A Dynamic Study on Energy Forecasts and The Potential of Renewable Energy Sources

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***Abstract*— With developing countries, energy demand has been rapid over the years. Bangladesh contributes just 5% of the entire energy ratio in a proportion of renewable energy, and desire to 10% of the year 2025. Bangladesh is based on imported fossil fuel, which is quite expensive and uses natural gas for about 65% of energy production. Bangladesh is fortunate to have a small amount of fossil fuel, i.e., natural gas assets, but these are not adequate to meet the desired robust growth for glorious achievements in the government and non-government sectors. The sustainable power source is a key segment for improvement and has just made significant track in succeeding the greater part of the nation's power request; both in Urban and Rural territories. The motivation behind this study is to analyse energy forecasting for upcoming days and the potential of alternative renewable energy sources to assimilate a comparison in the general diagram of the power utilization of Bangladesh from a global perspective. Anticipating the future demand and looking at the competent outcomes of renewable energy may make urgency among the developing countries to satisfy the high future need for clean energy. In this article, we have focused our attention on the examination of sustainable power sources and the potential outcomes for future energy.**

Keywords - Renewable Energy, Energy Demand, Energy Production, Forecasting, Linear Regression

I. INTRODUCTION

The normal outgrowth of Bangladesh with an annual 7% plus Gross Domestic Product (GDP) over the last twenty years and new additions of other socio-economic factors is significant and regarded by numerous global literary organizations. As of October 2021, the Bangladesh utility electricity sector has single power grid with an installed capacity of 22,031 megawatts (MW). The total generation capacity is 20,934 MW. That, however, is not enough. Government and non-governmental organizations, by 2021, have taken significant oaths and measures to ensure sustainable energy output and supply to and entrance. Plenty of policies have been drafted to cope with the challenges in the energy sector. The administration wants earnestly to grow a critical segment of Renewable Energy (RE) commitment in the national grid, such extension must be accomplished if key difficulties including the RE ventures are appropriately addressed [1]. Electricity has been demonstrated to be important for a nation to make a positive impact on economical enhancement. In this modern era, electricity is most costly and insufficient for isolated areas to their geographical impregnability. In this case, people are used high-cost diesel generators for their electrification source of energy. [2]. Extending the target in the power division can be done cost-effectively by clean renewables and energy productivity, which minimize the emission level of ozone-damaging pollutants, enhance human well-being by reducing air pollution. The benefits of expanding clean energy, as indicated by a study from the Low Emission Growth Strategies Global Partnership (LEDS GP) based on research. Renewable energies today help the United States save roughly 70 million metric tons of carbon emissions annually that would have been released if electricity had been generated with fossil fuels. During the period of research and development investment by industry and government in the US Department of Energy, rapid advancement in the expense, performance, and durability of renewable energy systems have occurred (DOE). Renewable energy technologies will meet the increased worldwide energy demands therefore in a way, contributing 30–50% of global energy by 2050 [3]. In this research, we have observed the energy forecasting by the linear equation to raise energy demand and generation for upcoming challenges with overcome solutions from alternative renewable sources.

II. RELATED WORK

Qazi et al, in their study, worldwide energy crises are managed by integrating renewable energy. They review more

