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A Case Study on Optimal Mix Electricity Generation & Demand Calculation of Bangladesh By 2042

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Abstract

Bangladesh has demonstrated strong economic fundamentals with a consistent GDP growth rate over 7 percent in last few years. With this rapid economic growth, the demand of electricity will also be increased. Since the development of power sector is dependent on many factors, the power sector of Bangladesh is very challenging. In this case study, a brief discussion on Power sector of Bangladesh has demonstrated with recent information and data including power crisis of the country. Future plans and programs of Power sector has been discussed too. A detailstudy on power demand and production is also calculated. Our main objective was to provide a genuine power scenario of Bangladesh and calculate the upcoming demand by 2042 which will be followed by some recommendations through which the Power sector of Bangladesh can improve. The forecasting was calculated by multiple regression analysis using GMDH Streamline software.

Keywords: Demand forecasting • Multiple regression analysis • GDP • Renewable energy

Introduction

Electricity is the major source of power for most of the country's economic activities. Bangladesh's total installed electricity generation capacity (including captive power) was 15,351 megawatts (MW) as of January 2017 and 20,000 megawatts in 2018. The country's power sector showed a rapid growth in the recent years, with currently providing 80 percent of the country's total population effective access to electricity, according to official sources.This demand is fueled by the sustained growth in GDP in recent years. Bangladesh Government has undertaken various projects to meet this rapidly growing demand. New policies have been drafted to cope with the challenges in the energy sector.

A long-term plan of electricity generation against the demand up to 2030 has been incorporated in the PSMP 2010 (Power System Master Plan). Under the plan, generation capacity requirement in 2021 will be 24,000 MW against the demand of 20,000 MW and in 2030 generation capacity will be 40,000 MW against the demand of 33,000 MW.

But up to now, it has not been possible to achieve reasonable success in meeting the growing demands. The gap between the projected demand and the actual demand is increasing because of inadequacy of indigenous resources, improper planning, unreliable policies and decisions on the development of power sector. Similar to many other developing countries, Bangladesh is facing enormous challenges to provide affordable, reliable and equitable energy supply to its citizens and industries [1].

In this case study, it was tried to study on whole power scenario of Bangladesh including generation and demand. A details study on power plants of Bangladesh and power crisis of Bangladesh has been discussed. Our main objective is to provide a genuine power scenario of Bangladesh and calculate the upcoming demand by 2030 which will be followed by some recommendations through which the Power sector of Bangladesh can improve.

Literature Review

Load forecasting helps an electric utility to make important decisions including decisions on purchasing and generating electric power, load switching, and infrastructure development. The subject of load forecasting has been in existence for decades to forecast the future demand. This involves the accurate prediction of both the magnitudes and geographical locations of electric load over the different periods of the planning horizon. Electricity demand forecasting is considered as one of the critical factors for economic operation of power systems. Bunn and Farmer infers that accurate load forecasting holds a great saving potential for electric utility corporations. The maximum savings can be achieved when load forecasting is used to control operations and decisions like economic dispatch/ unit commitment and fuel allocation /on -line network analysis. [2] According to Haida and Muto, the operating cost is increased due to the forecasting errors (either positive or negative).This part of the research work is necessary to establish the statistical relevance of the proposed research work, establish a generalized research question, analyzing existing methods, and explore areas of possible improvements.

The traditional load forecasting techniques may be grouped broadly in four groups:

[1] Regression, [2] multiple regression, [3] exponential smoothing andIterative reweighted least-squares technique.

Multiple Regression is often used to forecast the load affected by a number of factors ranging from meteorological effects, per capital growth, electricity prices, economic growth etc. Multiple Regression analysis for load forecasting uses the technique of least-square estimation. The Polynomial degree of influence of the variables from 1 to 5 can be selected by the data analysis program [4].

