewable Energy Policy of Bangladesh-2008

The Renewable Energy Policy issued by the Government of the People's Republic of Bangladesh, defines the necessity for the country to develop renewable energy technology. Indeed, in Bangladesh efficient utilization of renewable energy resources is yet to assume commercial dimensions and hence rational policy dissemination on renewable energy usage is essential. Renewable energy includes solar, wind, biomass, hydro, geo-thermal, tidal wave.

The objectives of renewable energy policy are to harness the potential of renewable energy resources and dissemination of renewable energy technologies in rural, peri-urban and urban areas, to enable, encourage and facilitate both public and private sector investment in renewable energy projects and to develop sustainable energy supplies to substitute indigenous non-renewable energy supplies.

Besides, this policy focuses to promote appropriate, efficient and environment friendly use of renewable energy and to create enabling environment and legal support to encourage the use of renewable energy. The most notable goal of this policy program is to achieve the targets for developing renewable energy resources to meet five percent of the total power demand by 2015 and ten percent by 2020.

2.7 Sustainable Energy Programs in Developing Countries

World has now understand the consequences of fossil fuel over our climate. So, most of the developed countries have changed their energy policies towards renewable programs to secure sustainable energy. Although, current technology does not permit cost minimization of renewable energy, but future is very promising. Most developing countries relay greatly on fossil based energy mix power generation policies. However, developing countries have abundant renewable energy resources, including solar energy, wind power, geothermal energy, and biomass, as well as the ability to manufacture the relatively labor-intensive systems that harness these. By developing such energy sources developing countries can reduce their dependence on oil and natural gas, creating energy portfolios that are less vulnerable to price rises. In many circumstances, these investments can be less expensive than fossil fuel energy systems. More developing countries are implementing the public policies needed for the widespread development of renewable energy technologies and markets.

The Philippine government sees the growth of the renewable energy sector essential for national energy security. Based on a report of an Australian consulting firm, International Energy Consultants, the Philippines has the highest electricity rate in Asia, followed by Japan. Transmitting power and transporting fuel throughout the Philippine archipelago is problematic due to very high cost [10]. The Philippines could be considered a world leader in renewable energy, with its 30 percent of its power generation being powered by the renewable energy sector. It has the world's second largest generator of geothermal energy and was the first Southeast Asian nation to invest in large-scale solar and wind technologies [10]. Renewable Energy in Costa Rica accounts for over 90% of the total output of the nation's energy. The country is the world leader in renewable use with massive investment in windmill technologies [11]. In South-East Asia, countries like Thailand, India are moving to sustainable programs. India is one of the countries with large production of energy from renewable sources. As of 31 March 2020, 35.86% of India's installed electricity generation capacity is from renewable sources, generating 21.22% of total utility electricity in the country [12]. Even countries like Nepal, Bhutan has huge programs for hydropower plants [13]. So it is evident that Renewable Energy sector is the future for power generation throughout the nations. According to IRENA 2018, nearly 85 percent of global energy generation is projected to come from renewables by 2050 [14].

Chapter 03

Analysis

We have interviewed 28 graduates from different discipline from different institutes of Bangladesh to share their views on main problems, challenges of achieving sustainable power and energy security and how Bangladesh has progressed. We use their opinion as primary data for our thesis. 53% of them think that scarcity of natural resources is the main problem. 75% of them think that the main challenges of achieving sustainable power is the proper implementation of policy with adequate funding. 71% of them believe that Bangladesh has improved in power sector over the last decade. 83% people address that Bangladesh is advancing towards right direction with existing PSMP-2016. Finally, 78% people express that Renewable Energy with energy efficiency will be the Key to achieve energy security.

We are almost there to achieve 100% electricity for the people of Bangladesh with the motto "শেখ হাসিনার উদ্যোগ, ঘরে ঘরে বিদ্যুৎ". All the departments of the power sector of Bangladesh: Generation, Transmission, Distribution and Cell unit have been performing well according the task to achieve the desired target. And thus, the power sector of Bangladesh has become one of the most reliable departments. The government took several initiatives such as instant, short, medium and long-term plan to meet the increasing demand of electricity. Performance of electricity sector has been increased significantly due to constant monitoring and evaluation. In order to achieve the government's vision 2021, there are plans to generate 24,000 MW by 2021, 40,000 MW by 2030 and 60,000 MW by 2041 [15] electricity.

Table 3.1: Installed capacity and maximum generation from FY 2014-15 to 2018-19.

Fiscal Year	**Installed Capacity, MW**	**Maximum Generation, MW**
2014-15	11534	7817
2015-16	12365	9036
2016-17	13555	9479
2017-18	15953	10958
2018-19	18079	11623
2019-20	23548 (Including Captive & Renewable)	12893

3.1 Progress of PSMP-2016 in 2020

'Power System Master Plan 2016 (PSMP)' has been prepared based on the availability of primary fuel supply for mitigating the growing demand of electricity and to provide the electricity for all by 2021 [6].

Table 3.2: Future projection according to PSMP

SL	Description	2020 (June)	2021 (PSMP2010)	2030 (PSMP2010)	2041 (PSMP2016)
1.	Installed Capacity (MW)	23548	24000	40000	60000
2.	Electricity Demand (MW)	13500-14000	19000	33000	52000
3.	Transmission Line (Ckt. KM)	12293	12000	27300	34850
4.	Substation Capacity (MVA)	47304	46450	120000	261000
5.	Distribution Line (KM)	582000	515000	526000	530000
6.	Per Capita Power Generation (kWh)	512	700	815	1475
7.	Access to Electricity (%)	97%	100%	100%	100%

The pace of advancement exercises in different divisions of Bangladesh was altogether influenced due to lack of access to electricity, weak infrastructure, and mismanagement of energy resources. For example, the population's access to electricity was only 50.0 percent and more than 80.0 percent of the power in Bangladesh was created by natural gas until 2009.

Having understood the significance of the power sector, the present Government began reforming the energy sector since 2009 to guarantee an efficient energy sector for future economic stability. For instance, the legislature reinforced the fuel diversification process, permitted the privately owned oil-fired Quick Rental (QR) power generators increased the allocation of energy share for the mega projects in the national budget and Annual Development Program (ADP) fund.

The result of every one of these endeavors can be noticeable now through the landmarks accomplishments in the energy sector. For instance, installed generation capacity has increased from 5,272 Megawatt (MW) in 2009 to 23,548 MW in August 2020, and nearly 97.0 percent of the population is now under the electricity coverage.