than 300 articles and find a renewable energy development for the future based on previous data. [4]. A. Ahmed and M. Khalid described in their paper, a renewable resource and power forecasting models. They also work with facilitating of optimal integration of renewable energy (RE) in power systems [5]. X. Xu, et al. in his research, Global renewable energy development. they mainly focus on the autoregressive integrated moving average model (ARIMA), neural network model (NNM), support vector machine model (SVM) and predicts the development for better accuracy. In their article discussed seven regions based on a global perspective to promote renewable energy development and trends to growing sustainable energy sources. They used the ARIMA model to predict the distribution of renewable energy policies by region. The paper contained four factors of renewable energy forecasts values present scenarios and upcoming scenarios in different regions. Asia pacific has marked a robust evolution day by day for increasing green energy [6]. R. corizzo et al. in their research proposed a new model tucker tensor to develop and investigate multi-aspects renewable energy forecasting. They have compared various algorithms forecasting methods to PV, wind and light source power prediction errors. Among all data prediction, it finalized tucker clus is the best performing model globally to use reducing errors [7]. IoT is the blessing of a technological revolution in modern life. It has been used for industrial and smart grids for better accuracy and safe optimization. Nearly all power station is optimized in IoT system by using remote sensing automation nowadays. IoT combined with renewable energy alters the power grid by observing, executing operational ways to increase efficiency, and effectively distributing the energy obtained. Consumers save time and money when IoT is integrated with renewable energy [8]. I. Salehin and B. Islam et al. described their research a smart city can obtain advancement of the technology revolution. IoT makes a significant contribution to any developing outcomes for upcoming challenges. They analyzed sensors data and connect smart prototype devices to get real-time updates, IoT was the main focusing part for their potential results to integrate any smart automation system [9]. I. Salehin and S. Noman et al. investigated the combination of using Iot and agriculture automation systems. In their research they have simulated various data from farmer's fields and monitored by GSM technology. They recommended a wireless fidelity module monitoring system by using IoT automation system to identify crop-pest detection and alert the end-user [10]. Tao Hong et al. presented energy forecasting trends with six valuable open data sources. In this paper, researchers tried to find out the best accuracy forecast value and solve the errors by using proper forecasting formula as per analysis among publication papers for current and future researchers to make awareness. They discussed different types of forecasting methods such as renewable energy generation, electricity cost, future energy demands is the common factors to predict [11]. J. Angel et al. analyzed probabilistic forecasts by using quantile regression methods that were easy to access, not mandatory use of heavy machine tools. They utilized data mining techniques for quantile regression autonomously to use a new nearest neighbors quantile filter (NNQF) for probabilistic forecasting [12]. H. Liu and C. Chen in their studies, reviewed wind energy forecasting models using data processing strategies. They used seven categories of formulas that are addressable to implement methods in linear and nonlinear strategies. In this paper, they have focused on different forecasting model aspects from seven categories formula to data processing of wind energy. They short out decomposition forecasting models which are most viable and accurate for data processing [13].

III. Energy Overview of Bangladesh

A. *Energy Utilization of Bangladesh*

The integral necessity of human life is electricity and the 20 trillion kWh of electricity used worldwide today [14]. Currently, Gas being decayed (41%), Industry & Tea-Estate (17%), Captive Electricity (17%), CNG (5%), Industrial (01%) and Domestic (12%) by electricity and advancing in 2.5 million consumers. Whereas industry orientated electricity decayed by residential, manufacturing, commercial, irrigation and others are 50%, 34%, 9%, 5% and 2% respectively shown in Fig. 1 [15]

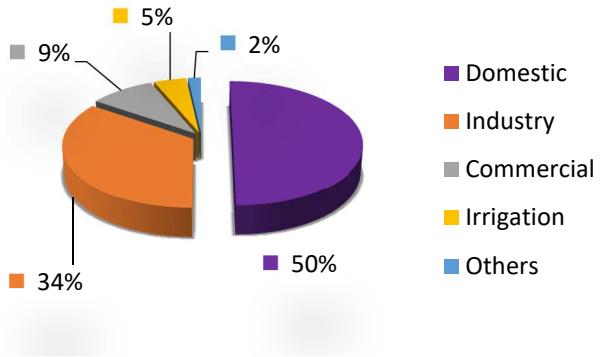


Fig. 1. Electricity consumption in Bangladesh

The price of electricity for households and non-households in Bangladesh which includes all the components of electricity bill such as, the cost of Power, distribution excluding Taxes, shown in Fig. 2.