The regression analysis is a statistical tool that aims to explore the strength of the relationship between one dependent variable which is the respond variable and one or many other changing variables known as the independent variables or the explanatory variables. It is a powerful technique that uses the values from historical data of one or more variables to develop a model that helps in predicting the value of the dependent variable (Suri, 2006).

This demand forecast calculation based on GDP has one independent variable and two dependent variables. This problem can be solved in multiple regression among the stated methods. That's why multiple regression analysis method is selected.

The calculation method of multiple regression model is both complex and sensitive. That's why high accuracy must be ensured to get the most accurate solution. In these case, an accurately programmed software must be used rather than manual process. GMDH Streamline is an advanced demand planning and inventory optimization solution for distributors and manufacturers. This software effectively incorporates modern planning technologies and

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strategies with inventory optimization tools and provides crucial and timely information for decision-making. The software has been proven dependable by Jasol(cleaning and hygiene solutions), UBS (United Bible Societies), Respiratory Therapeutics Group etc. [3].

Multiple regression generally explains the relationship between multiple independent or predictor variables and one dependent or criterion variable.A dependent variable is modeled as a function of several independent variables with corresponding coefficients, along with the constant term.Multiple regression requires two or more predictor variables, and therefore it is called multiple regression.

The multiple regression equation explained above takes the following form:

$y = b_1 x_1 + b_2 x_2 + \ldots + b_n x_n + c$.(1)

Here, b_i's (i=1,2…n) are the regression coefficients, which represent the value at which the criterion variable changes when the predictor variable changes.

Since among many available software, GMDH is the most powerful of the sales forecasting system, it is used in this work for the calculation of multiple regression method.

Bangladesh is moving forward to be an industrialized country. As a result, day by day the demand for electricity is increasing at a higher rate. So, to reach a solution to the electricity demand problem, at first it is needed to forecast the upcoming demand regarding GDP. For forecasting this demand where there are many methods, among them multiple regression analysis satisfies with the needed conditions. So, this method will be used in this paper to forecast the demand up to 2042 using the GMDH Streamline software.

Data Calculation

All the necessary data were collected from Bangladesh Power Development Board (BPDB) [5]. As the GDP was at a constant rate of 7% for some few years, the desirable economic growth rate would be 7% in this calculation. Starting from the year of 2010 to 2030 was the input data for this calculation. These input data was first placed to excel spreadsheet to make a table. After opening the GMDH Streamline softwer the input data was imported from the MS excel spreadsheet. GDP was set to 0.7 and horizon was set to 12. The calculated data is given below (Figure 1), (Tables 1 & 2).

After the calculation, it was found that the demand has increased to 25,199MW by 2025; 33,708MW by 2030; 43,551MW by 2036 and 53,545MW by 2042.So, the percentage of increase in electricity demand is compared to 2018:

In 2025,

$$\% \text{ increase} = \frac{25199-14014}{14014} \times 100 = 79.30\% \quad (1)$$

In 2030,

$$\% \text{ increase} = \frac{33708-14014}{14014} \times 100 = 139.63\% \quad (2)$$

In 2036,

$$\% \text{ increase} = \frac{43551-14014}{14014} \times 100 = 209.42\% \quad (3)$$

Table 1. Collected Data for demand forecasting from PSMP 2010.

Fiscal Year	Peak Demand (MW)
2010	6,454
2012	7,518
2013	8,349
2014	9,268
2015	10,283
2016	11,405
2017	12,644
2018	14,014
2019	15,527
2020	17,304
2021	18,838
2022	20,443
2023	21,993
2024	23,581
2025	25,199
2026	26,838
2027	28,487
2028	30,134
2029	31,873
2030	33,708