However, Bangladesh's exhibition in improving the portion of off-grid power generation by expediting exploitation of renewable energy sources is still unsatisfactory. More than 90.0 percent of the power is produced primarily from fossil fuels: natural gas and imported oil. Up

until now, just 628 MW of power (3.0 percent of the total generation capacity) has been produced from renewable sources, which is far less than the real objective of producing 10.0 percent.

A sum of 1,221 MW power from the sustainable sources are either under development or in the planning process. For sustainable energy, the government has adopted measures to solar panels on the rooftops of every educational institution in the country. Besides, electricity has been provided to the people living in off-grid areas by installing 58 lakh solar home systems. The overcapacity rate in 2020 is found to be well above the targeted reserve capacity of 25.0 per cent, as mentioned in the Power Sector Master Plan (PSMP) 2016.

Still power division has achieved remarkable success in the last fifteen years. Few notable remarkable achievements in the FY 2019-20 are as follows [16]

1. Under the leadership of honorable Prime Minister, great achievements have been made in the field of electricity. Number of Electricity consumers has increased from 3 crore 43 lakh to 3 crore 73 lakh in the FY 2019-20 which results in increase of 30 lakh consumers in the mentioned fiscal year.
2. Electricity privileged group of people has increased from 94% to 97% in the FY 2019-20 which results in 3% increase in the mentioned fiscal year.
3. After decreasing of 0.62% system loss in distribution, it reached 8.73% from 9.35% in the FY 2019-20.
4. Per capita energy generation has reached 512 kWh in the FY 2019-20 which was 510 kWh previously.
5. Distribution line of 45000 km and 633 circuit kilometer is built in the FY 2019-20.
6. 1773 MW electricity is added to the National grid in the FY 2019-20.

3.2 Distribution of Power in Bangladesh

Although the current state is promising on providing 100% people with electricity, quality of power from generation to consumer end is not ensured. So still we cannot say the total power system of this country is sustainable. There is scarcity and lack of diversity of fuel for power generation. Conventional power plants are not environment friendly. Transmission lines are overloaded along with grid sub-stations. It is tough to upgrade electric lines. Length of the distribution line is very long in some cases mainly in rural areas. Therefore, voltage regulation is poor with frequency fluctuation and harmonics problem in supply voltage. Moreover, mass

area become out of electricity in case any failure occurs in the distribution system. Frequent interruption of supply for long duration of time although there is no generation shortage. In recent years it is very common that power interruption happens mainly due to distribution system failure.

According to PGCB total length of transmission line of power is 12,282 ckt km up to June 2020. Total substation capacity upto June 2020 is 45,276 MVA. There is one back to back 2×500MW HVDC substation for importing power from India [17].

Table 3.3: Transmission and Grid Substation present status

Transmission Line		Grid Substation	
400 kV	861 ckt km	400 kV	1 Nos. 2x500MW HVDC Back to Back station
230 kV	3,658 ckt km	400/230kV	3 Nos. 3120 MVA 1 Nos. 650 MVA (Others)
132 kV	7,763 ckt km	400/132 kV	2 Nos. 1,300 MVA
		230/132kV	22 Nos. 12,075 MVA 6 Nos. 1910 MVA (Others)
		132/33kV	114 Nos. 22,055 MVA 31 Nos. 4,166 MVA (Others)

There is no 765 kV transmission line in Bangladesh. To transmit the upcoming massive amount of power with reducing transmission loss 765 kV transmission line is vital. Moreover, the national grid is interconnected. So a sudden shutdown of bulk power may cause blackout in the country. This happened in 1th November 2014 when a sudden knockout of 445 MW imported power caused whole country into blackout for almost 10 hrs [18].

According to Power Division, total length of distribution line is 5 lakh 82 thousands km to supply electricity to almost 3.79 corer consumers. Access to electricity is now 97% [4]. To increase accessibility of electricity to 100% population, upgradation of distribution line is a must equipped with modern technology.

3.3 Frequency Fluctuation Control

Fluctuation of frequency is quite common in the power system of Bangladesh which hampers reliability. As large scale power plants are coming fluctuation of frequency control is a dire need. For instance, Bangladesh grid system to accommodate the Rooppur Nuclear Power

Plant, the upper limit of normal operation frequency of the grid must be changed to 50.5 Hz to meet the requirements of the WWER-1200 nuclear plant units. This contrasts with the existing Bangladesh Electricity Grid Code that specifies a normal frequency fluctuation range of 49.0 to 51.0 Hz (i.e. 50 Hz ±2%). It is now noted that this limit should be modified with proper equipment. Free Governor Mode of Operation (FGMO) can be a great option in present set-up available in Bangladesh. It is not usual internationally to control power system frequency exclusively through the use of governor droop actions (FGMO). However, there is an urgent need to improve Bangladesh power system frequency and FGMO is only readily available technology that, associated with NLDC developed tool, will enable significant improvements in frequency control.

3.4 Investment and Funding in Power Sector

Investment in power sector is very much return oriented. In the past investment was mainly loan from different organization which had increased generation cost ultimately. In 2009, Government planned some small and medium scale projects and then planned for long term vision of 2041 for sustainable power. According to power system master plan projected installed capacity will be 40GW in 2030 and 60GW in 2041, transmission line will be 27,300 ckt km in 2030 and 34850 ckt km in 2041, grid substation capacity will be 1,20,000 MVA in 2030 and 2,61,000 MVA in 2041 . Mega projects have been taken which requires bulk amount of money and time. So, huge amount of capital investment will be needed in coming years. It will be an uphill challenge to arrange funding in time for these mega projects. Because of load facility shortage Government has changed strategic plans for funding in power sector. Private sector, Joint Venture and Innovative financing are encouraged in recent years. Involvement in small scale power generation from private sector is very much hopeful. Still huge funding is essential for large scale projects and power plants like coal based power plants. In that case Joint Venture and Export Credit Agency Financing seem to be effective in that case.

