Draft

CPD Study on

Proposed Power and Energy System Master Plan (PESMP)

Perspective on Analytical Frame, Methodology and Influencing Factors

Presentation by

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Discussion points

1. Introduction and Objectives
2. Network of Bangladesh's Power Sector
3. Review of the PSMPs: Demand Side Issues
4. Review of the PSMPs: Energy-mix Issues
5. Analytical Framework and Methodologies for Projection of Future Power Demand
6. Conclusion: Recommendations

1. Introduction and Objectives

1. Introduction and Objectives

- The Ministry of Power Energy and Mineral Resources (MoPEMR) has initiated the process of drafting the new Power and Energy System Master Plan(PESMP)
  - CPD appreciates the initiative undertaken by the ministry
  - The Power sector is currently guided by the PSMP 2016
  - A revised version of PSMP 2016 was published in 2018. However, the version is not referred due to its various limitations
- Drafting of the New Plan issue has been reported in the media over the last six months
  - The State Minister for the MoPEMR mentioned about this in a web-based discussion in June, 2020 which was organised by the CPD
  - It was subsequently reported in the national media (20 August, 2020; 13 March, 2021)
- Government has signed an agreement with JICA in this regard
  - JICA mentioned on its website (15 March, 2021) that the aim of the new plan is to promote a low or zero-carbon transformation of the total energy supply and demand system.
- The importance of formulating a new master plan has further increased due to aggravated structural and operational challenges and changing power demand amidst the COVID-19 pandemic in the country
  - The new plan is expected to deliver the future outlook of the power sector in the context of transitioning of the power sector towards clean power

1. Introduction and Objectives

- Successive PSMPs have been criticized in a number of accounts including weak demand-side analysis
  - The projection of demand has been made on weak benchmark, over-projection on long-term economic growth and per capita income and lack of methodological rigour (World Bank, 2017)
- Over projection of electricity demand and thereby creating excess capacity in power generation are major weaknesses of the successive PSMPs
  - Both the power sector and the economy have been confronted with multiple challenges because of weak demand projection
- Such excess reserve capacity caused inefficient use of the public fund, increased use of imported fossil-fuel, additional spending of foreign exchanges for importing raw materials and inefficient use of power plants and excess payment of different charges to power producers (Nicholas and Ahmed, 2020)
  - BPDB's debt burden for such faulty power sector development initiatives has been increasing (Moazzem, 2020)
  - The power sector has been confronting multiple number of challenges and threats which has accumulated during the COVID pandemic period
- In this backdrop, a proper analysis of the demand-side issues is of critical importance with a view to making rational power demand under the new PESMP

1. Introduction and Objectives

- The study will put forward a set of suggestions for analytical frame, factors and methodology for demand side analysis under the new plan based on
    - Reviewing of demand-side analysis carried out in the earlier PSMPs (2005, 2010 and 2016) in order to identify the weaknesses
    - Identifying factors responsible for demand-side analysis in a developing country like Bangladesh where electricity demand is at a growing stage
    - Reviewing methodologies used in other countries
    - Put forward a set of alternate methodologies for demand-side analysis of the power sector for the new plan
- The study is conducted on the basis of secondary data analysis and KIIs with a number of eminent academics and discussion with professionals

2. Network of Bangladesh's Power Sector

2.1 Generation of electricity

- The power sector has made an important contribution to country's overall GDP mainly by providing primary energy for all kinds of economic activities
    - The sectoral contribution to GDP has increased by 16.3%/year which is significantly higher than any other sector
    - Its share to GDP has increased from 0.95% in 2009 to as high as 1.3% in 2020
    - The performance has been reflected in the global ranking - the quality of electricity supply as % of output has improved from 124 in 2015 to as high as 68 in 2019

Electricity generation

- This has been increasing over the years -between 2009 and 2020, the average yearly growth of net electricity generation was about 19.3%
    - Electricity demand varies throughout the day and night, which needs to be managed through estimating load factor and load management.
    - Better capacity utilisation is linked with efficient cost management of energy-mix in the power generation plants
    - A number of load management related activities have been undertaken
- **Generation Capacity:** Total electricity generation capacity is 21,778MW (BPDB, 2020) which includes 9990 MW under public sector (46%), 9384 MW under private sector (43%), 1244 MW (6%) under PPP and 1160MW (5%) of imported electricity

2.1 Generation of electricity

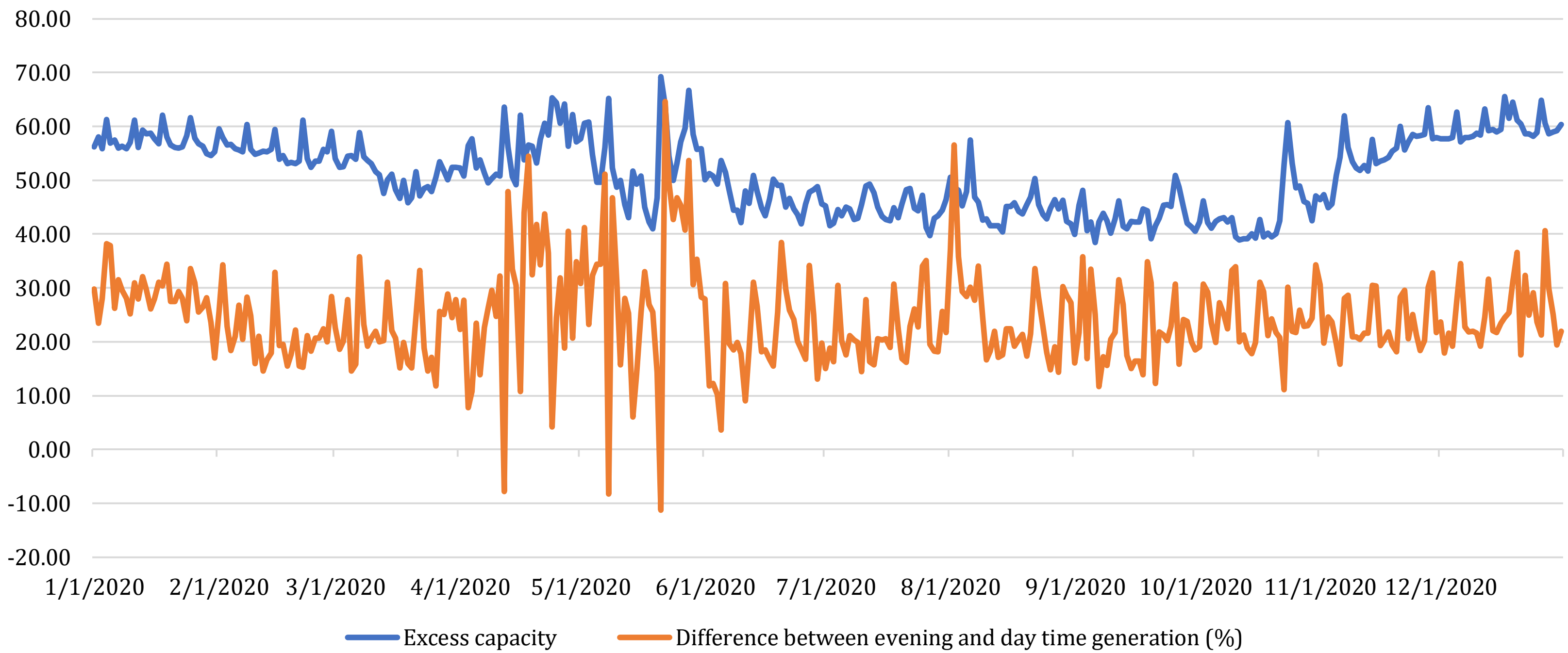
Fuel	Net generation (GWh)	% share
Hydro	825	1.16%
Natural gas	51,290	71.82%
Furnace oil	9,461	13.25%
Diesel	139	0.20%
Coal	2,968	4.16%
Renewable	62	0.07%
Power import	6,674	9.34%
Total	71,419 (GWh)	100%