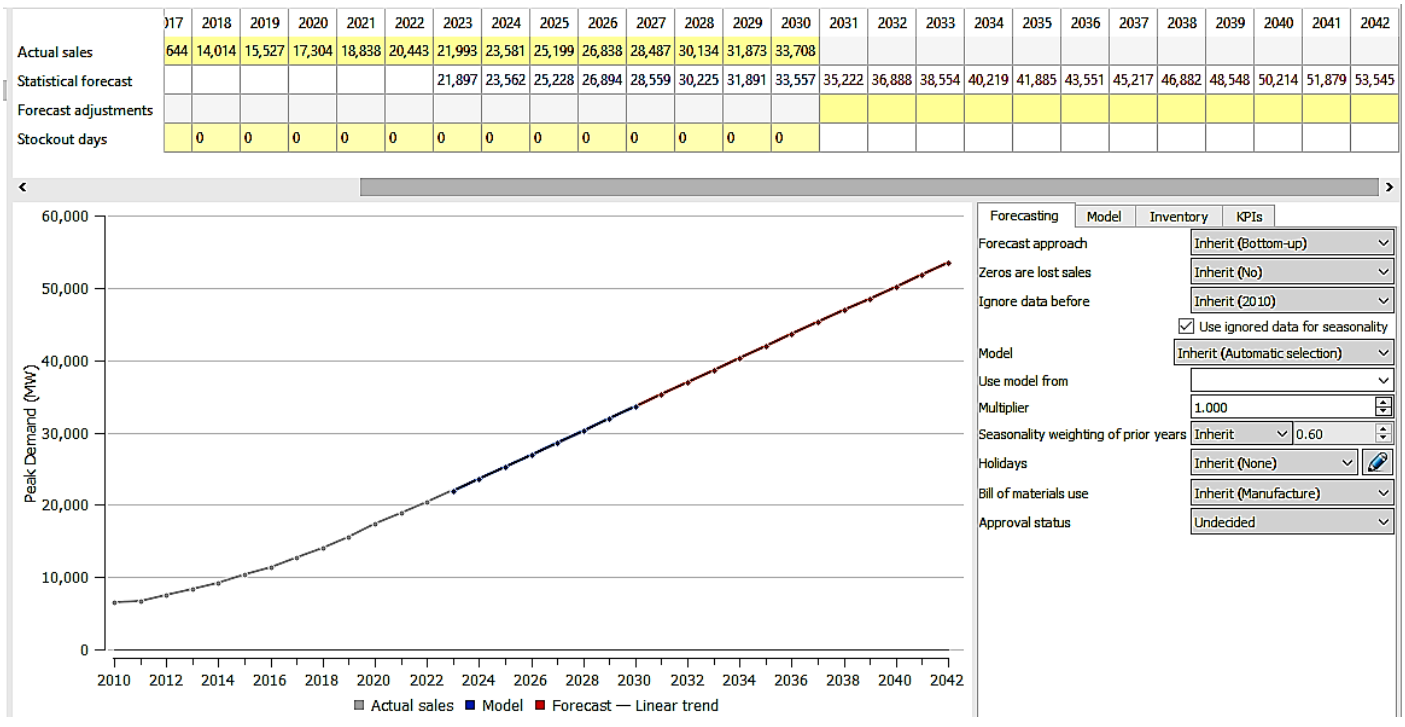

Figure 1. Calculated data on GMDH Streamline software.