From 2008-09 to 2018-19 total investment in power generation, transmission and distribution system was almost 19 billion US Dollar from which 11.5 billion was from Government and 7.5 billion from private sector. In 2018-19 total allocation in annual development program in power sector was 24,836.42 core taka. With respect to this investment total expenditure was 23,145.11 core taka i.e. 93.19% of total allocation. More funding is needed to ensure sustainability in power sector. In the meantime, 4.5 billion US Dollar investment is assured for Matarbari 1,200MW coal based power plants. Beside this, financing in Rampal 1,320MW and Payra 1,320MW coal based power plant is also assured [19]. Sector wise net energy generation in FY2018-19 (up to January 2019) is shown in the following figures [20]

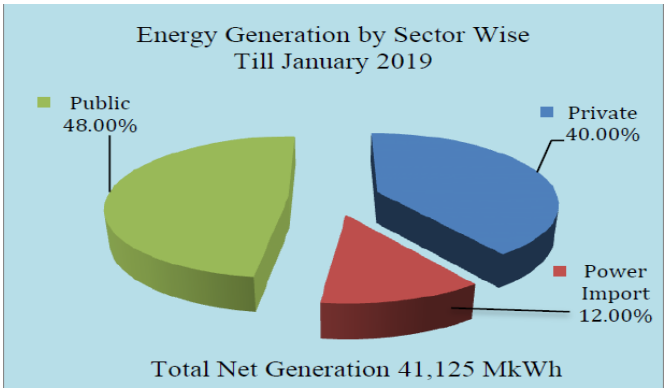


Figure 3.1: **Energy generation (National) by Sectorwise**

3.5 Primary Fuel

In 2009 number of Power Generation Station in Bangladesh was only 27 with installed capacity of 4,492 MW. Now according to BPDB number of Generation Station is 138 in July 2020 with total installed capacity of 23,548 MW [4]. Access to electricity is increased from 47% to 97%. Per capita power generation is also increased significantly from 220 KWh in 2009 to 512 KWh in 2020 [4]. Bangladesh does not have naturally abundant of natural resources in its belt. Natural gas and coal are the main primary sources found in this country as a primary fuel of electricity. However, main choice of primary fuel in Bangladesh is Natural Gas traditionally. Bangladesh had a good amount of Natural Gas in reserve which was once thought to be inexhaustible. Therefore policy makers always considered natural gas as prime source of power generation.

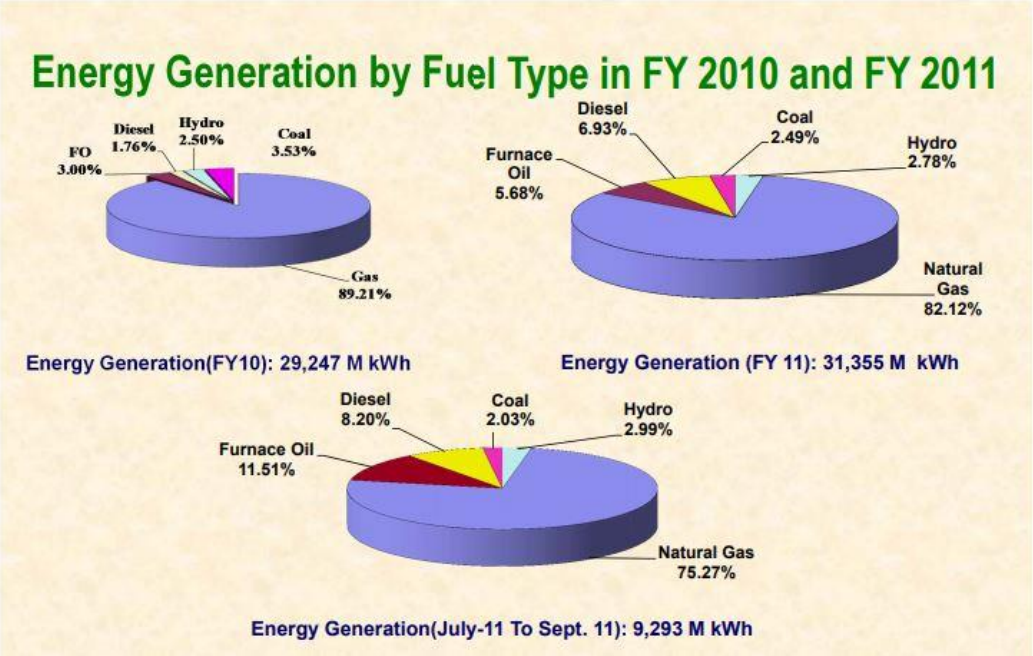


Figure 3.2: Energy Generation by Fuel Types

In 1993, the initial estimated recoverable gas reserve was around 12.43 TCF. The amount became around 26.84 TCF by 2011 and finally grew to 27.12 TCF at the end of 2017. From this amount, around 15.22 TCF gas has already been used up. So, the remaining 12 TCF gas can be used for future use. It is projected that the country would be able to fulfill the growing demand of natural gas for the next 10–12 years with the remaining gas reserve [21]. So it is obvious that too much dependency on natural gas as primary fuel of power generation has a huge risk involved for sustainable power and energy security. Still in 2019 half of the power is generated from natural gas. However, context of fuel mix have changed in recent years. According to National Database of Renewable Energy fuel mix in 2019 is as follows: [22]

Fuel/Resource	Installed Capacity	Share
Coal	524 MW	2.36 %
Gas	10678 MW	48.07 %
HFO	5208 MW	23.45 %
HSD	1795 MW	8.08 %
Imported	1160 MW	5.22 %
Renewable	648.02 MW	2.92 %
Captive	2200 MW	9.9 %
Total	**22213 MW**	

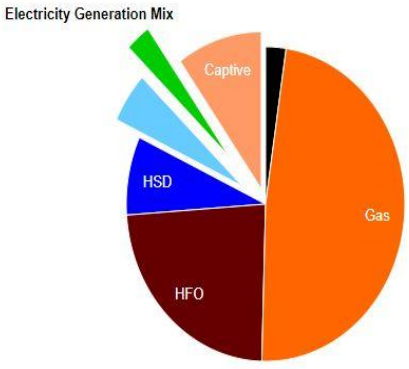


Figure 3.3: Fuel Mix in 2019

In 2019 share of gas producing electricity have come down to 48.07%. On the other hand diesel and furnace oil share of producing electricity was 1.76% and 3.00% respectively.

Economy has boomed rapidly in the last decade in this country. To fulfill the dire electricity demand many quick rental power plants were established in that period. Many of them were inefficient in term of pricing of primary fuel. Government is now addressing this issue and now is starting to stop renewal of those HFO/HSD based inefficient rental power plants. Still in 2019, HFO and HSD share in primary mix of fuel was 23.45% and 8.08% respectively. Price of unit production of electricity is very high using HFO and HSD according to Bangladesh Energy Regulatory Commission. Per unit cost of electricity generation by HFO and HSD is about 13.62 taka and 27.21 taka respectively which is very high compare to gas, coal, and hydro. Per unit production of electricity using gas is 2.73 taka only but gas is about to extinct in near future. Hydro power generation cost is 1.37 taka only but Bangladesh has only 230 MW of hydropower plant in Kaptai. Bangladesh does not have the luxury of further hydro project because of geographical location. Renewable energy is the future but cost is still high (11.66 taka/per unit) in current technology.