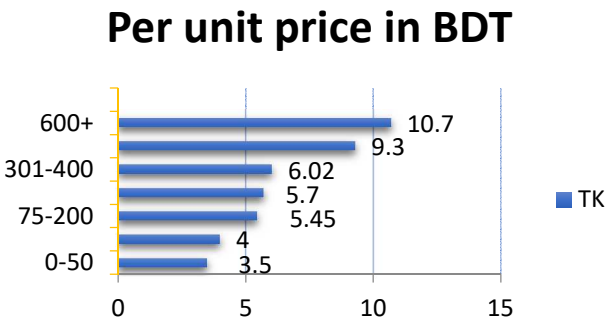


Fig. 2. Retail price for electricity for householders in Bangladesh

B. *Available Energy Sources*

Fossil fuels are heavily dependent on the present generation, as seen in Fig. 3 and 4; the total capacity of natural gas is 8,530 MW, followed by 2,629 MW of furnace oil, 1,028 MW of diesel, 660 MW of imported electricity, 250 MW of coal,

230MW of hydropower, 2200 MW of captive electricity and 245 MW of solar power.

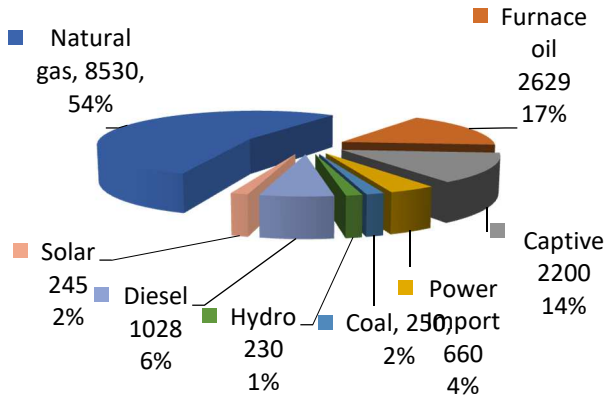


Fig. 3. Power installed capacity in MW

In terms of generation, natural gas generates 35,822 GWh. The rest is generated by furnace oil 8,673 GWh, power import 3,822 GWh, diesel 2,067 GWh., hydropower 962 GWh, coal 847 GWh, solar 229 GWh shown in Fig. 4.

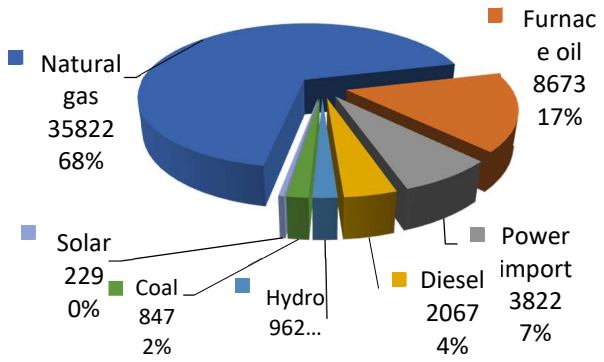


Fig. 4. Power generation capacity in GWh

C. Available Renewable Energy Sources

Total Renewable energy installed capacity in Bangladesh of 2017 is 437.6 MW as of 2017.The capacity of solar, wind, hydro and biomass are 200 MW, 2.9 MW, 230 MW and 4.7 MW. According to the above data Fig. 1, more than 50% of electricity is used by domestic users, followed by 34% by industries. Since Bangladesh is still a country focused on agriculture, most people live in rural areas. Although in villages, the demand and supply of cities are stable but rather imbalanced. Besides, the hilly region of 13,295 square kilometers, which is one-tenth of the total area, is a nation of geological diversity. There is a significant potential for renewable energy investment such as Solar PV and CSP to conduct rural electrification much faster than fossil fuel projects and to support the 'Electricity for All' target of the government by 2021. In this country, has a strong potential to transition to a superior and increasingly green energy as a developing country. Since renewable energy (RE) projects are increasing day by day and moving forwards to escape unforeseen hazards and threats, capital investment can be faced with effects on potential business improvement, commercialization and advances for speculators. The purpose of this research is to look into the effects of renewable and non-renewable energy on long-term development. The goal of the 7th Sustainable Development Goals (SDG) is to substantially increase the proportion of clean energy sources energy supply by 2030 [16]. Nowadays budgetary agencies and financial sponsors are cordial to investment in these sectors. Developing solution of all type solar services to convert empty-unused roof into power sources by the installing solar system. Riverbanks and islands, reclaimable land in Meghna estuary, khaas land owned by the government, and canals that could host solar on their surface and banks are the most potential solar sites in the land-scarce country.