Source: BPDB Annual report 2019-2020

- **Total net energy generation** in FY2020 was 71419GWh (1.26% higher than FY2019)
    - Of these, the public sector is accounted for 35,316 GWh (49.4%), while the private sector is accounted for 29,429GWh (41.2%)
    - Net generation is overwhelmingly dependent on natural gas/LNG (71.8%) followed by furnace oil (13.3%), coal (4.2%)
    - 89.4% of net generation is directly dependent on fossil fuel, and another 9.34% is dependent on indirectly – overall, 89.7% is carried out by fossil fuel
- **Excess capacity:** Maximum peak generation in 2020 was 12,738 MW which was only 58.5% of total generation capacity.
    - In other words, as low as 41.5% capacity remain unutilized which was much higher while comparing with the average generation capacity
    - During 2020, the excess capacity has increased as much as 69..2% which has declined to 38% but gradually increasing at the end of the year.
- **Plant efficiency:** The plant efficiency of public sector power plants was 37.39%

2.1 Generation of electricity

Excess Capaicty (%) and Difference between evening and day time generation (%)



Source: Author's calculation

Day and Evening Peak during January-December, 2020

Maximum and minimum generation		Date	Actual Peak Day, MW	Actual Peak Evening, MW
By evening peak	Largest	Sunday, July 19, 2020	12324.7	15082
	Smallest	Thursday, May 21, 2020	6745.3	5984
By day peak	Smallest	Thursday, May 28, 2020	4216.5	6481

Source: Author's calculation

2.2 Transmission of electricity

- **Transmission:** Till 2020, the power generated in different power plants is transmitted to the national grid through 400 kV, 230 kV and 132 kV transmission lines (Saleh Ibn, 2020).
- The transmission line length (ckt.km) has increased by 5.15% during 2020
    - Total length of 400 KV transmission line increased to 861 circuit km from the previous year 697.76 circuit km (23.4%)
    - The total length of 230 kV transmission line increased to 3658 circuit km from the previous year of 3406.69 circuit km (7.4%)
    - The total length of 132 kV transmission line increased to 7,764 circuit km from the previous year of 7545.5 circuit km (2.9%)
- **Grid sub-stations:** The transformer capacity has enhanced by 8.4% at different voltage levels.

Transmission line type	Circuit km
400kv Transmission line	861.31
230kv Transmission line	3,658
132kv Transmission line	7,764
Total Transmission line	12,283.31
Transmission Loss (%)	2.93%

Source: BPDB annual report 2019-2020

Sub station type	No. of sub station	Capacity
400kV HVDC Sub-station (MVA)	1	1,111
400/230Kv Sub-station capacity (MVA)	4	3,770
400/132Kv Sub-station capacity (MVA)	2	1,300
230/132Kv Sub-station capacity (MVA)	25	13,075
132/33Kv Sub-station capacity (MVA)	145	26,222
Total	177	45,478

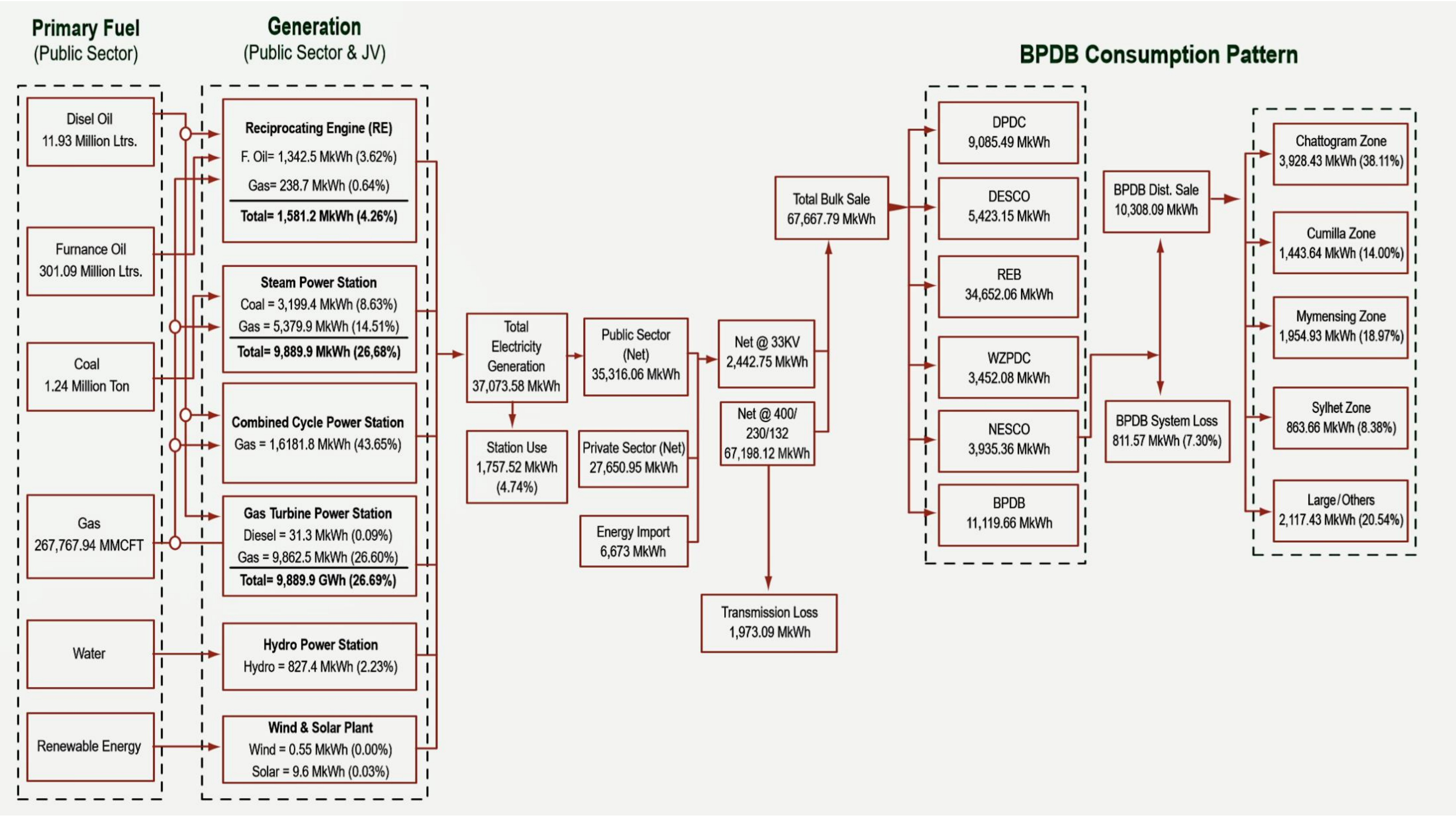
2.3 Distribution of electricity

- BPDB operates its distribution-related activities under four distribution zones- Chattogram, Cumilla, Mymensingh and Sylhet
  - The distribution transformer has increased to 24,012, which could serve the purpose of 1876 MW
  - The energy sales both without bulk consumers and with bulk consumers have increased by 0.98% per year and 4.8% per year since 2012
- The system loss (without bulk consumer) was estimated to be 8.99% which was declined from 9.12% in FY2019
  - The system loss (with bulk consumer) has further declined in FY2020 (7.30%)
  - The total number of consumers increased to 3,236,886 which was 6.26% higher compared to the earlier year
  - There was a huge amount of account receivable during FY2020 - Tk.1650.3 crore which was increased by 15.5% compared to the previous year