Table 3.4: Per Unit Cost of Electricity Generation (Net) in 2019

Description	Energy	Per Unit Fuel Cost	Per Unit Fixed Cost	Per Unit Variable O& M	Per Unit Cost of Electricity
	(MKwh)	Taka/ KWh	Taka/ KWh	Taka/Kwh	Taka/Kwh
Gas	46389	0.78	1.80	0.15	2.73
HFO	11426	9.55	3.74	0.33	13.62
HSD	2022	14.92	11.92	0.37	27.21
Coal	1230	4.23	3.21	0.20	7.75
Hydro	725		1.23	0.14	1.37
Import	6786			5.76	5.76
Renewable	38			11.66	11.66
Total:	68616	2.63	2.26	0.75	5.64

3.6 Opportunity of Coal in Bangladesh:

In 2019, 524MW power was produced from coal in a share of 2.76% of total fuel mix. According to PSMP-2016 many coal based power plant will be installed. Total 3.2 billion ton of coal reserves in 5 mines of Bangladesh. Government planned to import high quality coal from Indonesia, Australia, and South Africa. Bangladesh has at least 29 coal power projects with a total capacity of more than 33 gigawatts in the pipeline, with some already under construction. If all the proposed power plants get built, the nation's coal power capacity would increase by 63 times [23]. As Bangladesh is abundant of coal, Bangladesh can rely significantly on coal as a part of fuel diversification and ensure energy security. Coal is

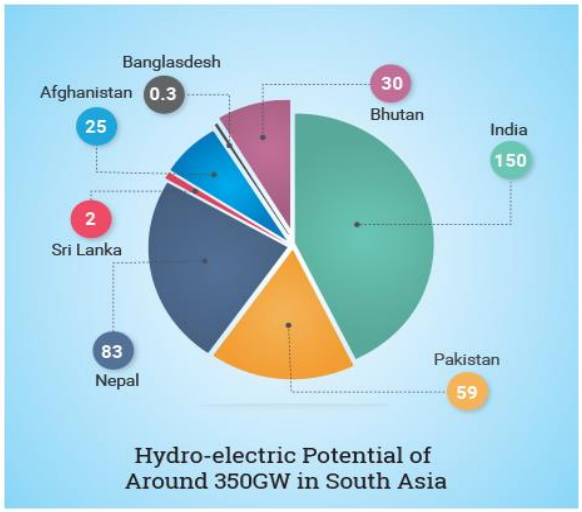
cheaper and efficient fuel and Bangladesh has high quality of fuel which contains less sulphur, hence large-scale coal-based power plants can be set up. Bangladesh has approximately 3 billion tons of underutilized coal resources [7].

Till now, five major coal-field has discovered in Bangladesh- Jamalganj, Jaypurhat (1962), Barapukuria, Dinajpur (1985), Khalashpir, Rangpur (1989), Dighipara, Dinajpur (1995) and Phulbari, Dinajpur (1998) which have coal reservation of 1053 million ton, 303 million ton, 147 million ton, 200 million ton and 380 million ton respectively. At present, only Barapukuria coal mine commercially produces coal, about 1500 ton per day. The only coal-based power plant (250MW) in the country is in operation near Barapukuria coal mine, Barapukuria Coal Power Plant (525 MW capacity; Units 1 & 2: 125 MW, Unit 3: 275 MW). Several coal based power plants are proposed- Rampal Power Station, Bagerhat (1320 MW), Payra Power Plant, Patuakhali (1320 MW), Matarbari power station, Cox's Bazar (1200 MW), Mirsarai power station, Chittagong (300 MW), Mawa power station, Munshiganj (660 MW) and others. [Source: Banglapedia-National Encyclopedia of Bangladesh] Government has revealed its willingness to make appropriate use of the vast supply of indigenous coal through the Rampal power project. The government has undertaken 13 mega coal-based power projects in cooperation with China, Japan, India, Malaysia, South Korea and Singapore. The government aims to produce energy- 35% by coal by 2041. Bangladesh has a huge prospect in coal. If harnessed properly existing 5 coal mine will produce 35 GW of electricity which will run for next 30 years. However, present policy is not supporting to produce coal from these coal mine. So new policy should be implemented properly to ensure energy security from coal.

3.7 Cross Border Power Trade

The South Asia region is endowed with limited fossil fuels but ample hydro resources. Electricity generation largely depends on available domestic resources. Limited oil and gas resources have led to growing import dependency. Nepal and Bhutan are dependent on Himalayan-fed hydro resources. Bangladesh, the Maldives, and Sri Lanka are largely dependent on fossil fuels. Bhutan and Nepal are almost completely dependent upon hydroelectricity to meet their requirements. It is observed that excessive dependence on one energy resource (due to energy endowments in different countries) raises concerns related to energy security. According to CBET Hydropower potential in South Asia is around 350GW

[24]. Given the significant potential of hydro-electricity generation potential in South Asia it is expected that this would play a major role in any future strategy for regional power sector cooperation.



In South Asia, the existing Cross-Border Electricity Trade between Bangladesh and its neighbors mainly India, Bhutan and Nepal, provides a foundation for furthering this cooperation at the regional level. The existing electricity trade agreements are bilateral in nature. Bangladesh is only importing power from India. As of June 2020, Bangladesh imports 1160 MW of electricity from India. The first cross-boundary electricity import initiative began in 2013 when 500 MW electricity was imported from Baharampur, India [25]. The second line linking the power grid at Suryamaninagar in Tripura to the Comilla power grid in eastern Bangladesh imported 160 MW electricity although 200 MW can be imported by developing the necessary transferring facilities in Bangladesh side [26]. However in the context of energy mix power trade in this area is very much limited because of political issues in the neighboring countries. Policy makers should think about the possible reliable power import as it is more price competitive. More projects are needed to set up for more cross-border interconnections between Bangladesh, India, Nepal and Bhutan. Bangladesh have almost finalized importing 500MW of electricity from Karnali hydropower project through GMR Group [27]. Nepal allows electricity trade with Bangladesh, India. The government of Nepal recently gave the go-ahead to the Nepal Electricity Authority (NEA) [28]. Bangladesh can import electricity from Bhutan as well. Bhutan has huge scope of hydropower. Bangladesh have discussed about financing in Bhutan hydropower and to import 340MW of electricity through Tripura channel of India [29]. The main problem of importing power from Nepal and Bhutan is that Bangladesh does not have any border with these countries. Power must be imported through India and here the problem lies. Political and financial aspect still hampers regarding this matter. Recently Indian government have revised its cross border power trade policy [30]. So a window has opened. However significant improvement to import power from Nepal and Bhutan is not visualized. Therefore Bangladesh could lose this scope because China recently plans to invest heavily in

the Tibet basin which will cause huge need of electricity [31]. In long vision China could import power from Nepal for Tibet which eventually will affect Bangladesh Nepal power import/export policies. So Bangladesh have to proactive regarding this issue.

