

## A Study on Generation of Electricity Plan by 2041 for Sustainable Development in Bangladesh

Md Rosaidul Mawla<sup>1\*</sup>, Md. Ziaur Rahman Khan<sup>2</sup>,

<sup>1</sup>Department of Electrical, Electronic & Communication Engineering, Military Institute of Science and Technology, Dhaka-1216, BANGLADESH

<sup>2</sup>Department of Electrical & Electronic Engineering, Bangladesh University of Engineering and Technology, Dhaka-1000, BANGLADESH

### ABSTRACT

Bangladesh having 147,570 km<sup>2</sup> with a population of approximately 166 million has manifested extraordinary success in attainment of average gross domestic product in recent years. The demand of electricity has increased in several manifolds due to the thriving economic progress, quick urbanization and increasing industrialization. For socio economic emancipation and poverty alleviation, energy is considered a key ingredient. As such the vision of the GoB is to generate 24,000 MW for universal access to electricity by 2021, 40,000 MW for affordable, reliable, sustainable and modern energy for all according to SDG 7 by 2030 and 60,000 MW to be for developed nation by 2041. To fulfill those visions, the GoB is relentlessly working and given due importance to generate electricity through non-renewable and renewable energy resources and also forecasted short, medium and long-term power production plans. Further, the GoB has given additional attention to produce electricity from renewable sources especially in the remote areas of the country. Therefore, Bangladesh is at par to develop huge infrastructure of power plant as per the master plan PSMP 2016. For this reason it is required to know the future plans for power generation, transmission and distribution by 2041.

Keywords: Renewable energy, PSMP 2016, generation, transmission, distribution.

### 1. Introduction

Bangladesh being the populated country and aspires to be a developed nation by 2041, Bangladesh is in race to generate electricity for economic emancipation. For economic development more power is required. In Bangladesh, generation of electricity is mostly dependent on non-renewable fuels. Approximately 91.54% of electricity is produced from fossil fuels whereas 5.56% from import and the rest 2.9 % of power comes from the sources of renewable energy. Among the fossil fuels, around 46.29% of electricity is being produced from natural gas reserve [1]. Natural gas is considered to be the principal source of energy supply for the electricity generation in Bangladesh.

According to the Power System Master Plan (PSMP)-2016, 70% of the power to be generated from gas and coal and the remaining from renewable, nuclear energy and cross border connectivity [2]. To support the governments' vision 2021, Power Sector Master Plan 2010 has been congregated to eradicate the demand supply gap and to accomplish the vital goal of providing "electricity to all" by 2021 by increasing the generating capacity of 24,000 MW [3]. Energy sector of Bangladesh's is booming day by day. Recently construction work of Rooppur Nuclear Power Plant with capacity of 2.4 GW has started and is likely to go into operation in 2023. The Government of Bangladesh (GoB) has set long, mid and short term plans. Few long term plan of the GoB are fuel densification, enhancement of domestic fuels, encouragement of private and joint scheme initiative, improvement of energy efficiency, utilization of alternative and nuclear energy, power import from neighboring countries,

edifice of efficient and modern organization, multi-sector coordination. Increase production from prevailing gas & coal fields, increase exploration activities for new reserve, management of demand side, strategy to meet increasing primary energy demand term, import of LNG & LPG and domestic coal production enhancement & import of coal are the mid-term plan of the government. The short term includes increase production from prevailing gas & coal fields, management of demand side and conservation & efficient use of energy [4]. However, to be a developed country, GoB has varies plan to promote and develop the infrastructure of the power sector. Government has planned accordingly for time worthy development for generation, transmission and distribution. This paper will portray the future plan of power generation for sustainable energy of Bangladesh for a develop nation by 2041.

### 2. Methods

This paper is articulated based on interviews, literature from newspapers and online websites. Research related articles and comments were very useful to compile important data. Besides that, websites of different relevant government and nongovernmental organizations were also rummaged. Finally filtering and compiling the required data were taken for logical sequence of this paper.