FY	Distribution Loss in per cent	Total Loss (Distribution+ Transmission Loss) in per cent
2001-02	23.92	27.97
2005-06	16.53	21.25
2010-11	12.75	14.73
2015-16	10.96	13.10
2019-20	7.58	10.03

Source: Bangladesh Power Sector Review 2020

2.4 Power sector network in Bangladesh



Source: BPDB annual report 2019-2020

3. Review of the PSMPs: Demand Side Issues

3.1 Demand projection methods used under PSMPs

- Different methodologies are used in different PSMPs for estimating the power projection
- GDP growth rate is considered to be the most important variable in the PSMP's demand estimates
  - A linear relationship is considered between GDP and electricity demand
  - Often the linear relationship is not applicable in low income and lower middle-income-countries with a gradual rise in demand
- In successive PSMPs, GDP growth rate is used as the main variable while a number of other variables are also considered
  - PSMP 2005 used GDP and historical electricity consumption data in order to forecast power demand
  - PSMP 2010 used GDP per capita instead of GDP, electricity consumption and maximum load data
  - PSMP 2016 used the elasticity of GDP

3.1 Demand projection methods used under PSMPs

- **PSMP 2005:** The correlation analysis was done by using the following formula
  - Ln (Estimated net energy generation (n)) = - 11.919 + 1.482 Ln (GDP (n))

- **PSMP 2010:** The plan used 'electricity intensity method'
  - The study showed that as country exceeds the GDP per capita income \$1000, it tends to show a decreasing pattern in electricity density.
  - Bangladesh at that time had a GDP per capita income more than \$700 and was soon to exceed \$1000.
  - So, the electricity intensity method was used. The used formula was : $e=\alpha+ßy+xy^2\ (+\lambda_1 D_1+\lambda_2 D_2+\cdots+\lambda_{n-1} D_{n-1})$

- **PSMP 2016:** This time the used methodology was "GDP Elasticity Method"
  - The used formula was : projected GDP × GDP elasticity of peak demand

3.1 Demand projection methods used under PSMPs

Summary table of Demand side analysis of previous PSMPs

		PSMP 2005	PSMP 2010	PSMP 2016
Demand Side Issues	Methodology	• Correlation analysis	• Electricity Intensity Method	• GDP Elasticity Method
	GDP growth rate	• Base case: 5.2% • High case: 8% • Low case: 4.5%	• Base case: 7% • High case: 8% • Low case: 5.5%	• Base case: 4.4% • High case: 5% • Low case: 4%
	Variables	• GDP • Historical electricity consumption	• GDP per capita • Power consumption • Maximum load	• GDP • GDP elasticity
	Used Formula	• Ln (Estimated net energy generation (n)) = -11.919 + 1.482 Ln (GDP (n))	• $e = \alpha + ßy + xy^2 (+\lambda 1D1 + \lambda 2D2 + \cdots + \lambda n - 1Dn - 1)$	• Projected GDP * the GDP elasticity of peak demand
	Findings	• The result showed that sales grew faster than generation. • In case of high and low demand cases the optimal mix of new resources did not change significantly. • Costs and fuel requirements followed the same trend as well.	• The test showed that the increase in electricity intensity slowed down with the increase in GDP per capita. • The second coefficient of GDP per capita was a negative value, as assumed.	• Data showed that the total electricity consumption was greater than the available supply from the grid. • The reason was total electricity consumption included the factories' own consumption from captive power generation.

Source: Prepared by authors from previous PSMPs

3.2 Projection of electricity demand and actual consumption

- Successive PRSPs have forecasted maximum demand for electricity using different methodological approaches
  - Forecasted demand has been revised downward in the successive PSMPs
  - BPDB had taken into consideration the 'base case' of electricity demand for different years

Table: Demand forecast under different PSMPs

	PSMP 2005			PSMP 2010			PSMP 2016			Maximum forecasted demand (MW) by BPDB
	Base	Low	High	Govt. Policy	Low	High	Base	Low	High	
2005	4308	4308	4381	-	-	-	-	-	-	-
2006	4693	4627	4839	-	-	-	-	-	-	-
2007	5112	4970	5345	-	-	-	-	-	-	-
2008	5569	5339	5904	-	-	-	-	-	-	-
2009	6066	5734	6467	-	-	-	-	-	-	-
2010	6608	6160	7355	6454	6454	6454	-	-	-	-
2011	7148	6569	8237	6765	6756	6869	-	-	-	6,765
2012	7732	7007	9288	7518	7083	7329	-	-	-	7,518
2013	8364	7473	10473	8349	7436	7837	-	-	-	8,349
2014	9047	7970	11810	9268	7819	8398	-	-	-	9,268
2015	9786	8501	13408	10283	8232	2019	8920	8920	8920	8,920
2016	10512	9066	15223	11405	8680	9705	9600	9600	9600	9,600
2017	11291	10313	17166	12644	9165	10463	10400	10400	10400	10,400
2018	12128	11000	19357	14014	9689	11300	11200	11200	11200	11,200
2019	13027	11732	21827	15527	10255	12224	12100	13300	12100	12,100
2020	13993	12424	24445	17304	10868	13244	13300	14500	13300	13,300

Source: prepared by authors based on data compiled from previous PSMPs and BPDB annual report

3.2 Projection of electricity demand and actual consumption

- The difference between forecasted demand and maximum demand served has been narrowed down over the years
  - The gap was 38.3% in FY2011 which has reduced to as low as 4.4% in FY2020
  - Even the gap was found negative in a year (FY2019) which means that the generated electricity has served all the demands within the country
- Installed capacity against that of projected demand has been widening over the years
  - The reserve capacity is way above the maximum reserve capacity limit set in the PSMP 2016 (37.3% vs. 25%)
  - The generation capacity has increased overtime with little consideration of projection made in the plan documents

Table: Installed Capacity, Present Capacity (Derated), Maximum Forecasted Demand Maximum Demand served

Year	Maximum forecasted demand (MW)	Installed capacity (MW)	Present capacity (MW)	Maximum demand served (MW)	Gap between forecasted demand and maximum demand	% of gap between forecasted demand and maximum demand	Gap between forecasted demand and installed capacity	% gap between maximum demand served and installed capacity
2010-11	6,765	7,264	6,639	4,890	1,875	38.3	499	32.68
2011-12	7,518	8,716	8,100	6,066	1,452	23.9	1,198	30.40
2012-13	8,349	9,151	8,537	6,434	1,915	29.8	802	29.69
2013-14	9,268	10,416	9,821	7,356	1,912	26	1,148	29.38
2014-15	8,920	11,534	10,939	7,817	1,103	14.1	2,614	32.23
2015-16	9,600	12,365	11,170	9,036	564	6.2	2,765	26.92
2016-17	10,400	13,555	12,771	9,479	921	9.7	3,155	30.07
2017-18	11,200	15,953	15,410	10,958	242	2.2	4,753	31.31
2018-19	12,100	18,961	18,438	12,893	-793	-6.2	6,861	32.00
2019-20	13,300	20,383	19,892	12,738	562	4.4	7,083	37.51

Source: Prepared by authors based on data compiled from previous PSMPs and BPDB annual report

3.2 Projection of electricity demand and actual consumption

- As per the Plan of BPDB, a total of 21,977 MW electricity would be added by 2025 if ongoing projects realized n time (including coal-fired power plants) which rose the total capacity to 36,018 MW. The maximum demand at that time would rose to only 24,952MW
- Hence excess capacity will remain a major challenge during the next five years
  - If the ongoing generation plan is being continued, the excess capacity did not decease and it reached 30.7% at the end of 2025.
  - Such a huge excess capacity would be a major burden for the BPDB
- Hence the BPDB in no way in a position to further enhance the generation capacity which are mostly fossil-fuel based mainly of LNG-based
  - Instead BPDB should take measures to gradual scale down the fossil-fuel based power generation by discouraging new investment in power generation through coal, LNG and petroleum based energy
- The new PESMP should rather encourage phased-in clean power by encouraging private and public investment in renewable energy- based power generation.

