

Electric Power Generation-Mix for Bangladesh and Its Future

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Abstract— Bangladesh is a developing country and over populated nation using electricity 80% of people. Electricity demand is gradually rising day by day. Electric power generation-mix is share sources from where electricity produces. Generation sources are significant for the country those depend on geography, demography, environment and economics. So, natural gas is large share in electricity generation mix in Bangladesh. Respectively other sources like oil, coal, hydro, renewable energy are contributed for generating electricity. In future, renewable, coal, uranium will be more in generation share. The cost of electricity depends on economic and market of country. In this paper, spatiotemporal data of electric power generation mix and cost are analyzed and revealed electricity cost of per unit varies with consumer and distribution line Voltage. The analysis of this paper shows future of electric generation mix (renewable energy, coal and uranium) is best option for the large capacity power plant in Bangladesh to satisfy electricity demand.

Keywords— Generation-mix, Price, Renewable energy Natural gas, Wind, Coal.

I. INTRODUCTION

Electric power generation mix of a country defines the percentage of power produces from various types of energy source. There are two types of energy sources which are renewable and nonrenewable energy sources. If the Electric power generation mix of a country is known, anyone can easily understand the availability of energy sources of this country and also predict future power generation sources. Electric power generation-mix depends on a particular geographical location and time.

World Energy share presents comprehensive world electricity generation mix on all energy sources - coal, gas, oil, electricity, renewable sources and waste. Coal is the highest source (39.3%) of electricity generation mix in the world. It is followed by natural gas which is contributed 22.9% in World electricity generation. Hydro (16%), nuclear (10.6%), Renewable energy excluded hydro (7.1%) and oil (4.1%) are respectively in the list of electricity generation mix in the world [1]. Compare to geography and demography, Uranium shares in electricity generation mix in USA whereas Australia does not have nuclear in mix [2]. Price of Electric power is determined by region economic and product price of country. Unit price of power of USA is

10.54 cents and Australia is almost 25 cents [3] [4]. So, the composition of the energy mix depends on the availability of usable resources domestically or the possibility of importing it for each region or country considering Policy which depends historical, economic, social, demographic, environmental and geopolitical factors [5].

Agriculture income based Bangladesh is one of world's most populated countries. Demand of energy creates with rapid urbanization and industrialization in Bangladesh. So Bangladesh government should ensure electrical energy generation mix for the people that will be affordable and environmentally friendly. Energy sector in Bangladesh is reviewed. And it is hard to accomplish Millennium development goals (MDG) and Sustainable Development Goal (SDG) without improving energy sector [6]. Bangladesh government has already taken action to announce tax breaks for foreign investors in renewable [7]. Though Renewable currently play a small role in Bangladesh's fuel mix, despite domestic roof-top solar power units have brought electricity to over a million homes which are not on the grid. There are lots of opportunities in urban building to establish on grid solar power. The authority of Power Development is in the process of carrying out Bangladesh government goals for the coal and uranium based power plants. Electricity market and cost of energy are hard to determine for power plant project. The competitive electricity market is optimized by game theory for revealing existence Nash equilibrium for network incommodity. [8]. Last ten years, there is no any wind energy project in Bangladesh. This uncertainty of wind generation and market is managed proposing wind induced demand response (WIDR) using bi-level optimization frameworks [9]. The levelized cost of electricity (LCOE) including import and export is discussed for the each country [10].

In this paper, a spatiotemporal data of electricity generation mix and prices of Bangladesh are analyzed for future indication using excel. World Bank organization maintains online data bank and data is used for this research and analysis [11]. The objective of this paper is to explore electricity generation mix and cost which are an effective

generation-mix towards the long-term energy security of Bangladesh.

II. STATUS OF ELECTRIC POWER IN BANGLADESH

Bangladesh is a developing country, population of 162.95 million with growth rate 1.1%. The Population density is 1251.8 per sq. km of land area. Electric power consumption is 407 kWh per capita. Table I. shows the country profile of Bangladesh [12].

TABLE I. COUNTRY PROFILE OF BANGLADESH

Population, total (millions)	162.95
Population growth (annual %)	1.1
Surface area (sq. km) (thousands)	147.6
Population density (per sq. km of land area)	1,251.8
Urban population growth (annual %)	3.3
CO ₂ emissions (metric tons per capita)	0.46
Electric power consumption (kWh per capita)	407
Access to electricity (% of the population)	80%
Access to electricity, rural (% of rural population)	68.85
Access to electricity, urban (% of urban population)	94.01

Bangladesh power generation capacity has increased from 13,883 megawatts (MW) in 2015 to 15,351 megawatts (MW) in 2017. Bangladesh Government shares 56% of total power generation and private sector share 46%. In Bangladesh, the Maximum Power generation in 2018 is 11387 MW. In Dhaka 3965 MW, in Chittagong 1094 MW, in Comilla 998 MW, in Mymensingh 767 MW, in Sylhet 475MW, in Rajshahi 1160MW, in Khulna 1342MW, in Barishal 273 MW, in Rangpur 577 MW maximum power generate. Bangladesh imported power 660MW. In Bangladesh, future power demand will need 34000 MW by 2030 [13]. Table II shows the installed, generation capacity of power in Bangladesh.