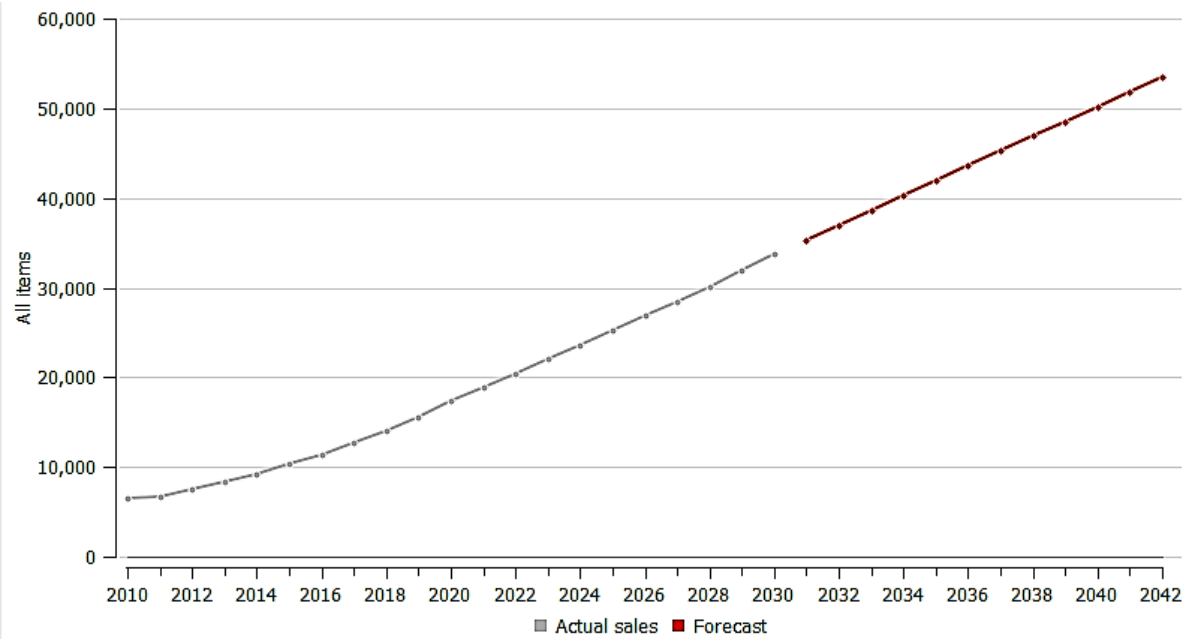

Figure 2. Result.

Table 2. Calculated data of demand forecastingusing GMDH Streamline software.

Fiscal Year	Peak Demand (MW)
2031	35,222
2032	36,888
2033	38,554
2034	40,219
2035	41,885
2036	43,551
2037	45,217
2038	46,882
2039	48,548
2040	50,214
2041	51,879
2042	53,545

In 2042,

$$\% \text{ increase} = \frac{53545 - 14014}{14014} \times 100 = 280.28\% \quad (4)$$

Result

According to our data analysis and calculation, the result which is found that if GDP continues to grow at least at 7% average then the aggregate power demand is expected to grow by 79.30% during 2025 and 139.6% during 2030. It is expected that the aggregate power demand will increase by around 209% during 2036; and also around 280% during the year of 2042. According to that the demand will be around 53,545 MW against 14014 MW during 2018 (Figure 2).

Recommendations

According to the power generation capacity of the nation will reach to 34,000 MW in 2030.

- Contribution of Natural gas in total power generation will reduce to 22.87% during to 2030 against 56.06% in 2010.
- It is expected that Coal will be the major source of fuel for power generation during 2030, as per PSMP, around 50% of the power generation will come through Coal against 3% in 2010.
- Nuclear power generation will be around 10.34% and power import will be around 9.04%.

Currently, the nation rely on natural gas for power generation i.e. around 56% of power generation comes through Natural gas, but due to environmental issue and shortage in supply it is believed that the natural gas consumption will come down in near future.

Coal is expected to become the major fuel for power generation in future, currently the nation imports around 3.5 MnT. It is believed that in order to meet the aggregate power demand and shortage of Natural gas, the import will rise to 30 MnT during 2030.

Why Nuclear Power is recommended

Energy planning of a developing country such as Bangladesh is a great challenge if a target is set to ensure sustainable development. Being low the present energy consumption of Bangladesh, the road map of its development is affected greatly. Since the gap between demand and generation for electricity is increasing day by day, there is no alternative way to meet the power crisis without nuclear power.If Bangladesh is to get out of the chronic power shortage problem and look for energy security, entry into a long term nuclear power program should not be delayed anymore and decision has to be made by Bangladesh not by other countries. Safety and safeguards issues can be dealt with by BAEC and IAEA.