Plan for Generation of Electricity till 2025 (with coal or without coal) (MW)							
	2020	2021	2022	2023	2024	2025	Total
Public sector	2456	2139	981	3621	2400	1975	13572
Private sector	1063	150	3109	757	590	1240	6909
Import	0	0	1496	0	0	0	1496
Total	3519	2289	5586	4378	2990	3215	21977

Projected Excess capacity in power generation, 2020-2025

	2020	2021	2022	2023	2024	2025
Probable maximum demand for electricity (MW)	14757	16823	18731	20697	22769	24952
Probable net generation capacity (MW)	20383	23699	28595	31026	32887	36018
Over-generation capacity (reserve capacity)	7083	6876	9864	10329	10118	11066
% of over-generation capacity (reserve capacity)	**34.7**	**29.0**	**34.5**	**33.3**	**30.8**	**30.7**

Source: Prepared by authors based on BPDB data

3.3 Major weaknesses of PSMPs: demand side issues

- Longer-term demand projection weaken the plan: There is no need for setting projection of the demand for longer-term (e.g. next 20 years) since power sector plan has been updating and reviewing in every 5 years
    - There is no proper mechanism for monitoring the plan
    - Widening gap between installed capacity and even the high-case demand projection portrayed that little relation exists with the investment in generation
    - Making longer-term demand projection perhaps is associated with making higher installed capacity justified
        - This might have a political economy dimension as well
- Limited number of variables considered: The main difference that was observed between the methodology used in Bangladesh and that of other countries is the variables that were used as the exploratory factors of power demand.
    - GDP or economic growth is the most important variable that influences the electricity or power demand but is not the only factor that causes power demand
- GDP/GDP growth is mainly attributed to service sector-led growth where the intensity of electricity consumption is less: The majority growth in the economy is originated from service sector and the electricity demand in service sector is relatively low (table)
    - GDP-based estimates of electricity putting similar weight to different sectors to that of GDP would provide a faulty estimate
    - Developing countries are not only using GDP/GDP growth rate alone as variable rather are using many other significant variables that may influence power demand

3.3 Major weaknesses of PSMPs: demand side issues

Incremental Contribution to GDP Growth

	FY20 (p)
AGRICULTURE SECTOR	7.8
AGRICULTURE AND FORESTRY	3.9
FISHING	3.9
INDUSTRIES SECTOR	41.6
MINING AND QUARRYING	1.4
MANUFACTURING	25.8
ELECTRICITY, GAS AND WATER SUPPLY	1.8
CONSTRUCTION	12.7
SERVICES SECTOR	50.1
WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES, MOTORCYCLES AND PERSONAL AND HOUSEHOLD GOODS	12.8
HOTEL AND RESTAURANTS	0.9
TRANSPORT, STORAGE & COMMUNICATION	12.5
FINANCIAL INTERMEDIATIONS	2.8
REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	5.5
PUBLIC ADMINISTRATION AND DEFENCE	4.0
EDUCATION	2.8
HEALTH AND SOCIAL WORKS	3.5
COMMUNITY, SOCIAL AND PERSONAL SERVICES	5.4
Total GVA at constant basic price	99.5
Tax less subsidy	0.5
Growth rate	100

Source: Authors' calculation based on National Accounts for FY2020

3.3 Major weaknesses of PSMPs: demand side issues

- Estimates of GDP/GDP growth rate is not out of question: Country's GDP/GDP growth is not out of question according to the scholars which also affect the estimates of power demand
- Long wish list: In the absence of detailed sectoral estimates of GDP and sectoral consumption of electricity, the team involved in drafting the PSMP were likely to be affected by government's presentation of wish list of activities where substantial amount of electricity will be consumed in the future
  - In the absence of proper methodological approaches, taking such wish lists into consideration would make a bias estimates of electricity demand
- Faulty way of undertaking sectoral approach: The sectorial approach is used in the revised version of PSMP 2016 released in 2018.
  - Though such approach is said to be a better approach, due to limited information on electricity consumption by different sectors, the estimates could not provide a better forecast
- Limitation of Data: Lack of data is a major weakness in undertaking appropriate estimates of power demand. Besides, panel data of important variables are not available.
- No dedicated wing for data collection: There is no dedicated wing for data collection and preserving those data.
  - Often data related activities have been carried out on an ad-hoc basis
  - Limitations are observed in case of data collection, data process and data use

4. Review of the PSMPs: Energy-mix Issues

4.1 Projection on energy-mix in the PSMPs

- Successive PSMPs projected energy-mix overwhelmingly based on fossil-fuel.
  - Availability of natural gas in the country and making it available for power generation at a highly subsidized rate – has been a pressing factor
  - Despite having availability of coal, imported coal is largely used in power plants
  - Little effort has been made on renewable energy-based power generation although potentials of solar, hydro-power, wind and bio energy had been discussed.

Table: Projected Fuel-mix under different PSMPs

<table>
<tr><th>Fuel Mix</th><th>PSMP 2005</th><th>PSMP 2010</th><th>PSMP 2016</th></tr>
<tr><td>Gas</td><td>85%</td><td>25% (including LNG)</td><td>35% (including LNG)</td></tr>
<tr><td>Coal</td><td>-</td><td>50% (30% domestic coal and 20% imported coal)</td><td>35% (34% imported)</td></tr>
<tr><td>Liquid fuel</td><td>10% (Imported oil)</td><td>5% (liquid oil)</td><td>-</td></tr>
<tr><td>Cross- border trade</td><td>-</td><td rowspan="3">20%</td><td rowspan="3">30%</td></tr>
<tr><td>Renewable</td><td>5% (Hydro)</td></tr>
<tr><td>Nuclear Power</td><td>-</td></tr>
</table>

Sources: Prepared by authors based on compiled data from different sources

4.1 Projection on energy-mix in the PSMPs

Natural Gas

- Natural gas is considered in the successive PSMPs as the dominant fuel for generation of electricity
  - The PSMP 2005 had been designed on the basis of the availability of natural gas at the local level
  - Projected demand for gas for the period of 2005-2025 under the PSMP 2005 was about 50 per cent of total energy mix
  - But due to the unavailability of domestic supply of gas the utilization of gas in power generation started to decline from PSMP 2010
- Since 2011 the domestic production of natural gas did not increase much
  - In 2014 the actual gas supply was lower than the projected gas supply mentioned in PSMP 2010
  - The gap in energy demand was mainly covered by crude oil & oil products
  - Projected domestic supply of gas increased from 2016 to 2017 then again started to decrease
- Considering the shortage of natural gas, GoB had plan to import LNG from 2019

4.1 Projection on energy-mix in the PSMPs

Petroleum Oil

- In PSMP 2005, petroleum wasn't discussed widely as an important energy-mix
  - It was widely discussed later in PSMP 2010 and PSMP 2016 as the usage of petroleum was increasing due to the unavailability natural gas and coal
- According to the PSMP 2010, the supply of petroleum in Bangladesh was 3.8 million tons per annum during 2006
  - While the demand for petroleum in different sectors has been increasing, the power sector observed the highest rise in demand for petroleum (6.6% vis-à-vis 4.9% in 2006)

Coal

- One of the most widely discussed energy-mix for power generation is coal
  - Domestic production of coal in Bangladesh first appeared in 2005, and since then it has been used mostly for power generation
  - The quantity demanded of coal for power sector was relatively small at the beginning but its demand has substantially increased with the initiation of the first large coal-based plant in 2017
- PSMP 2005 forecasted that a sum of 10,297 TMT (Thousand metric tons) of domestic coal will be demanded for power sector and zero demand for imported coal
  - According to PSMP 2010, the demand for coal was forecasted to be more than double from 2019 to 2025
  - According to the PSMP 2016, the coal demand of Bangladesh was expected to become 60 million tons in 2041

4.1 Projection on energy-mix in the PSMPs

- Government has recently announced to scrap all coal-fired power plants (12) except three which are either implemented or made considerable progress
    - However, government's stance on scraping coal fired power plants is yet to make through official gazette. Besides, it is unclear how the land of the coal fired power plants to be used
- The 8th fifth year plan did not make it clear the stance on clean power.