### 3. Plan to generate electricity for Bangladesh

For achieving goals of vision 2041, targets and forecasting of power demand growth and sustainable generation plan is required. Therefore, power generation capacity is required to be increased with the growth of power demand proportionately. In addition, power

\* Corresponding author. Tel.: +88-01769004275

E-mail addresses: mawla71@yahoo.com

transmission and distribution networks should be developed parallel to support the system. Following paragraph will highlight the targets and forecast of generating electricity for a developed country in 2041:

### 3.1 Strategic power generation plan as per PSMP

PSMP-2016 has been formulated based on the availability of primary fuel supply for mitigating the accelerated electricity demand and to provide the electricity for all by 2021. As per PSMP 2016, power generation capacity will be 24000 MW by 2021, 40000 MW by 2030 and 60000 MW by 2041. Table 1 shows strategic power generation plan as per PSMP of the government up to 2041.

**Table 1** Strategic power generation plan as per PSMP [5]

Description	August 2019	2021 (PSMP 2010)	2030 (PSMP 2010)	2041 (PSMP 2016)
Installed Capacity (MW)	22,329*	24,000	40,000	60,000
Electricity Demand (MW)	14,000	19,000	33,000	52,000
Transmission line (Ckt. KM)	11,650	12,000	27,000	34,000
Grid Substation Capacity (MVA)	41,195	46,450	1,20,000	2,61,000
Distribution Line (KM)	5,37,000	6,00,000	6,60,000	7,83,000
Per Capita Generation (KWh)	510	700	715	1,475
Access to Electricity (%)	94	100	100	100

\*Including Captive and RE

### 3.2 Major targets of PSMP 2016

Bangladesh aspires to generate 60,000 MW electricity by 2041 as per the revised master plan and wants to rise the per capita electricity generation to 1,500 kWh which is given in Table 2. This plan likes to completely phase out quick rental power plant model to reduce the cost. It further portrays that generation of electricity will be of energy mix where the PSMP 2016 emphasizes on primary dependence on imported liquefied natural gas (LNG), coal and oil primary energy along with the limited reserves of local natural gas and coal.

**Table 2** Major targets of PSMP 2016 [6].

Particular	Existing	Target 2041
Access to electricity	80%	100%
Generation Capacity	20,133 MW	60,000 MW
Per Capita	250 kWh	1500 kWh

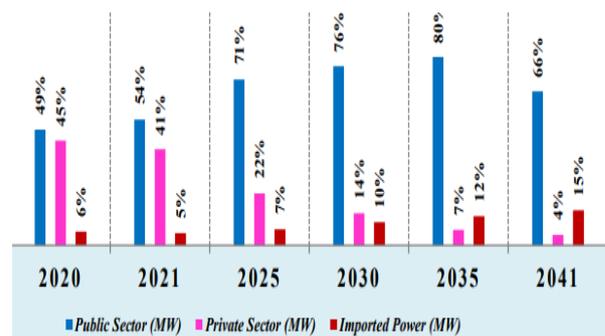
Consumption		
Thermal Efficiency	30%	50%
Rental Power Plant	1,745 MW	0 MW
Power Import	1,160 MW	9,000 MW
Nuclear Power	0 MW	7,200 MW

Source: PSMP 2016

Besides these, Bangladesh has the target to generate 2,470MW by 2021 and 3,864MW by 2041 electricity from renewable energy power source. After finalizing the rules and regulations' along with capacity building, cross-border energy import target is set 3,500~8,500 MW by 2031, 9,000 MW by 2041 [7].