TABLE II. POWER SECTOR OF BANGLADESH

Installed capacity	16193 MW
Generation capacity	15351 MW
The Share of Government(%)	56
The Share of private (%)	46
Electricity coverage(%)	90

III. ELECTRIC POWER GENERATION MIX

Bangladesh power sector generates power from different types of Energy sources like nonrenewable energy sources and renewable energy sources. The non-renewable energy sources in Bangladesh which are coal, natural gas, oil etc. The Renewable sources of energy in Bangladesh are hydro, solar, biogas, wind etc. In fig.1 Electricity generation mix of Bangladesh is shown where data are given from 2001 to 2015 [11]. From the year of 2001 to 2010 Electricity generation from natural gas in Bangladesh was increased but after 2010 Electricity generation from natural gas in Bangladesh gradually decreased. From the year 2001 to 2010 Electricity generation from oil gradually decreased but after 2010 Electricity generation from oil gradually increased due to electricity production from natural gas was decreased. From Coal electric power generation start in 2006 and gradually increased in 2017 and 2018. After 2008

Electric power generation from coal was decreased. In 2012 and 2013 Electric power generation from coal remain the same but it was less than the previous year. In 2014/15 Electric power generation from coal was less than previous. Electric power generation from nuclear energy was not available in Bangladesh till 2015. From Hydroelectric power plant, Electric power generation in 2001 is 5%. After 2001 Electric power generation From Hydroelectric power plant is reduced. Now one hydroelectric power plant is situated in kaptai which capacity 230MW From Renewable energy Electric power generation is started from 2014.

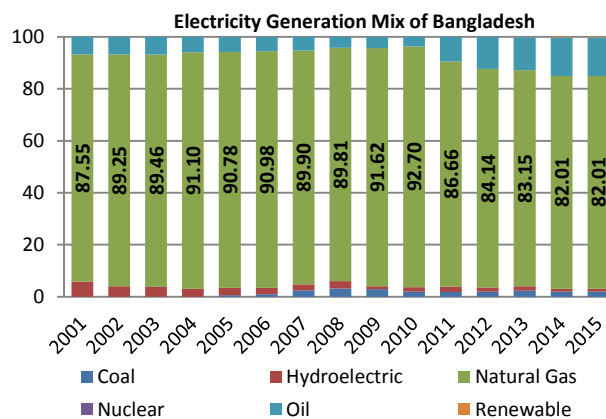


Fig. 1. Electric Power Generation Mix of Bangladesh

IV. RENEWABLE ENERGY MIX IN BANGLADESH

Government of Bangladesh (GOB) tries to send power for all people and non-renewable energy is depleting rapidly by 2021. So that, GOB and private sector increase investment in the renewable sector. Currently 2.87 percentages is share in power generated from renewable energy in Bangladesh.

The Government has planned the most creative power generation plan for the fuel diversity. GOB is trying to add 2 GW generations every year up to 2021. So, Renewable Energy dependable projects can help to contribute Bangladesh to fulfill its policy goals. Renewable energy R&D authority has implemented 37.50 kWp Solar System on rooftop of Bidyut Bhaban and 32.75kWp Solar System on WAPDA Bhaban terrace. On-grid 3 MWp solar PV power plants have implemented in Sharishabari and Jamalpur and 0.9MW grid connected Wind Turbine power plant in Muhuri Dam and Feni. BPDB has also installed another Wind turbine Power Plant of Capacity 1 MW at Kutubdia. There is more project are ongoing based on solar and wind which is observed by BPDB and IPP [14]

Bangladesh is situated from 20.30 degrees north to 26.38 degrees north latitude and 88.04 degrees east to 92.44 degrees east which is an ideal location for solar energy utilization. Bangladesh receives an average daily solar radiation of 4-6.5 kWh/m² [15]. In Bangladesh, Solar Home Systems (SHS) are very popular. Every division in Bangladesh has SHS in details Table III. SHS is established 26.21% in Dhaka, 19.50% in Chattagram, 10.63% in Sylhet, 14.02% in Rajshahi, 18.56% in Barishal, 11.10% in Khulna, 26.21% in Dhaka [16].