Renewable Energy

- The current renewable energy situation in Bangladesh is not impressive
    - It was mentioned in the PSMP 2010 that renewable energy would cover 5% of the total electricity demand in 2015 which is approx. 510 MW. But the actual installed capacity was less
    - PSMP 2016 projected the total installed generation capacity through renewable energy would be 2160 MW by 2020 which would be about10% of total installed capacity (21,600MW in 2020)

Hydro-power

- According to PSMP 2016, the potentiality of hydro-power is evident through high rain fall and water abundance in the Northeast and Southeast part of the country
    - 9 possible sites for hydro power plant project have been identified; however, a huge adverse impact on the livelihood of people would be evident

Nuclear Energy

- PSMP2016 assumed that the first unit of the Rooppur Nuclear Power Plant with a capacity of 1200MW is to start operations by 2024 and the second 1200MW by 2025

4.1 Projection on energy-mix in the PSMPs

Cost of fuel

- Cost for energy in power generation is an important factor in selecting the energy-mix
- Domestic supply of gas is the cheapest fuel option for power generation
    - The price of natural gas is being almost constant in Bangladesh over the period of time through government subsidy even though the international price is increasing day by day
- The second lowest option considered by the government is coal especially domestic coal but the production of domestic coal is low due to environmental and livelihood impact
    - Imported coal is about 25-30 per cent expensive than domestic coal
- Government is using both costly and cheap fossil fuels even some are higher than that of solar energy
    - Since a large part of fuel is now imported, BPDB needs to take the burden of meeting the import payment – during 2016-2020, about US$24.1 billion spent for importing different fuels.

Generation Cost of Electricity (Tk./KWh)

Ownership type	Gas	Furnace oil	Diesel	Coal	LNG (projected)	Solar
IPP	< 3.00	9.00-14.00			12.00-21.00*	
Government owned	3.00	13.00-16.00	15.00-32.00	6.98		11.24
Rental or quick rental	4.00	9.50-13.00	23.00-33.00			

Sources: Prepared by authors based on compiled data from different sources

4.2 Major weaknesses of PSMP: energy-mix issues

- Fuel-mix on an ad-hoc basis: According to the expert, the fuel mix is still happening on ad hoc basis
    - It is alleged that often the fuel-mix is influenced by political and other interests

Fuel Mix: Projected vs. Actual

	2010			2016			2020		
	Low case	High case	Actual	Low case	High case	Actual	Low case	High case	Actual
Coal			4.3	1.5	1	1.6	7.1	11	4.2
Gas/lng			82.8	61.7	62	68.6	49.5	49	71.8
Liquid fuel			8.9	30	30	20.6	35.9	34	13.5
Import			0	4.9	5	7.3	6.5	6	9.3
Nuclear			0	0%	0	0	0	0	0
Hydro+ Renewable			3.9	1.9	2	1.8	1	1	1.3

Sources: Prepared by authors based on compiled data from different sources

- Overdependence on natural gas: PSMP2005 was planned heavily based on natural gas.
    - In 2010 the shortage of natural gas came to spot light and power plants were shifted from gas to coal.
    - The depleting gas reserve was not unknown but wasn't considered
- Imported liquid fuel use increasing: Rising import payment for liquid fuel is a growing concern.
    - This would also raise the burden of domestic and external debt burden

4.2 Major weaknesses of PSMP: energy-mix issues

- Lack of comprehensive plan: Lack of comprehensive plan of energy and power sector is a major weakness for ensuring better functioning transmission and distribution system
  - While new generation plants have been signed a lot but no focus is given on transmission and distribution.
  - In the past, the "country had pillars but no power; now the country has power no pillar".
- Lack of investment in transmission and distribution is another major drawback of transmission and distribution system.
  - Private sector shows interest in power generation plants but they show limited interest in T&D
  - Government has made considerable investment over the last several years in order to improve transmission and generation.
  - Experts advised to concentrate on transmission and distribution in order to ensure reliable electricity service.

4.2 Major weaknesses of PSMP: energy-mix issues

- Lengthy transmission system: Energy experts especially pointed out to the unnecessary lengthy transmission lines
  - There should have T&D connections with industrial zones and industrial parks
- Lack of reliance by the industries on government's T&D: Concerns expressed by the industries about level of efficiency in T&D of electricity supplied by the government
  - Hence industries are relying on their captive power plants
- The safety and environmental concerns of nuclear power plants need to pay attention

4.2 Major weaknesses of PSMP: energy-mix issues

Renewable energy

- Poor record of implementation: There are many investment proposals of Bangladesh regarding solar and other renewable energy, but very few are being implemented (8 out of 36 projects have been implemented)
- SREDA's institutional authority needs to be improved: It is important to note that renewable energy policy is still not supportive, particularly for large scale investment. SREDA needs authority and credibility to sign large scale projects.

Demand-side management

- Load curve is not well-distributed: Load curve of Bangladesh is not in a good condition. On peak the load curve reaches to 10000 to 12000 MW but then in the time of off peak it comes down to 7000 to 8000 MW.
  - On average, 10000 MW is required, so what we can transfer few loads from on-peak to off-peak.
- Limited use of energy-efficient equipment: Bangladesh as a nation have a tendency of cost sensitiveness, so people always tend to buy cheap products and forget that it is for a long time usage.
  - Awareness has to be raised and let people know about the phenomenon of using energy-efficient equipment, which may costs high.