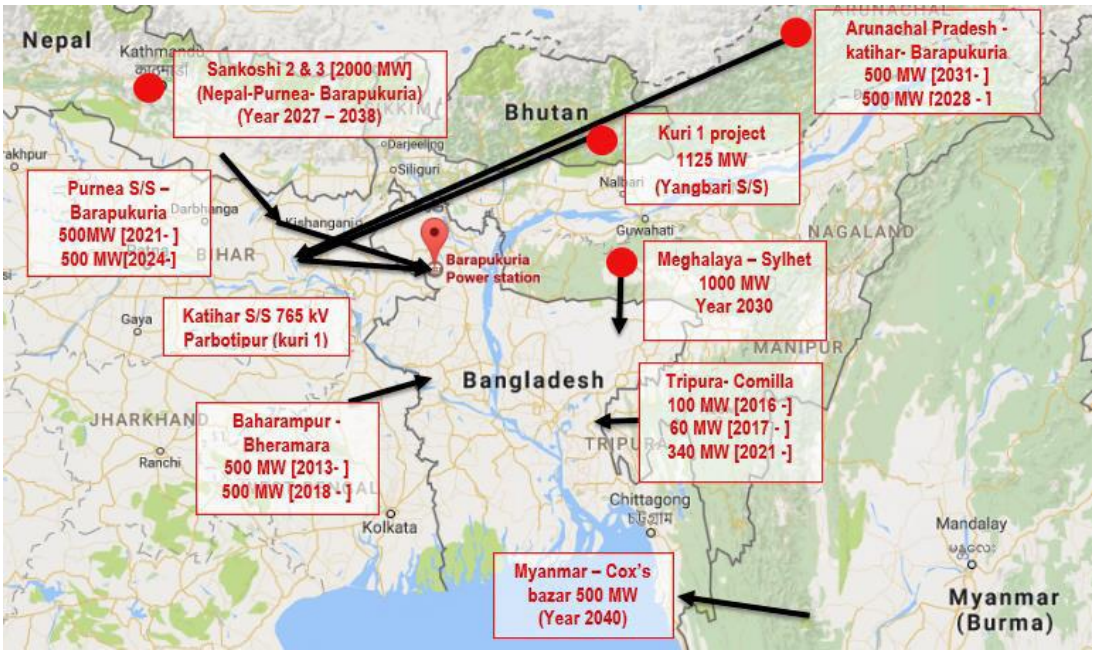


Figure 3.4: Power import and potential in the context of Bangladesh

3.8 Performance Improvement in the Power Sector

Government has taken many programs to improve the performance of the electricity transmission and distribution sectors. Historically transmission of power was mainly delegated to government bodies. Same case was for distribution sectors too. It was seen in the past that government had to subsidize heavily in almost all sections of power sector. Key reason was lack of accountability and explanation. System loss was a prior concern. It was a matter of fact that nearly half of the electricity was disappeared because of system loss. So government planned to disintegrate the power sector in different organization. Company act 1994 was implemented in power sector to disintegrate it so that accountability can be ensured. PGCB was created in 1996 for operation and maintenance of transmission lines and to enhance the grid capabilities to ascertain a stable grid. Distribution entities also divided into many sectors. Public companies have reformed. For all of these steps system loss crept down from 27.97% back in 2001 to 11.23% in 2019 [32]. System loss is one of the key performance indicators. To achieve desirable performance and viability of the sector, there is no alternative to bring down the system loss to an acceptable limit. Various measures like continuous monitoring of the performance of the utilities, reforms & target-oriented measures are

underway to reduce the system loss. The system loss (distribution) comes down to 9.35% this year as against 9.60% in previous year [32]. Government have planned to minimized system loss in single digit in the upcoming years.

Table 3.5: System Loss in power sector from 2001-02 to 2019-20

FY	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Distribution	23.92%	21.64%	20.04%	17.83%	16.53%	16.26%	15.56%
Transmission	4.05%	3.79%	3.48%	3.42%	3.44%	3.15%	3.51%
Overall	27.97%	25.69%	24.49%	22.79%	21.25%	20.25%	18.45%

2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
14.33%	13.49%	12.75%	12.26%	12.03%	11.95%	11.36%	10.95%
3.06%	3.08%	2.66%	2.96%	2.94%	2.74%	2.76%	2.63%
16.85%	15.73%	14.73%	14.61%	14.36%	14.13%	13.55%	13.10%

2016-17	2017-18	2018-19	2019-20
9.98%	9.60%	9.35%	8.73%
2.67%	2.75%	3.10%	2.91%
12.19%	11.87%	11.95%	11.23%

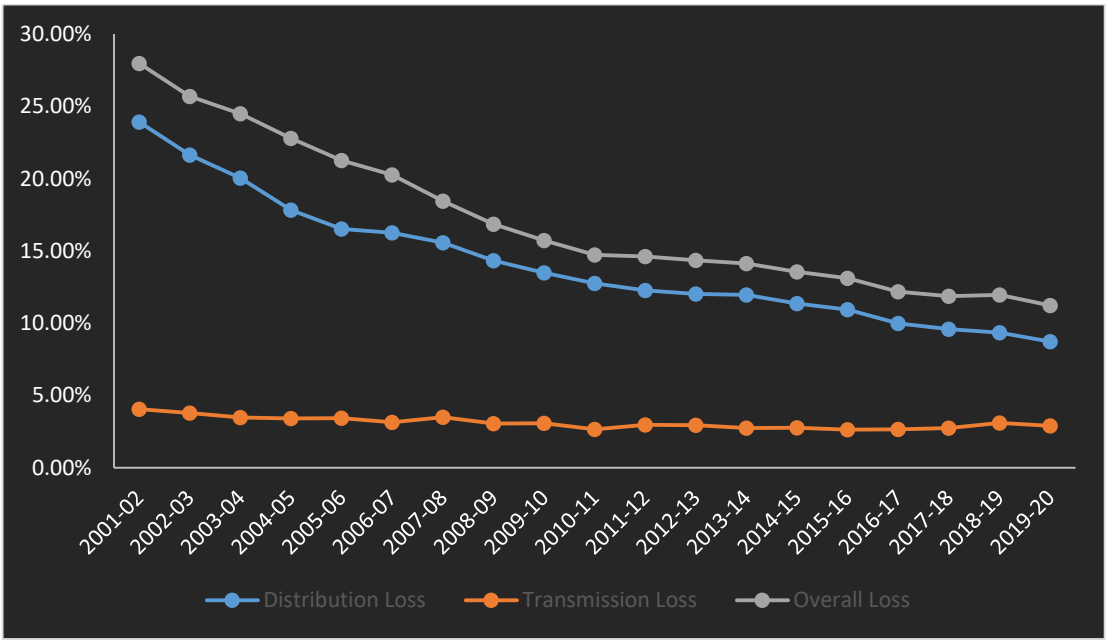


Figure 3.5: Reduction of system loss from 2001-02 to 2019-20

To improve financial viability and efficiency of the sector, the government adopts a financial action plan to maintain power sector receivable at no more than 2 months' billed amount equivalent and reduce receivables from autonomous, public entities and private customers to an acceptable limit. To improve power distribution system, 15.87 lakh prepaid meters have been installed by different entities. Till January 2019, BPDB, BREB, DPDC, DESCO,