### 3.3 Contribution of generation of electricity by public and private sector in Bangladesh

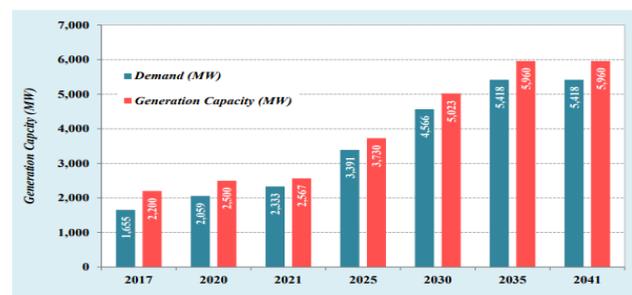
For high case study, the share of electricity production as per PSMP-2016, for public and private sector is 59% and 41% respectively in 2020 which is likely to contribute 66% (61,882 MW) from public, 4% (4207 MW) from private and 15% (14,121 MW) from import in 2041. The contribution capacity of public and private sector up-to 2041 is shown in Fig. 1.



**Fig. 1** Shared generation capacity of public and private sector [8]

### 3.4 Captive power generation capacity and demand (2017-2041)

Captive power generation capacity and demand in different years are projected in fig. 2 where it is reflected that generation and demand of electricity are in close race and generation of electricity is always more than the projected demand. In Fig. 2, the captive power generation capacity and demand from 2017 to 2041 is shown.



**Fig. 2** Captive power generation capacity and demand (2017-2041) [8]

### 3.5 Forecasted peak demand and energy mix in power generation plan

Bangladesh has the national development vision of a middle income country by 2021, a totally poverty free nation by 2030 and a developed country by 2041. For that, generation of electricity has a close link. Following Table 3, Table 4 and Table 5 describe the forecasted peak demand, fuel mix in power generation plan, MW (high scenario) and fuel mix in power generation plan, MW (low scenario) respectively.

**Table 3** Forecasted peak demand [9]

Year	Projected Peak Demand in MW		
	High	Base	Low
2021	19,034	18,023	16,823
2030	41,890	39,663	37,024
2041	82,292	77,540	72,379

**Table 4** Fuel mix in power generation plan, MW (high scenario) [9]

Year	Coal	Gas /LNG	Liquid Fuel	Nuclear	Import	Total
2021	4745	13187	8728	000	1500	28390
2030	24462	22803	5894	2232	6121	61842
2041	30166	40661	2186	6696	14121	94160

**Table 5** Fuel mix in power generation plan, MW (low scenario) [9]

Year	Coal	Gas /LNG	Liquid Fuel	Nuclear	Import	Total
2021	2864	13846	7864	000	1500	26304
2030	17969	23744	5591	2232	3496	53262
2041	25596	34165	1840	5580	11996	79507

### 3.6 Power generation plan

The GoB likes to generate 24,000 MW of electricity by 2021 to provide 100% electricity accesses for all. Further, 40,000 MW and 60,000 MW of electricity is planned to produce by 2030 and 2041 by the government. Besides that, according to renewable energy policy 10% of power will be shared by renewable energy sources of total power by 2020. As per PSMP 2016, the GoB has plan to produce 35% electricity from coal and gas each and rest 30% electricity will be produced from other sources including nuclear and import by 2041. According to the PSMP 2016, government is on progress to install number of coal plants in the subsequent years [10]. Therefore, power generation plan of Bangladesh is given in Fig. 3.



**Fig. 3** Power generation plan [11]

### 3.7 Generation plan by different entities

Bangladesh has planned to generate the targeted amount of electricity by different organizations. The forecasted plan is projected in Table 6.

**Table 6** Generation plan up to 2041[5]

Utility	2021	2031	2041
BPDB	7,800	5,100	11,000
APSCCL	1,300	5,000	6,900
EGCB	1,000	2,300	4,000
NWPGCL	1,100	3,500	4,500
RPCL	200	2,800	3,400
CPGCBL	700	4,800	6,000
BIFPCL	1,300	1,300	2,700
Joint Venture	1,200	5,200	5,200
Private	8,000	4,000	11,300
Power Import	2,400	4,500	5,000
Total (MW)	25,000	38,500	60,000

### 3.8 Fuel mix (year-wise) in total net generation capacity for high case studies

According to the plan of the GoB for high case study, the projected generation capacity of the fuel wise generation will be 94,160 MW in 2041 against the demand of 82,292 MW. More than 2% power will be essential from liquid based power plants 15% from imported power and approximately 7 % is required from nuclear power to meet the expected demand in 2041. Fuel mix (year-wise) in power generation plan is shown in Table 7.