4.2 Major weaknesses of PSMP: energy-mix issues

Tariff

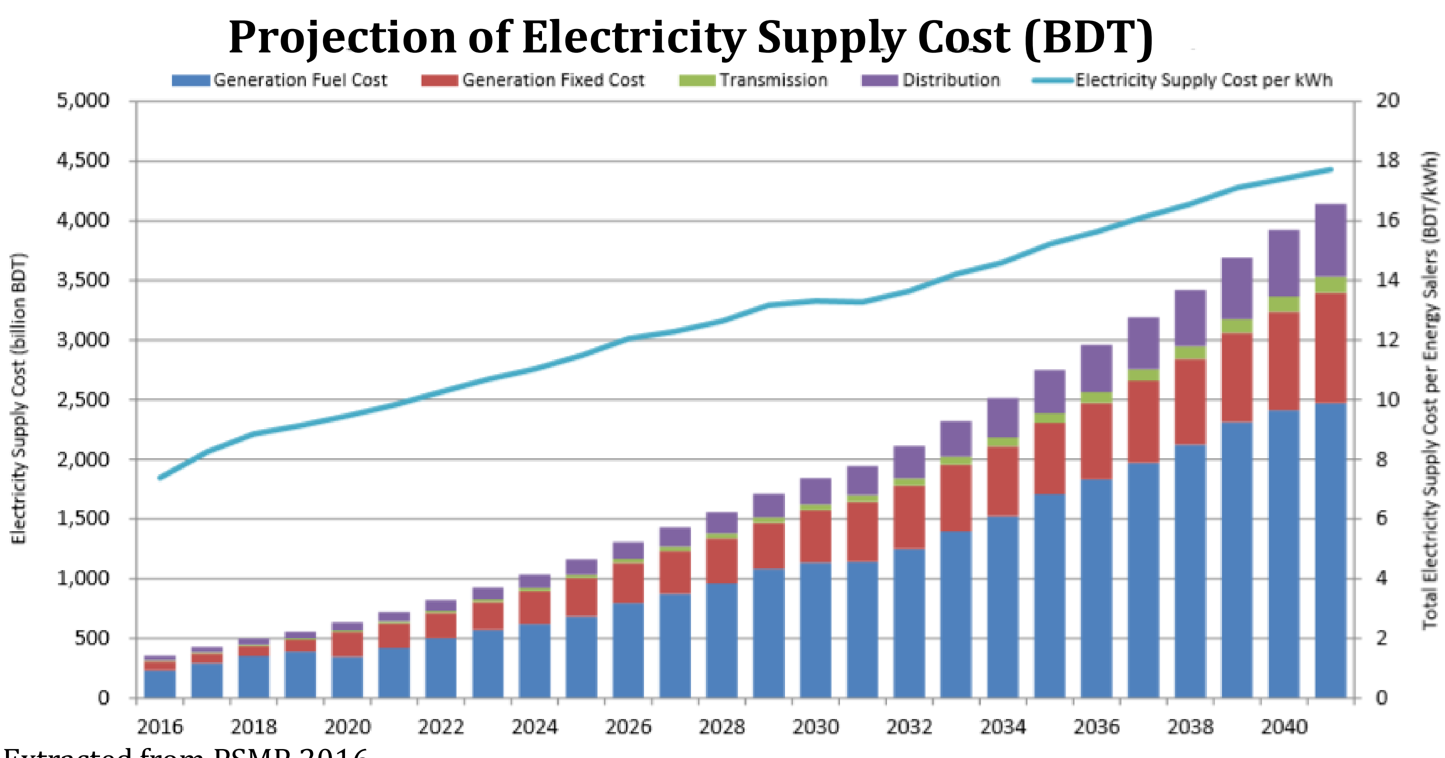
- Currently, the electricity tariff is being determined through administrated pricing system considering the different categories of consumers
    - Without having a transparent and efficient mechanism and capable public agency (without any influence) set-up such rationale and justified pricing would be difficult to implement
- Different levels of tariff have been fixed for different consumer groups.
    - Consumers often need to the take burden of such costs which are not supposed to be under them (e.g. capacity payment to private power producers, use of costly energy-mix)
    - Often government provides subsidy to the power sector in order to accommodate its additional expenditure. The amount of subsidy was about US$1 billion in FY2020.
    - Consumers bear the burden of power generated by fossil fuel with little attention on clean energy

Power Tariff

Range	Rate/unit			% increase from 2015 to 2020 (Paisa)
	1-Sep-2015	1-Dec-2017	1-Mar-2020	
0-50*	3.36	3.5	3.75	11.61
0-75	3.8	4	4.19	10.26
76-200	5.14	5.45	5.72	11.28
201-300	5.36	5.7	6	11.94
301-400	5.56	6.02	6.34	14.03
401-600	8.7	9.3	9.94	14.25
600+	new	10.7	11.46	

4.2 Major weaknesses of PSMP: energy-mix issues

- It was estimated in PSMP2016 that the total electricity supply cost increases from approximately 4.5 billion USD to 41.4 billion USD in 2041
    - With a 9.3% increase per annum
- The average cost of electricity supply per kWh of energy sales was expected to increase from 9.34 US cent/kWh (7.38 BDT/kWh) in 2016 to 17.70 US cent/kWh (17.72 BDT/kWh) in 2041
    - During this period, the average cost of supply increases by 2.6% per annum (3.6% per annum in BDT)



Source: Extracted from PSMP 2016

5. Analytical Framework and Methodologies for Projection of Future Power Demand

5.1 Forecasting techniques for projection of power demand

- Forecasting with the minimum error depends on the selection of an appropriate model
  - Forecasting can be on the aggregated level, or at the lowest level, or even both.
  - Good forecasting is the prior condition for efficient and effective power demand prediction
  - So, the forecasting can be based on top-down approach or bottom-up approach
- Top-down approach: Series are first aggregated to produce a combined forecast, then the forecast is disaggregated.
  - A derived forecast is established for each series usually by means of proportions.
  - In top-down approach, aggregate level forecasts are proportioned down to individual per location forecasts. Top-down approach achieves a better forecast at the aggregate level.
  - This approach begins with the big picture and then narrows in on a specific sector.
  - In order to conduct the analysis, detailed lower level data is very important which helps to aggregate it and use it in a well-fitted model

5.1 Forecasting techniques for projection of power demand

- Bottom-up approach: The forecast is developed for each series individually and then combined to generate a cumulative forecast of the aggregated series.
  - Since it is made up of the combination of the individual forecasts of each series, it is called cumulative forecast
  - Proponents of bottom-up forecasting point to the fact that one can achieve a better mean absolute percent error (MAPE) value at the lower level (Gordon et. al., 1997).
  - This is due in part to the fact that the lower-level models reflect the actual nature of the business. A bias also has been documented in regression co-efficient when aggregated data is used.
- Dangerfield & Morris (1992) found that the bottom-up forecasting outperformed the top-down forecasting in nearly three out of four cases
  - The relative superiority of the bottom-up forecasting was more pronounced as the correlation between the two items increased and/or one item increasingly dominated electronic machine forecast on aggregate level and inter generation models all together
  - These findings were also supported by Gordon et al. (1997), Weatherford et al. (2001) and Diebold (1998, p. 188).
  - However, Gross & Sohl (1990) numerically found that the top-down strategy (with a proper disaggregation method) provided better estimates than the bottom-up forecasting in two out of three product lines examined
  - Other papers in this stream include Barnea & Lakonishok (1980), Miller et al. (1976), Zellner & Tobias (2000) and Zotteri & Kalchschmidt (2007).

5.1 Forecasting techniques for projection of power demand

Comparative Analysis of Bottom-up and Top-down Approach

	Bottom-up Approach	Top-down Approach
Assumption	• No prior assumption is made	• One seasonal pattern fits all, that is, the seasonal pattern both at the aggregate and disaggregate levels are the same
Strength	• Proponents of bottom-up forecasting point to the fact that one can achieve a better mean absolute percent error (MAPE) value at the lower level (see Gordon, Morris, and Dangerfield 1997). • This is due in part to the fact that the lower level models reflect the actual nature of the business. • A bias also has been documented in regression coefficients when aggregated data is used.	• Proponents of top-down forecasting favor smoothing lower level data by aggregating it so that one can develop a better fitting model (the top level model will reflect a better R2 value than lower level models). • It is also felt that top-down models often reflect better accuracy for top-level forecasting.
Weakness	• Bottom-up forecasting often has very poor accuracy at higher forecast levels. • This may be a result of forecast error at intermediate (middle) levels accumulating as data moves up to higher levels.	• The problem is top-down models typically do a poor job of forecasting at lower forecast levels (e.g., ' at the item per location level). • The reason: aggregated data at the top level is an artificial representation of the true nature of the business because such data does not typically reflect sales low level "peaks and valleys," which are canceled by aggregation.
Objective of usage	• If production and distribution schedules (electricity generation and distribution) are driven by forecasts	• If the company uses forecasts to develop strategic plans and budgets
Forecast automation method	• ARIMA	• State Space Models

Source: Prepared by authors based on different web-based materials

5.1 Forecasting techniques for projection of power demand

Traditional methods

- The traditional methods mainly include autoregressive (AR), autoregressive moving average (ARMA), autoregressive integrated moving average (ARIMA), semi-parametric, grey model, similar-day models, and Kalman filtering method (Kouhi & Keynia, 2013).
    - The algorithms have few theoretical limitations; it is difficult to improve the power demand forecasting accuracy using these forecasting approaches