WZPDCL and NESCO installed 8,61,99; 61,500; 3,20,580; 2,51,331; 73,299 and 18,894 numbers of prepaid meters respectively. In addition, installation of 2 crore smart-prepaid-meters is underway. Moreover, due to introduction of prepaid meters, system loss has been reduced significantly and also consumption pattern has also been changed. Power Division has set a target to bring all large and medium consumers under prepaid meter.

Use of information technology in power utilities is a must to increase the reliability and trustworthiness from consumers. For this Government has implemented ICT Road Map. To improve the customer services, organizational competency, grievance redress, accountability and NIS, information technology is being utilized. Combined ERP system in power sector has been implemented from 11th October 2018. To remove the suffering of getting new connection, online based new connection application system is adopted along with paying bills and posting any complaints. Still there is some gaps in achieving customer trustworthiness. Adaptability to modern technology is difficult in this part of the world both in customer and provider sides. Social awareness has to be extended which will be a difficult task.

3.9 Action plans of Power Division to achieve SDG Goal

UN sustainable development goals programs open the path to create a better world for all. In 2015 United Nations general assembly 17 goals are set which are intended to be achieved by the year 2030. So baseline for SDG tracker started from 2015. To achieve SDG target Bangladesh also have to fulfill goal 7 of SDG.

Goal 7.1 of SDG is ensure universal access to affordable, reliable and modern energy services by 2030. The indicator of this goal is Proportion of population with access to electricity. To achieve this goal Power Division have implemented action plans up to 2030. 7th FYP Goals/Targets related to this goal is as follows [33]:

- Government's target to ensure electricity reaches every household by FY2021.
- Power generation capacity targets of 23,000 MW by FY2020 (end of Seventh Plan); 24,000 MW by 2021; and 40,000 MW by 2030.
- Projected share of coal based power from only 3 percent (FY2015) to 21 percent by the end of the Seventh Plan and subsequently to 50 percent by FY2030.
- Expansion up gradation of 1,50,000 (km) electric distribution line
- Construction/Upgradation of 480 sub-station

- New 70,00,000 consumer connection
- 30,000 Village electrification
- 40 Switching station construction
- 40 (Set) River crossing tower construction
- Replacement of 1,90,000 Overloaded Distribution transformer
- Replacement of 75,00,000 electromechanical/digital meter by pre-paid meter
- Rehabilitation and Intensification of 25,000 (Km) Distribution System
- Establish Gas Allocation Policy (incl. LPG and Biogas Alternative policy)
- Domestic Gas Exploration Policy
- Domestic Coal Export Policy
- Develop Energy Subsidy Policy
- Promote Use of LPG in Domestic and Transport Sector
- Import LNG Strategy
- Planning for Import Coal Facilities

Mega projects are being taken and are in the consideration to ensure energy security for all. Some of the key strategic plans in 2021-2030 are Rampal 1320 MW Coal based PP [BIFPCL] in Mar 2021, Payra, Potuakhali 1320 MW Coal fired PP (2nd Phase) [BPCL (NWPGCL)] in Dec 2023, Ruppur 1200 MW Nuclear Power Plant (Unit-1) [MoST] in Dec 2025 and Ruppur 1200 MW Nuclear Power Plant (Unit-2) [MoST] in Dec 2026, Pakua 1320 MW USCPP [EGCB] in 2026 and so on. According to power division total of 17 such projects are in progress in the year between 2021 and 2030. Another big project is Maheshkhali power complex. Maheshkhali power complex is a proposal to build a cluster of coal-fired and gas-fired power plants in Maheshkhali, Chittagong, Bangladesh. BPDB plans up to 13,500 MW of coal plants in the region. In January 2014, BPDB invited expression of interest (EoI) from companies to provide consultancy services for the project with February 20, 2014 as last submission date. STEAG Energy Services (India) Pvt. Ltd. and BCL Associates Ltd. were awarded a US$2.5 million contract to undertake the master plan [34]. In August 2017 STEAG and BCL submitted their feasibility study report on the power hub to BPDB. BPDB plans up to 13,500 MW of coal plants in the region. It was reported that BPDB signed memoranda of understandings with China Huadian, a Malaysian Consortium of Tenaga Nasional Berhad, Korean KEPCO, and China SEPCO to build four coal-fired power plants of 1320 MW each at the hub [35].

Goal 7.2 of SDG is increase substantially the share of renewable energy in the global energy mix by 2030. The indicator of this goal is Renewable energy share in the total final energy consumption. In the baseline year of 2015 total percent of renewable energy in the fuel mix was 2.79%. The share of renewable energy have increased in later years. In 2016, 2017 and 2018, renewable energy share is 2.85%, 2.87% and 3.15% respectively. This value is climbed up to 3.25% in 2019. 7th FYP Goals/Targets related to this goal is as follows [33]:

- 500WM Solar Program (340MW commercial purpose and 160MW social sector)
- Commercial Projects: (a) Solar Park (grid connected); (b) Solar Irrigation; (c) Solar Minigrid/ micro-grid; and (d) Solar rooftop.
- Social projects: (a) Rural health centers; (b) Remote educational institutes; (c) Union e-Centers; (d) Remote Religious Establishment;

On-going Project/Programme to achieve 7th FYP Goals/Targets up to 2020 is as follows [33]:

1. Kaptai 7.4 MWp Solar Park, Rangamati [BPDB]
2. Sarishabari, Jamalpur 3 MW Grid Connected Solar PV Power Plant , Jamalpur (Sponsor: IFE-CPC-JEL) [BPDB IPP]
3. 1 MW Municipal Waste to Electricity Project at Keraniganj, Dhaka [BPDB]
4. Solar Home System (SHS) -90 MW
5. Solar Mini-grid 12 MW
6. Solar Irrigation-60 MW
7. Solar Roof Top System-8 MW

Many plans have taken for Actions/Projects beyond 7th FYP Period (2021- 2030). For instance Mollahat 100 MW Solar PV Power Plant & Fisheries Project Mollahat, Bagerhat will feed in Tariff for Renewable Energy generation, 10 MW Wind Power Plant, Patuakhali Solar based mini grid, Faridpur Solar Park (Grid Tied), Sirajganj Solar Park (Grid Tied), Madargonj 100MW Solar PV Power Project, Jamalpur etc [33].