**Table 7** Fuel mix (year-wise) in power generation plan in high case studies [8]

Fuel-wise composition (MW)	2020	2025	2030	2035	2041
Coal	2874	13506	24462	28510	30166
Gas/LNG	12514	18143	22803	28924	40661
Liquid Fuel	8674	7157	5894	2096	2186
Import	1500	2996	6121	9121	14121
Nuclear	0	1116	2232	4464	6696
Hydro	230	230	330	330	330
Total	25792	43148	61842	73445	94160

3.9 Planning of transmission line, grid station and number of sub grid station

Power Grid Company of Bangladesh (PGCB) is responsible for planning and execution of transmission network. Bangladesh currently regulates its national grid through 400 kV, 230 kV and 132 kV lines which are planned to enhance 765 kV as per PSMP-2016 considering further industrial expansion. In case of 765 kV transmission lines, it is also targeted to construct one double circuit of 765 kV transmission line from Moheshkhali to Dhaka from Patuakhali to Dhaka by 2024 and 2027 respectively. Table 8 represents the transmission timelines up to 2041.

**Table 8** Transmission timeline up to 2041 [8]

Parameters	2021	2025	2030	2041
Substation Number	272	344	428	562
Substation Capacity (KVA)	90,382	1,36,986	1,78,635	2,44,406
Transmission Line Length (Ckt. Km)	18,126	23,472	28,320	36,870

It is estimated that number of substation will be 428 & 506, substation capacity will be 1,78,635 kVA & 2,14,236 kVA and transmission line length will be 28,320 & 32,436 circuit kilometres by 2030 & 2035 respectively.

3.10 Renewable targeted generation capacity

The total projected demand of electricity is 82,292 MW whereas the production of electricity is projected to be 94,160 MW for high case study. The generation of electricity from renewable sources is projected to be 9,400 MW by 2041 and 2,800 MW by 2021 as the renewable energy target is aimed to be 10%. Similarly, the demand of electricity is 72,000 MW whereas total electricity production is expected to be 79,500 MW for low case study. The generation of electricity from renewable sources is projected to be 7,950 MW by 2041 and 2,600 MW by 2021 as the renewable energy target is aimed to be 10%. According to the Bangladesh's PSMP-2016, Bangladesh has the possibility to produce total 3.6 GW of electricity from renewable energy sources and another research revealed that only wind can generate 20GW [12]. Besides the government initiatives, NGOs are also playing pivotal role for promoting renewable energy. However, the renewable energy (utility wise) based new addition generation plan- 2018 to 2041 is given in Table 9.

**Table 9** Renewable energy (utility wise) based new addition generation plan- 2018 to 2041 [8]

	2020	2021	2022	2023	2024	2025	Total
BPDB	215	0	0	0	0	0	223

APSCL	0	0	200	0	0	0	200
EGCB	0	0	0	0	0	0	300
NWPG CL & BCPC L	100	50	100	0	0	0	329.5
RPCL	0	200	0	0	100	0	530
BR POWERGEN	0	0	0	100	50	0	300
Private	0	0	0	0	0	0	950
Total	315	250	300	100	150	0	2,833

3.11 Investment requirement for new generation, transmission & distribution

In the year 2017-2030, the investment requirement for development of generation, transmission and distribution (in high case) is 56, 14 and 12 billion USD respectively. This investment is expected to increase 29 billion USD in case of generation, 6 billion USD for transmission and 44 billion USD. The year-wise requirement of investment is shown in the Table 10.