Modern forecasting techniques

The intelligent methods mainly include artificial neural network (ANN), fuzzy systems, knowledge based expert system (KBES) approach, wavelet analysis, support vector machine (SVM), and so on

- Knowledge-based expert system is the combination of knowledge and experience of numerous experts to maximize the experts' ability, but the method does not have self-learning ability
- Modern forecasting techniques have the ability to handle the nonlinear relationships between load and factors affecting it directly from historical data
- KBES is limited to the total amount of knowledge stored in the database and it is difficult to process any sudden change of the conditions

5.1 Forecasting techniques for projection of power demand

Hybrid Algorithm

- As single algorithm method doesn't give appropriate forecasting always, two or more models can be hybridized according to the purpose of the researcher with the aim of forecasting the most accurate load.
    - A new hybrid forecasting method, namely ESPLSSVM (M.Y. Zhai, 2015), based on empirical mode decomposition, seasonal adjustment, PSO and LSSVM model was proposed
    - Hybridization of support vector regression (SVR) with chaotic sequence and EA is able to avoid solutions trapping into a local optimum and improve forecasting accuracy successfully (Zhang et al. 2012).
    - Ghofrani et al. proposed a hybrid forecasting framework. This was a combination of new data preprocessing algorithm with time series and regression analysis to enhance the forecasting accuracy of a Bayesian neural network (BNN)
    - A hybrid algorithm based on fuzzy algorithm and imperialist competitive algorithm (RHWFTS-ICA) is also developed (Enayatifar et al. 2013), in which the fuzzy algorithm is refined high-order weighted
    - Yan Hong Chen et al. used a combination of the global harmony search algorithm (GHSA) with LSSVM to optimize the parameters of LSSVM in their study

5.1 Forecasting techniques for projection of power demand

Advantages and disadvantages of various methodologies

Name of the method	Advantage	Disadvantage
ANN	• Can easily handle nonlinear relationships between dependent and independent variables • Best suited for complex information processing	• Has a black-box nature. The black box implies that while approximating a function, there is less information on the internal structure of the ANN and how it approximates the function. • Faces difficulty in choosing parameters. • ANN also has high computational complexity.
Fuzzy system	• Can be coded using less data, so they do not occupy a huge memory space. • As it resembles human reasoning, these systems are able to solve complex problems where ambiguous inputs are available and take decisions accordingly. • These systems are flexible, and the rules can be modified.	• Completely dependent on human knowledge and expertise. • The accuracy of these systems is compromised as the system mostly works on inaccurate data and inputs. • There is no single systematic approach to solve a problem using Fuzzy Logic. • As a result, many solutions arise for a particular problem, leading to confusion
ARIMA	• Uses the autocorrelation between series of values while the latter targets trends and seasonality	• Fails to capture the rapid changing process underlying the electric load from historical data pattern.
MLR	• Really easy to utilize	• May not always provide the accurate forecast
K mean clustering	• Produce tighter clusters than hierarchical clustering, especially if the clusters are globular.	• Implemented by considering different factors like seasonal consumption, type of consumer and area of consumption
Holt- winter	• Used to cater for seasonal changes in predicting electricity demand	• Best suited for forecasts that are short-term rather than seasonal or cyclic.
SSA	• Useful to implement in a densely populated country	• SSA method is non-parametric and makes no prior assumptions about the dataset
SVM	• Effectiveness with high-dimensional spaces and memory efficiency	• Computational complexity irrespective of the dimensionality of its input space

Source: Prepared by authors based on different web-based materials

5.2 Forecasting methods used in different countries

Methods Used in Different Countries

Name	Study area	Methodology	Variables	Study year
Electricity Demand in Developing Countries	Paraguay	• OLS with combination of log, linear, inverse & interaction variables	GDP per household, Real marginal price of electricity, house size, household size, downtime, dummy variable for Guairá	1977
Supply and Demand of Electricity in the Developing World	Developing countries		GDP, prices, income, the level and characteristics of economic activity/urbanization, and seasonal factors.	2010
A short-term power load forecasting model based on the generalized regression neural network with decreasing step fruit fly optimization algorithm.	China	Decreasing step fruit fly optimization algorithm	Historical data, weather/temperature data	2017
A Review of Electricity Demand Forecasting in Low- and Middle-Income Countries: The Demand Determinants and Horizons	Middle income countries	• The time series modeling approach has been extensively used while forecasting for long and medium terms. • For short term forecasts, artificial intelligence-based techniques remain prevalent in the literature.	the population, GDP, weather, and load data over different time horizons	2020

Source: Prepared by authors based on different web-based materials

5.2 Forecasting methods used in different countries

Methods Used in Different Countries

Forecasting of Turkey's monthly electricity demand by seasonal artificial neural network.	Turkey	• Seasonal ANN	Load data and weather	2017
Forecasting electricity consumption in Pakistan: The way forward	Pakistan	• Bottom-up approach • Winter Holt and ARIMA	Consumption Sectors: Household, Govt. Sector, Street Lights, Commercial, Industrial, Agriculture.	2015
Incorporating Economic and Demographic Variables for Forecasting Electricity Consumption in Pakistan.	Pakistan	• Univariate Time Series Model, • Multiple Linear Regression based Econometric Model	GDP, Income per capita and Population	2011
Electricity Consumption Forecasting in Thailand Using an Artificial Neural Network and Multiple Linear Regression.	Thailand	• Multiple linear regression model • ANN	GDP, Population	2015
Electric load demand forecasting for Aborlan-Narra-Quezon distribution grid in Palawan using multiple linear regression.	Philippines	• Multiple linear regression model	Historical data, number of consumers for past 5 years, development plans (commercial, industrial etc.) for next 10 years	2017

Source: Prepared by authors based on different web-based materials

5.2 Forecasting methods used in different countries

Methods Used in Different Countries

Long term load forecasting using K-mean clustering and ANN approach	India	K-mean clustering and ANN	Load data and population	2018
Indonesian electricity load forecasting using singular spectrum analysis, fuzzy systems and neural networks.	Indonesia	Singular spectrum analysis, fuzzy systems and neural networks	Load data	2019
Electricity load demand forecasting using exponential smoothing methods.	Malaysia	Holt-Winters Taylor(HWT),Holt-Winters, modified Holt-Winters exponential smoothing	Previous load data, seasonal patterns	2013
Bottom-up methodology for long term electricity consumption forecasting of an industrial sector-Application to pulp and paper sector in Brazil.	Brazil	Bottom-Up Approach	Previous load data (1995–2015),electric consumption by process, value added of different sectors, electricity price, production and value addition forecasts until 2050	2017
Singular spectrum analysis for forecasting of electric load demand.	Venezuela	Singular Spectrum Analysis of Time Series Data	Load data	2013
Electricity energy outlook in Malaysia	Malaysia		Population and income growth	2013

Source: Prepared by authors based on different web-based materials

5.3 Countries Taking Measures for RE-based Energy-mix

- India: The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy established in 2006.
  - *Target:* To boost India's renewable power capacity from 86.3GW in 2020 to 450 GW by 2030.
  - *Policy support:* The revised tariff policy requires all States to reach eight percent solar RPO by the year 2022. Solar water heaters and rooftop systems have been promoted through regulatory intervention. Off-grid and rooftop solar applications have been promoted through the provision of subsidies from the central government. R&D is also being encouraged
- United Kingdom: The year 2020 was a record year for renewable energy in the UK, accounting for almost 42% of the country's electricity
  - *Target:* To increase renewable electricity target from 50% to 65% by 2030
  - *Policy support*: The UK is establishing a financial framework that provides long-term, comprehensive and targeted support for renewable technologies. Taking steps to identify and address those issues that affect the timely deployment of established renewable technologies as well as developing emerging technologies
- Germany: Germany is unique in terms of its advanced renewable energy policy. The Energiewende aims to transform the country's energy system based on the twin pillars of renewable energy and energy efficiency
  - *Target:* 65% renewable power by 2030 and 80%-95% by 2050
  - *Policy support:* The Renewable Energies Act provides for special feed-in tariffs for electricity from renewable energy sources.