Goal 7.3 of SDG is double the global rate of improvement in energy efficiency by 2030. Indicator of this goal is Energy intensity measured in terms of primary energy and GDP.

Energy Efficiency and Conservation Program and Financial Incentive Mechanism for Improved Cooking Stove are the 7th FYP Goals/Targets related to SDG Targets and Indicators. According to SREDA baseline for this goal in 2014 is 3.13 Ktoe per Billion BDT which gradually increases to 3.41 Ktoe per Billion BDT in 2018. Establishment of EE&C Testing lab, Enforcement of EE&C standardization and labeling, Development of Green Building Rating system for Bangladesh, MoU sign with Sri Lanka Sustainable Energy Authority, MoU sign with Sustainable Energy Development Authority, Malaysia etc. are the future plans in 2021-2030 to achieve this goal [33].

3.10 Energy Efficiency (EE) and Energy Conservation (EC)

Energy efficiency is the key to ensuring a reliable, affordable and sustainable energy system for the future. A rapidly growing country like Bangladesh needs a huge amount of energy to feed its large growth appetite. In order to maintain a sustainable GDP growth of above 7%, the Government of Bangladesh needs to meet the essential energy needs for the people and industries. The Sustainable & Renewable Energy Development Authority (SREDA) is working for promoting of demand-side energy efficiency and conservation in the country. In collaboration between SREDA and Power Division of Bangladesh, a master plan named "Energy Efficiency and Conservation Master Plan up to 2030" shortly EECMP was set in 2015 with some visions and proposals for implementing our targets in Energy Sector.

Energy Efficiency (EE) means producing more with less energy. The Government aims to improve primary energy consumption per GDP in 2030 by 20%, of which 15% was targeted to attain by 2021.

EECMP has some action plans containing the EE&C policies and programs frameworks. Organization structure is prepared to show practical methodology to achieve and accomplish the targets set in the EECMP. Energy Efficiency & Conservation implementation is a multi-sectorial issue and should be done by the participation of all the parties including the people, private/public sectors and other organizations in the country. Every sectors i.e. MPEMR, SREDA, Local Govts, Utility companies, Energy experts, Educational Institutions have their own roles and responsibilities to play.

Periodical monitoring and data collection of indicators on the energy consumption in various sectors are key factors of success in the EE&C implementation. All the data are maintained

by SREDA for the EE&C initiative. SREDA is mandated to analyze them and review the progress of the EECMP and subordinate programs. The EECMP should be periodically revised along with the progress of initiative in accordance with the EE&C program development. Moreover, Energy auditing, Energy Management and Energy Labelling should be effectively implemented.

The government has undertaken a number of initiatives to ensure efficient use of energy. In the meantime, the government has formulated 'Energy Efficiency and Conservation Master Plan up to 2030' as well as 'Energy Efficiency and Conservation Rules and Action Plan' to ensure energy efficiency and conservation where numbers of interventions have been identified for implementation within stipulated time. The government set a target to improve energy efficiency in the Seventh Five Year Plan (2016-2020) and also in the Master Plan for energy security and to reduce carbon emission. The target is:

- Save 15 percent primary energy per GDP by 2021
- Save 20 percent primary energy per GDP by 2030.

Recent Achievement in Energy Efficiency Improvement:

- 'Energy Efficiency and Conservation Rules 2016' has been formulated
- 'Energy Audit Regulation 2018' has been formulated
- Energy Efficiency and Conservation Promotion Financing Project' has been started to promote energy efficiency in industries as well as in residential sector through introducing energy efficient equipment, appliances and electrical gadgets at 4 percent interest loan
- Credit facilities have been created in Bangladesh Bank for environment friendly and green industries
- Provision of Energy Efficiency and Energy Conservation has been included in 'Bangladesh National Building Code
- Energy Efficiency and Conservation topics have been included in text book of school, college and madrasa
- Energy Saving School Awareness Program has been introduced
- Preparation and implementation of Country Action Plan for Clean Cook Stove
- Initiate a pilot project for waste heat recovery form the exhaust of power plant and their productive use
- Implementation of Improved Rice Parboiling System.

Chapter 04

Findings

Power sector of Bangladesh is playing a vital role in the development of our country. All the Departments of power sector: Generation, Transmission, Distributions are performing very well to achieve the desired target. Bangladesh has been able to decrease the system loss of electricity as well as increase the per capita electricity consumption and installed capacity of power generation. At present Generation is surplus compare to demand. 97% to people have access to electricity means distribution system is upgrading with generation. Main problem lies in transmission of electricity. Evacuation of electricity from all power plants is not possible yet because of transmission backbone limitation. 660 MW of electricity from Payra coal fired power plant (Unit-2) cannot be evacuated due to transmission network shortage. So, force load shedding is happening even though generation is surplus. It will be a challenge to upgrade transmission network in time using modern technology with stable frequency. Funding for implementing these projects will be a tough task.

To perform a promising task of providing electricity to 100% people, Bangladesh are facing some problems like, lack of diversity of fuel for power generation, poor voltage regulation, fluctuation in frequency etc. Using of heavy fuel oil in power plants which is responsible for environmental pollution is also a big challenge.

Policy Barriers, lack of legal, regulatory and policy framework, institutional bafflers, lack of coordinating agency, technical barriers like lack of standards and quality control, market barriers, limited knowledge on the sustainable energy market potential, high upfront cost or absence of credit faculties for entrepreneurs, lack of information about sustainable energy resources, lack of skilled manpower for resource assessment & design are the problems towards achieving sustainable power in Bangladesh. Coal from mines in Bangladesh cannot be used produce electricity properly because of environmental policies and regulations.

Bangladesh government has already taken measures to alleviate these barriers. Several government organization and private companies are involved in renewable energy sector in the country. SREDA is working with full functionality. Nowadays, the government is emphasizing on renewable energy and installed many projects like Solar Home System project, several mini and micro hydro plant projects and harnessing wind

power. Mega projects are on the way to achieve fuel diversity. Nuclear power plant is about to provide electricity within few years.