**Table 10** Investment requirements for new generation, transmission & distribution (high case) in billion US\$ [7]

Year	Generation	Transmission	Distribution	Total
2017-2030	56	14	12	82
2026-2030	38	5	7	50
2031-2035	27	6	7	40
2036-2041	29	6	9	44
Total	150	31	35	216

3.12 Investment requirement for cross border power trade.

For cross border power trade, financial year wise investment requirement is shown in Table 11

**Table 11** Investment requirement for cross border power trade (in million US\$) [13]

Sub Sector	Financial Year 2016-21	Financial Year 2022-31	Financial Year 2032-41
Generator	140	900	1200
Transmission	30	400	200
Distribution	10	200	120
Total	180	1500	1520

3.13 Projection cost of fuel

Though domestic gas price is cheaper than LNG and as LNG is being added into grid, so expected cost of fuel will go high. The projection cost of fuel is shown in Fig. 4.

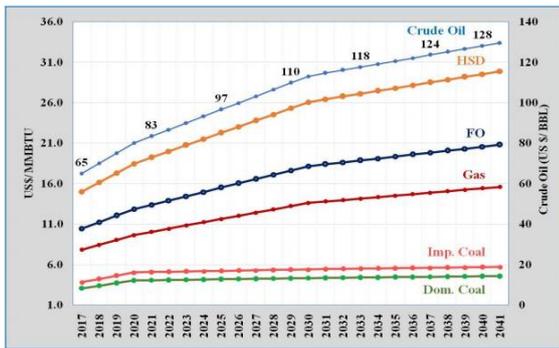


Fig. 4 Year-wise projection cost of fuel [8]

### 3.14 Average cost of generation

The average cost of generation per unit is 7.28 Tk/kWh in 2018, 7.29 Tk/kWh in 2025 and 8.20 Tk/kWh in 20431. The cost of generation has risen due to inclusion of LNG in generation system. The average cost of generation is given in Fig. 5 [8] and Fig. 6 represents the unit cost of generation (Tk/per kWh) [14]

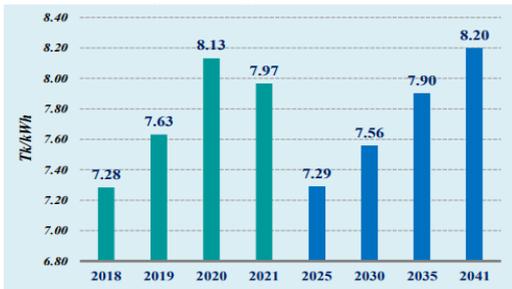


Fig. 5 Average cost of generation

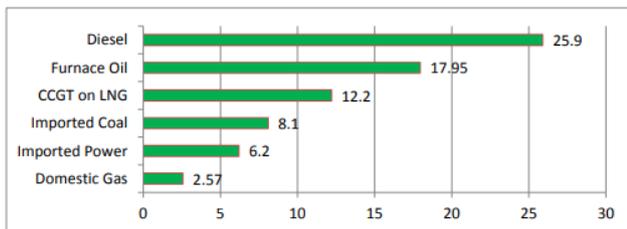


Fig. 6 Unit cost of generation (Tk/per kWh) [14]

### 3.15 Future potential power import and route

Continuous power supply is essential requirement for economical emancipation in Bangladesh. Accordingly the GoB has planned to generate electricity from numerous sources to fulfill the target of SDG and for a developed nation. Besides that, government has planned to import electricity from neighboring countries and already the GoB has imported electricity from India. Due to very high potentiality about hydroelectricity at Nepal and Bhutan, government has a plan to negotiate with them. Electricity trade from Myanmar can be also explored. To import electricity from neighboring countries, different negotiating team is formed and they are working. However, Fig. 7 shows the likely countries and routes for electricity trading.