IV. Trends in Renewable Energy and Methodology

A. Current Scenario of Global

In this 21st century, wellsprings of sustainable power source will govern the energy innovation advertise. Starting here of view, it tends to be seen that however sustainable power source is costly than different structures. As we can see from Fig. 5 all the renewable sources are reasonable price than any other form of energy price except oil and gas. Dealing with potential energy demand is the greatest obstacle for oil and gas limited storage. The world is now heading towards investing in research to explore new technologies and mounting the technologies to gain immense development. The main theme behind these is environmental aspects, increasing demand and prices of fossil fuel and reducing the threat of nuclear technologies [17]. The goal of the research is to determine the elements that influence the technology's adoption, given its relevance in environmental preservation. To examine the study hypotheses and raise awareness of environmental degradation and demand for renewable energy [18].

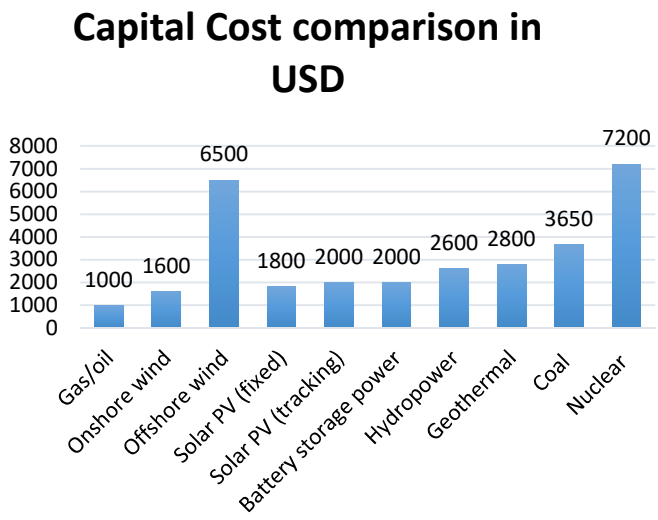
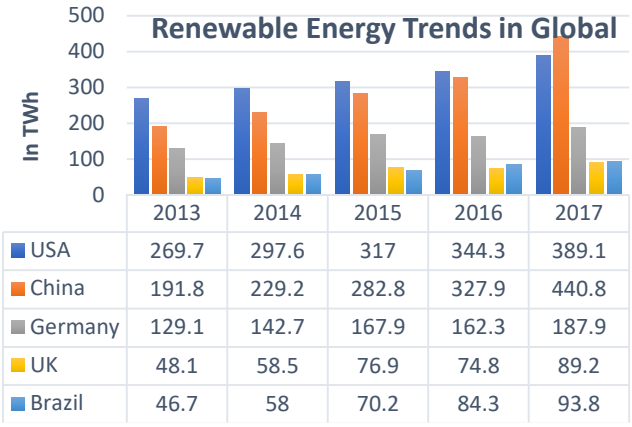


Fig. 5. Capital cost for power generation capacity of Global in USD/kWh

The following fig. 6 featuring the top 5 countries those are gained enormous success in generating energy by renewable energy sources (RES)