6. Conclusion: Recommendations

6. Conclusion: Recommendations

- The decision taken by the MoPEMR for preparing the new power and energy system master plan is a welcome initiative
  - This is particularly important when Bangladesh is in the process of energy transition with a view to scaled down the usages of fossil fuel and scaling up the usages of renewable energy
  - The sector needs to address a number of emerging challenges in view of covid 19 pandemic – excess capacity, huge capacity payment, inefficiency, use of expensive energy and high financial burden
- As like the earlier cases, JICA has agreed to work with the ministry in preparing the PSPEMP
  - JICA mentioned in its website (15 March, 2021) that the aim is to promote a low or zero carbon transformation of the total energy supply and demand system.
  - It will have an inclusive and long-term view, working for sustainable development, and will contribute to SDGs Goals 7 and 13.
  - This time the master plan project will also strengthen the capacity required for policy and planning development and energy data management so that in the future the Bangladesh government can carry out energy and electrical development independently.
  - It is important to review the ToR how the zero carbon emission initiatives have been designed in the preparatory process in order to incorporate that under the new Plan.
  - It is expected that BPDB will ensure sufficient consultation with private sector and CSOs

6. Conclusion: Recommendations

- Review of the earlier PSMPs has revealed a number of important observations which needs serious consideration while drafting the new PESMP
  - According to the PSMPs and BPDB, the power sector is almost close to meet the demand with its existing generation. In the future, power sector needs to create capacity only to cater the prospective incremental demand in different activities.
  - Installed capacity was way above the realized demand – even almost double than the reserve margin (44% vs. 25%)
  - PSMPs have been projected power demand based on only one variable – GDP/GDP growth which seems to be a weak method
- A number of weaknesses have been observed in the demand side analysis in the PSMPs. These include -
  - (a) Longer term projection weaken the plan, (b) mismatch in demand, (c) limited number of variables considered, (d) differences in weights of sectors between GDP and electricity consumption, (e) faulty longer projection, questionable GDP estimates, (f) long wish list of the government, (g) faulty of undertaking sectoral approach, (h) limitation of data and (i) lack of dedicated institutional support for data

6. Conclusion: Recommendations

- PSMPs are overwhelmingly based on fossil-fuel – initially on natural gas, followed by coal, petroleum and LNG along with natural gas
  - There is little focus on renewable energy; solar and hydro-power energy have been marginally reflected in the PSMPs
  - CPD appreciates government decision to scrap all coal fired power plants (23) except three which are either implemented or at advanced stage of implementation
- Major weaknesses regarding energy-mix include fuel-mix include
  - (a) decision on energy mix on an ad hoc-basis, (b) overdependence on natural gas/LNG, (c) rising financial burden of imported fuel, (d) lack of comprehensive plan by including transmission and distribution along with generation, (e) lack or limited investment on transmission and distribution, (f) lengthy transmission system, and (g) lack of understanding and proper planning
  - Regarding the renewable energy challenges are poor record of implementation and lack of authority of the SREDA
- From load management point of view major challenges include load curve is not well-distributed and limited use of energy-efficient equipment

6. Conclusion: Recommendations

- Different countries have applied different methods for forecasting power demand from the two-core forecasting framework – (a) top-down approach and (b) bottom-up approach
  - These approaches have various advantages and limitations
  - Major methodologies applied by different countries include ANN, ARIMA, MLR, SSA, SVM, Holt-Winters, modified Holt-Winters exponential smoothing, Singular Spectrum Analysis
  - Bangladesh should take due cognizance to any of these appropriate methods

- The new power and energy system master plan should be drafted based on the following principle
  - To be applied advanced method for estimating the demand forecast
  - Taking into account the limitations/weaknesses of earlier methods
  - Aiming to reduce excess installed capacity in a phased approach
  - Ensuring due importance in transitioning towards clean power by gradual phased-out of fossil-fuel and phased-in of renewable energy

6. Conclusion: Recommendations

- Bangladesh should undertake bottom-up approach with micro predictions
  - These micro-prediction will cover each sector and sub-sector
  - The projection need not be required to do for long period rather should be for 5 years
  - Limitations of data on each sector and sub-sector will need to be addressed. In case the data are not available, necessary survey should be conducted by an independent institute, particularly BBS
  - Data management of the ministry needs to be strengthened with appropriate institution, human resources and logistics
- The new plan shall specifically mention about the required installed capacity (lower case and upper case) and how to phased out excess capacity
  - It will provide how the energy-mix could be gradually made balanced with increasing share of renewable energy
  - Most importantly, it should suggest the revised reserve margin ratio (which should not be more than 10%)
- The demand side of the new plan will highlight on weaknesses in creating huge excess installed capacity and way-out of the excess capacity
  - Phasing out of investment in power generation in fossil-fuel based plants
  - The plan should strictly mention about no extension of quick rental power plants after the existing contracts expire
  - The plan should strictly mention about discontinuation of power plants which are dated, inefficient and using expensive energy
  - The plan should strictly take its stance that LNG-based power plants will not be set up in the land earlier planned for coal-based power plants

6. Conclusion: Recommendations

- The plan should discourage new investment for generation particularly through fossil-fuel including LNG
- The plan should highlight investment in transmission and distribution of electricity
  - Proper coordination between generation and T&D system
- The Plan should take its bold stance on clean-energy based power generation in the country through a phased-approach
  - The plan should provide direction about pro-active measures towards ensuring renewable energy – most importantly, how the share of renewable energy could be enhanced both by phased-out of fossil fuel and phased-in renewable energy
  - Strengthening SREDA particularly raising its authority to sign agreement for large scale renewable energy project
- The PSMP is expected to put priority on gradual phased-out from the administered power tariff to market-based power-tariff
  - Necessary protection should be ensured for target groups (e.g. low-income people, SMEs)
  - BERC should be more transparent and independent in taking decisions with regard to setting power tariff considering each of the important factors into account
- Given the development of the power and energy sector, PESMP should suggest repealing of the 'Speedy Supply of Power and Energy Act' immediately.

6. Conclusion: Recommendations

- A dedicated monitoring team should be formed so that changes in electricity demand can be observed and altered accordingly
    - Government should make a high-powered committee with concerned public offices to monitor implementation of the new PESMP
- The new PESMP should highlight on ensuring green and sustainable energy within the country as part of undertaking preparation for smooth LDC graduation
    - The Committee for Development Policy (CDP) has recommended accordingly
- Since the country is in energy-transition, this PESMP is the right document to highlight how renewable energy will be emphasized in the power sector for the future.
    - There is high risk of shifting it away from that direction
- The PESMP should put forward policy suggestion that will ensure that the industries are established in specified areas including SEZs, EPZs, BSCIC area, industrial village, industrial clusters and other declared areas
    - This could help better transmission and distribution of electricity
- PESMP should suggest for power tariff based on a cost-benefit analysis in order to ensure reasonable price for the consumers
    - It should suggest gradual introduction of market-based tariff setting mechanism
- PESMP should suggest use of energy efficient equipment and for that necessary awareness raising initiatives.

- Overall, the next PESMP must show a clear path towards *Energy Transformation* in Bangladesh.
    - Opportunities available for generation of RE to effectively address the existing Climate Emergency in general and Paris Accord in particular.

Thank you.