TABLE III. SOLAR HOME SYSTEM IN BANGLADESH

Divisions	Solar home system (%)
Dhaka	26.21
Chattagram	19.50
Sylhet	10.63
Rajshahi	14.02
Barishal	18.56
Khulna	11.10

V. ELECTRICITY COST IN BANGLADESH

The uninterrupted quality supply ensures exact value of product. This is especially true for electricity energy. But it is important to determine the proper cost of product in a country otherwise the economics of livelihood will be costly. In Bangladesh, there are different types of electricity cost which depends on usages.

TABLE IV. COST OF ELECTRICITY POWER NONCOMMERCIAL

Unit	Energy Rate (tk/kwhr)	Demand Rate (tk/kw/month)
0 -50 (lifeline)	3.50	25
0-75	4.00	
76-200	5.45	
201-300	5.75	
301-400	6.02	
401-600	9.30	
More than 600	10.70	

In Bangladesh, per unit price of power for 230V single phase and 400V three phase line (Lifeline) in the Residential area is 3.50tk for unit 0 to 50, 4Tk for unit 0 to 75, 5.45Tk for 76 to 200 unit, Tk. 5.75 for 201 to 300 unit, 6.02 Tk. for 301 to 400 unit, Tk. 9.30 for 401 to 600. Above 600 units the price of power per unit is 10.70tk. If the unit increases the rate also increases. The demand charge in the Residential area is 25tk/kw/month. For 11KV and 33KV line per unit price of power in the Residential area is 8tk. But peak hour per unit price of power 10tk and off-peak hour per unit price of power 7.20. Demand charge for the 11KV line is 50tk and for the 33KV line, it is 40tk. Table IV show per unit price of power for the Residential consumer in Bangladesh [17].

TABLE V. ENERGY RATE AND DEMAND RATE FOR COMMERCIAL

Line	Time	Unit price (tk/kwhr)	Demand rate (tk/kw/month)
230V/400V	Flat	10.30	30
	Off-peak hour	9.27	
	Peak hour	12.36	
11KV	Flat	8.40	50
	Off-peak hour	7.56	
	Peak hour	10.50	
33KV	Flat	8.30	40
	Off-peak hour	7.47	
	Peak hour	10.38	

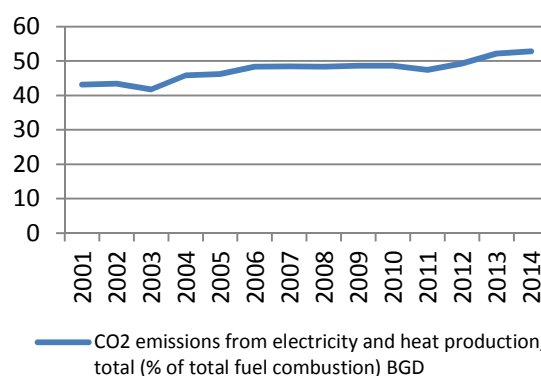
In agriculture sector per unit price of power 4tk and the demand charge 15tk.for small industry per unit price of power 8.20tk. But peak hour per unit price of power 9.84tk

and off-peak hour per unit price of power 7.38tk.In industry the demand charge for 25kw 15tk/kw/month but above25kw its 25tk. Table V shows the energy rate and demand rate for commercial sector [13].

VI. CONCLUSION

In Bangladesh, the population is rapidly increasing and fossil fuel is depleting day by day. The consumption of electricity 310KWh per capita and 76% population get electricity in Bangladesh. Electricity demand is increasing demand day by day. Coal and Uranium will be added as a high percentage in electricity generation mix in Bangladesh. Both sources have the ability to produce a huge amount of electricity to fulfill the demand.

CO₂ emissions from electricity and heat production, total (% of total fuel combustion) BGD

Fig 2. CO₂ Emission in Bangladesh

Present, most electric Powers generate from natural gas. Hydroelectric power plant adds less power in the national grid. From oil and coal electricity generation is increased day by day. So that, more CO₂ (Carbon dioxide) is emitting in the air of Bangladesh, shown in fig 2. Government of Bangladesh encourages to private and public owners to invest on the renewable energy project, accomplishing MDG and SDG for the development of the country without carbon emission. If renewable energy adds in power sector rapidly, per unit price of power is decreased as renewable energy sources are abandon. And 100% people can use energy which is an important goal of Bangladesh government. End of the paper, it is clear that Electricity generation mix build prosper nation considering education environment, global warming, stability, socio-economic and geographical location.

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