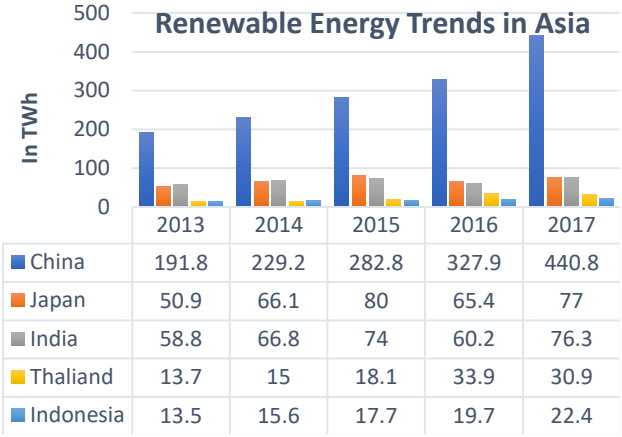


	2013	2014	2015	2016	2017
USA	269.7	297.6	317	344.3	389.1
China	191.8	229.2	282.8	327.9	440.8
Germany	129.1	142.7	167.9	162.3	187.9
UK	48.1	58.5	76.9	74.8	89.2
Brazil	46.7	58	70.2	84.3	93.8

Fig. 6. Current scenario of RE generation in Global in TWh

B. *Current Scenario of Asia*

As the Asian economy keeps on developing, its power production part is at a tipping point. Previously, the area's solid monetary development has depended on moderately cheap fossil fuels. In Asia, particularly China, Japan and India have gone in a remarkable height in terms of generating power by renewable sources. The beneath picture shows the key subjects on Asia's energy patterns and advancements in fig. 7. In this section, we have seen below fig. 7. China has committed to decreasing air pollution from energy security wide range of issues, choosing renewable energy technologies. In 2000 years, Chinese government was discerned to invest swiftly in renewable energy sources. China has expended a high capital amount to become a renewable energy exporter, with a 35 percent share of global renewable energy production [19].

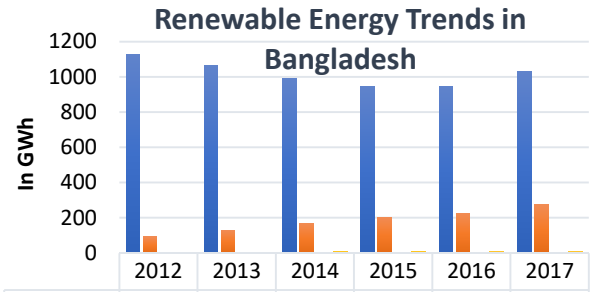


	2013	2014	2015	2016	2017
China	191.8	229.2	282.8	327.9	440.8
Japan	50.9	66.1	80	65.4	77
India	58.8	66.8	74	60.2	76.3
Thaliand	13.7	15	18.1	33.9	30.9
Indonesia	13.5	15.6	17.7	19.7	22.4

Fig. 7. Current scenario of RE generation in Asia in TWh

C. *Current Scenario of Bangladesh*

Renewable energy is advantageous for long-term development goals in lower-income countries. Iran's future renewable energy is divided into three categories: "long-term technology acquisition programs," "policy stabilization," and "attraction of foreign capital," with renewable energy policy relying on the selection of policies that are most responsive to national goals, technical capabilities, and the economic growth [20]. In Bangladesh, around 65% of energy is generated from petroleum gas. Among other fills oil, coal, biomass and so on are fundamental [14]. There is a tremendous save of coal in our nation, however, coal is less delivered just as less utilized here. Then again, flammable gas isn't that significant, however, its generation and utilization are the most noteworthy among the accessible assets. Other than those, energy demand is being met through imported oil and LPG. Additionally, the administration has just begun bringing in LNG to fulfil expanding gas need. Biomass is being utilized as a lot of energy. The vitality request is additionally being met by bringing in power from India. Fossil fuels are limited, on the contrary, renewable energy is a blessing to the earth like solar, tidal, wind, biomass etc. are boundless. In alliance with renewable energy, tidal energy is playing a vital role in developed and developing countries. Since 1988, Bangladesh has Karnafuli hydropower plant which generation capacity is 230 MW and the lowest generation cost from any other technology. [21]