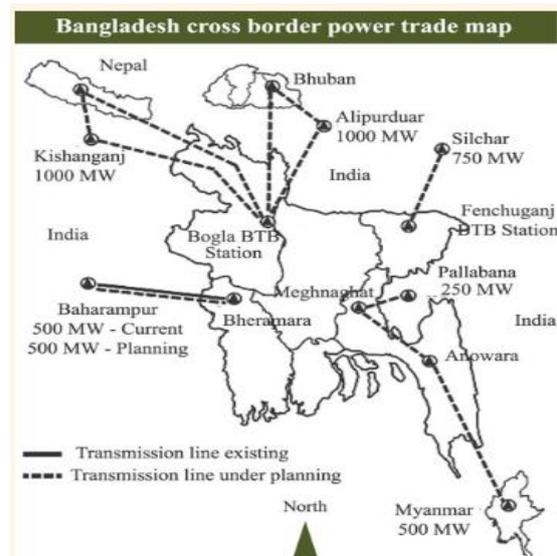


Fig. 7 Likely countries and routes for electricity trading [15]

To enhance the development of power sector the GoB is working with neighboring countries as well as SAARC, BIMSTEC, SASEC and D-8 for regional cooperation. In addition to India, Bangladesh has taken initiative for cross border trade of electricity through bilateral cooperation with Nepal, Bhutan and Myanmar. According to PSPM-2016, approximately 15-20 % (8.5 GW) of electricity is likely to be imported by 2040 [16]. The import plan up to 2040 is given in Fig. 8.

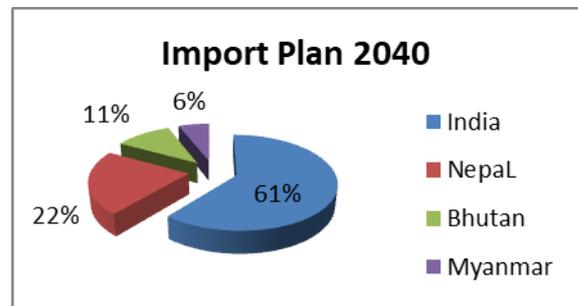


Fig. 8 Import plan 2040

## 4. Summary

According to PSMP- 2016, Bangladesh has targeted to produce 50% electricity from domestic and imported coal by 2030. The domestic coal of Bangladesh is of very high quality. The GoB has undertaken few coal base mega power plants at Rampal, Matarbari, Moheshkhali and Payra which will generate 8500 MW electricity [17]. The GoB is already leaning to import LNG and LPG from different countries. As per PSMP 2016, cross border electricity from India, Nepal, Bhutan and Myanmar will contribute around 15% in 2041 which is expected to be 14121 MW. In 2041, power generation from nuclear is expected to be around 7% of the total demand and the environment friendly renewable energy is likely to be 2833 MW. If Bangladesh aims to go with the plan to add additional coal and LNG power plants, it is like to produce 58%

more power than the required at least 2030 [18]. Due to overcapacity, there will be lower capacity utilization of those coal and LNG power plants. In brief, for ensuring energy security for development, leaving the overwhelming dependence on natural gas, the GoB has plan for fuel diversification mix where there will be supply-side and demand side management to conserve energy and discourage inefficient use. Further, according to Energy Efficiency & Conservational Master Plan up to 2030, 15% of primary and secondary energy saving by 2021 and 20% by 2030 are planned. Again, the GoB aims to obtain 300-400 kW of solar electricity by 2041 from rural communities like schools, colleges, hospitals etc. [19]. Therefore, the GoB should take all out initiative to implement the said plans for a developed country in 2041 for sustainable energy.

## 5. Conclusion

The GoB has a master plan to be a develop country by 2041 for which power infrastructure development is essential. In SDG, the 7<sup>th</sup> goal states that ‘clean energy for everyone: Secure access to affordable, reliable, sustainable and modern energy for everyone.’ For acquiring the vision 2041 and goal of SDG, planning for generation of electricity comparing with demand, transmission, and distribution up to the clients is very important. For generation, which type of fuel to be used to get the minimum per unit electricity cost so that it does not become burden which needs to be plan beforehand. Accordingly, PSMP 2016 portrays the comprehensive planning which will not only override the challenges but also give a smooth ending for developed infrastructure to be a developed country by 2041. This will ensure the optimal resource blending to achieve sustainable and secure power by 2041 for a developed country.

## 6. Acknowledgements

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