Demand-side energy management is just as important as supply-side infrastructure development. A rapidly growing country like Bangladesh needs a huge amount of energy to feed its large growth appetite. There is no room for wasting energy. Energy efficiency is so vital in coming days. Thus earned "energy savings" can be wisely reinvested. Business establishments can reinvest them to expand their businesses. The households can reinvest them for their children's' education and health cares. The Government can invest less in energy subsidies and more in industrial development. It is now the high time for stakeholders to start Energy Efficiency & Conservation (EE&C). Government must strive ahead with the promotion of EE&C, to urge the general public to lead energy efficient, non-energy wasting and most productive lives.

Dependency on natural gas is needed to be minimized. New sources of primary fuel is being searched align with the global trend. Several research and development works are going on. Crosse boarder trade is also a good option for sustainable power. Use of costly fossil should be limited to a marginal amount. No new HFO/HSD based power plant is allowed or renewed to produce electricity in coming years. In near future, Bangladesh will be able to achieve sustainable power which will be reliable as well as affordable.

Chapter 05

Recommendation and Conclusion

Government has rightly planned and execute its action plan for achieving its vision of electricity for all by 2021. At present, access to electricity is 97%. Government has taken several programs to connect Off Grid household by installing solar home system, mini grids and small IPP in Hatia by April, 2021. At present, the generation capacity in Bangladesh is surplus compare to its demand. Generation reserve margin is 52% in 2020 with decreasing order to 28% in 2041. Government also introduce primary control such as Free Governor Mode of Operation (FGMO) in different generators for having a target to achieve good amount of spinning reserve of 800MW which will eventually increase the reliability of power system as chances of major blackout in the country may reduce because of sudden shut down of large generating units.

As to be a high income country, prominent development should be in power sector towards sustainability necessary. Some of those are as follow:

1. Considering the resources available Government should focus on fuel diversity as reserve of natural gas is starting to decline. Future primary fuel mix will largely depend on Coal. Government should emphasize on harnessing domestic coal rather than exporting coal from foreign countries. Mine-mounted coal based power plants should be executed to produce electricity upon using modern technology and ensuring environmental safety. If excess to coal is hindered due to various issues in future, Government should ensure the reliability of obtaining continuous supply of good quality Coal as primary fuel.
2. Government should ensure importing LNG because natural gas will deplete in future if new gas field is not discovered. Imported LNG should be used for producing electricity while natural gas should be kept in reserve for future use. More infrastructure should be developed to import and transport LNG.
3. Renewable energy can play a great role for effective and environment friendly generation. It was not popular in early year because of its high price and shorter durability. Government should identify the reasons for not achieving the targets of renewable energy. Renewable energy policy and Power System Master Plan can be modified in this regard to achieve future goals. SREDA should implement star

labelling program as early as possible to improve the energy efficiency and reduce energy demand.

4. Transmission line and grid sub-stations should be designed on the basis of load forecasting for a long period. There should be provision for further expansion/up gradation of network. Single circuit can be converted with poly circuit in the same structure. New line construction will be difficult due to right of way problem. Protection system should more sensitive with up gradated software and hardware such that it should prevent grid from black out. Modern technologies to be applied for voltage regulation compensation. Regular maintenance and monitoring should be focused to improve the quality and reliability of power.
5. Distribution lines length should be shorter and sectionalisation is needed for long lines. Multi source should be for feeders. If one circuit is in fault, then there should have provision to energize it by other. Overhead lines should be converted to underground to ensure reliability. Considering line loads and distance booster should be used for control voltage regulation. SCADA can be implemented for control the distributed circuits. Regular checking and maintenance should be ensured to prevent equipment damage which may prolong the interruption duration.
6. Government can consider re-evaluating the effectiveness of the mega projects for electricity from fossil fuels. As the electricity demand seems to be met by the present generation capacity, allocations for relatively inefficient and old energy projects should be replaced by using clean and modern technology involved projects.
7. Government can revisit the policies regarding Quick Rental (QR) power generators. These rental power plants were introduced as a smart solution in 2009; however, the capacity charge paid by the government for the idle QR generators keeps soaring. In 2019, the government paid Tk. 89.21 billion as capacity charge, which is the highest amount ever recorded. Given the reduced demand for electricity and the existing generation capacity, it is high time to think about phasing out QRs by not renewing the contracts further and, if possible, bringing changes in the existing agreements.
8. Cross border trade can be good option as a source of electricity for Bangladesh. As it is surrounded by some countries which have huge potential of renewable energy like Nepal, Bhutan, India, Myanmar, china etc. government already dealt with India. Government should think about larger scale with other countries also. In cross border trade government has to conscious about its energy security too.

9. The subsidy for imported fossil fuels remains a significant burden for the Bangladesh energy sector. The average amount of subsidy allocated for the energy sector for the last seven years is around 6,241 crore taka. Since the oil price has already fallen and is expected to remain low given the lesser demand of the global transport sector, it is an ideal time for the government to reduce subsidy from oil products or diversify subsidy from non-renewables to the renewable sources. Subsidy reductions can lessen inefficiency and improve welfare by cutting down unwanted losses faced by institutions in the energy sector.
10. Government should take some training program to develop its employee skill as well as provoke common people to use electricity with safety. Energy efficiency improvement should be the future goal for optimal use of scare resource.
11. Some policy to be developed and implemented and some other policy like Renewable Energy Policy-2008 should be reformed to effective use of resources.

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Appendices

BERC: Bangladesh Energy Regulatory Commission

BIFPCL: Bangladesh India Friendship Power Company (P) Ltd.

BPDB: Bangladesh Power Development Board

BREB: Bangladesh Rural Electrification Board

CBET: Cross Border Electricity Trade

DESCO: Dhaka Electric Supply Company Limited

DPDC: Dhaka Power Distribution Company

EECMP: Energy Efficiency and Conversation Master Plan

FYP: Final Year Project

GDP: Gross Domestic Product

GOAL 7: Affordable and Clean Energy

HFO: Heavy Fuel Oil

HSD: High Speed Diesel

IPP: Independent Power Producer

IRENA: International Renewable Energy Agency

JICA: Japan International Cooperation Agency

Ktoe: Kilo tonne of oil equivalent

LNG: Liquefied Natural Gas

LPG: Liquefied Petroleum Gas

MoST: Ministry of Science and Technology

MoU: Memorandum of Understanding

NEA: Nepal Electricity Authority

NESCO: Northern Electricity Supply Company Limited

NWPGCL: North-West Power Generation Company Limited

PGCB: Power Grid Company of Bangladesh

PSMP: Power System Master Plan

REN21: Renewables Global Status Report

SCADA: Supervisory Control and Data Acquisition

SDG: Sustainable Development Goal

SREDA: Sustainable and Renewable Energy Development Authority

TCF: Trillion Cubic Feet

UN: United Nations

WZPDCL: West Zone Power Distribution Company Ltd