	2012	2013	2014	2015	2016	2017
Hydro	1126	1066	993	946	946	1029
Solar	90.9	129.6	167.6	204.4	224.3	274
Wind			5.081	5.081	5.081	5.081
Biomass	4	4.9	6.8	7	7.5	7.7

Fig. 8. Current scenario of RE generation in Bangladesh in GWh

V. Data Processing

A. *Demand forecasting with Regression*

We have taken data from 2011 to 2018 in order to forecast future production and demand. From the above data, we have analyzed the feasible future demand of Bangladesh till 2025. We have used the linear forecasting method equation (1) as discussed below shown in fig. 9 As we can see from the below spectrum the energy demand of Bangladesh is gradually increasing since 2010. By 2025 it will cross approximately 24000 MW mark and by 2030 it will be around 31000 MW [22].

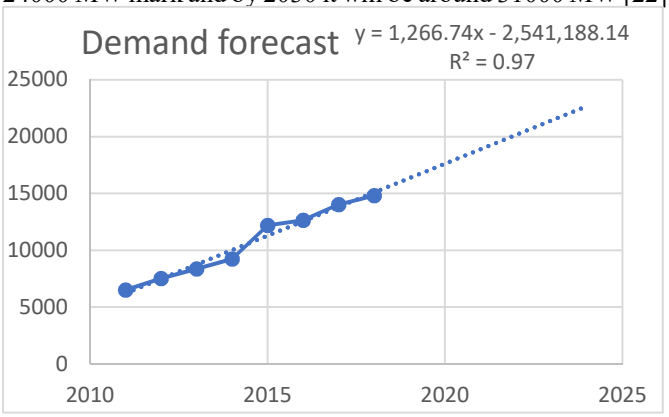


Fig. 9. Demand forecasting till 2025 in MW

B. *Mechanics of forecasting method formula*

We have implemented here Linear forecasting method equation (1). The Data which are used in this analysis is about production and capacity of Bangladesh power system from 2011 to 2018. We have first made a linear trend line is of the form of:

$$Y = a + bX \quad (1)$$

Where Y = forecast

a = intercept

b = slope

X = year

Here, Y is the forecast. Graphically 'a' is the point at which line would hit the Y-axis and 'b' is the slope. There is one more factor R2 which is in the data here, It's the strength of the relationship. It's called the co-efficient of inaction and varies between 0 & 1. If R2=0 then there is no relation between the two factors, we are comparing and if R2=1 or close to 1 then there is a strong relationship between them. From the above equation, we got: $R^2 = 0.97$

Since here the value of $R^2 = 0.97$ we can assume a good relationship between the year and the energy. By computing this equation, we have predicted the probable load demand until 2030 shown in Fig. 11.

C. *Production forecasting*

Similarly, we have calculated the production forecast by using the linear method. The figure shows that the production also increasing day by day. We have come to forecast that the production will be nearly 18000 MW by 2025 and if this gradual increment is carried then it will cross the 21000 MW milestone by 2030.