Local Coal Potential of Bangladesh

The Bangladesh Ministry of Power and Energy recently asserted that the country must more than double delivered power within the next five years (from around 4,000 MW to 9,000 MW per day). With the installation and operation of four new coal-fired power stations, it is claimed that the current daily gap between generation and demand would be reduced to 1,500 MW [6]. According to Bangladesh's National Energy Policy 2004 (quoted in The Independent, May 9) total coal reserves are 2,527 million tonnes, contained in four fields: Barapukuria with around 300 million tonnes; Phulbari with 400 million tonnes; Jamalganj containing 1,000 million tons, and 450 million tonnes at Khalaspir. Of these resources, 492 million tonnes are estimated to be recoverable by mining.

Barapukuria is already in electricity production of 500MW and recently added another plant of 275 MW which sums up electricity generation of total 775 MW. It will be a great asset for the country if other fields also join in production.

However, the key questions are: how much of this coal, and of what quality,

is actually usable; and when would it realistically be available to generate electricity? This is something that the proposed joint feasibility study between government and the Japan International Cooperation Agency (JICA) will hopefully address.

Renewable Energy and Potential

In line with the Renewable Energy policy 2009, the Government is committed to facilitate both public and private sector investment in Renewable Energy projects to substitute indigenous non-renewable energy supplies and scale up contributions of existing Renewable Energy based electricity productions.

Wind Energy Potential of Bangladesh

Though Bangladesh has a large coastal area. This might have think it can produce a huge amount of electricity using these areas. But the actual scenario is different. In support of the USAID Bangladesh Mission, NREL, in collaboration with the GOB, development of a national wind resource assessment that involved creation of a preliminary and final wind resource model. [7] As a result of this project, the wind profile and specific attributes are now well understood. A clear annual cycle in the winds was identified, with a peak in the spring and summer and a low in the autumn and winter. It was found that WRF slightly under predicted the observed wind speed at the SODAR locations year-round but with near-zero bias in the summer, under predicted the observed wind speed at the MET towers in winter and over predicted it the rest of the year, and over predicted the observed wind speed at the radiosonde locations year-round. However, in general, the WRF model reasonably reproduced the statistics of the observed winds across Bangladesh at 80 m AGL.

Investing in Neighboring Countries for Electricity Generation

At present, Bangladesh imports 1,160 megawatts of electricity from India. Infrastructure is being developed by way of a proposed high voltage direct current system in Comilla to enhance further supply. A dedicated power station with capacity of 1,600MW with a dedicated transmission system is being developed in India and will be ready in the next three and a half years, said BPDB. India has issued a new cross-border power trading regulation, which will go a long way in helping Bangladesh import electricity from Nepal and Bhutan using Indian transmission lines to meet growing energy needs, officials said. Bangladesh has the opportunity to build electricity generating infrastructure in these countries. Meghalaya and Assam state is concerned the remote states of India but has a long border with Bangladesh where is potentiality of producing hydro-electric plants along with Nepal, Bhutan whose economy is not that much strong to build such mega constructions. As Hydro energy can produce electricity at the lowest cost, it will be a great opportunity to sell 30-40% electricity to them and rest portion will be imported for the country. Thus both side will be benefitted.

Conclusion

It can be seen in a clear way now that in order to have an scenario with an even further increased energy demand in Bangladesh, for year 2042, the government of Bangladesh have to adopt energy policies which favors strong electrical energy savings and the use of a new infrastructure with reduced losses for production, transmission and consumption of electricity, using the most modern and highly efficient technologies, so that the electrical energy intensity rate of reduction can be kept, at least at the same level of the past 5 years in Bangladesh. Improved sustainability in the way of living, increased productivity based on energy efficient technologies and an energy saving approach will allow reduced electrical energy intensity, causing less electrical energy demand in the future, without restricting the economic and population growths.

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