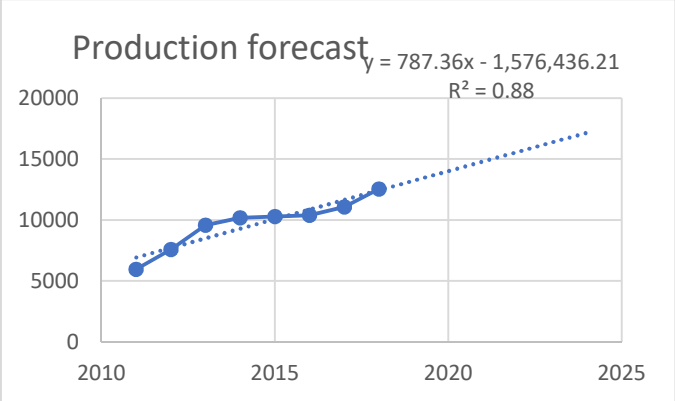


Fig. 10. Production forecasting till 2025 in MW

D. *Comparison between Demand and Production*

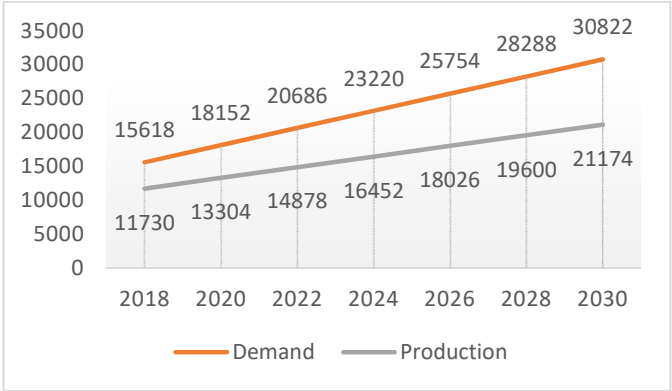


Fig. 11. Comparison between Demand & Production forecasting till 2030 in MW

From the above study, we can see that the production value in a particular year is always underneath the demand line. Though both are increasing gradually there will be still thousands of MW shortage between demand and production even in 2030. The gradual expansion of power plant and capacity won't be able to deliver the rest of energy demand. A growing limit in the power part can be accomplished cost-viably through clean energy choices, which diminish ozone-depleting substance discharges, yet additionally, increment occupations and improve human wellbeing by decreasing air contamination.

VI. RESULT AND DISCUSSION

From the above trends, it can be inferred that the rapid increase of renewable power generation wind and solar from a global perspective is highly appreciated to increase the overall demand for generation and the operation of power systems will substantially reduce the operating costs of a renewable energy micro grid. Herein we have collected data from various publication and internet sources. By the linear equation, we have assumed the graphical prediction on overall electricity demand and production rate. Sustainable energy can be an effective solution to the equivalent ratio of production between demand. In Bangladesh, the technological capacity of grid-connected solar PV was estimated at approximately 50174 MW [23]. After the Fukushima nuclear disaster, FIT schemes were developed to boost future renewable energy, with solar PV dominating. The current situation in Japan is explored, as well as the prospects and opportunities for an area powered entirely by renewable energy [24]. Analysis of research work that involves forecasting of Energy production models to sustain growth using renewable energy technologies. To fulfill the country's long-term development goals, a well-coordinated national energy policy is essential. Priorities for action and the energy regulatory framework must be identified in order to solve the energy crisis. Long-term energy planning and private funding strategy are also essential for accelerating energy progress [25]. In our study, we get a correlation between some previous yearly production and capacity which is 0.97. This correlation is very strong for our forecasting.

VII. CONCLUSION

This paper summarized the present energy circumstance of Bangladesh and looks at the accessible sustainable power source assets and their future possibility. Energy deficiency is deterring the financial and mechanical advancement of Bangladesh. The demonstrated saved of petroleum gas 34 TCF which will lead the nation next 20 years and as of now 82% flammable gas devoured in the power area for control creation. Though just 5% of power created from sustainable power sources. Notwithstanding, Bangladesh government have just reported a groundbreaking strategy for future power age through the interest for control developing quicker rate. Solar PV can be the solution for the upcoming greater energy demand. Though the capital cost of building of Solar PV plant is quite high than the coal, oil or Gas for per/kWh generation running charge and danger level is low than any other plants. Sunlight based energy is broadly accepted to be one of generally suitable and productive sustainable power source assets for the most part for its copious accessibility in worldwide. Bangladesh is a perfect spot for solar, wind, tidal based energy usage to accomplish upcoming limited fossil fuels crises and meet a large number of electricity demands.

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