RENEWABLE ENERGY DEVELOPMENT TRENDS IN BANGLADESH

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering

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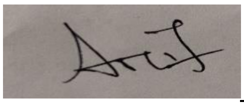
CERTIFICATION

This is to certify that this project and thesis entitled "**Renewable energy development trends in Bangladesh** " is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held in June 2021.

Signature of the candidates



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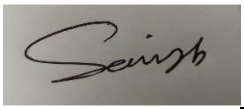

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APPROVAL LETTER

The project and thesis entitled "**Renewable energy development trends in Bangladesh** " submitted by **MD. ARIFUL ISLAM ,** ID: 163-33-324 & **MD. SAJIB HOSEN ,** ID: 171-33-416 , Session: Fall 2016 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in June 2021.

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Dedicated to

Our Parents

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LIST OF ABBREVIATIONS

GDP	Gross Domestic Product
RE	Renewable Energy
RES	Renewable Energy Sources
GHG	Greenhouse Gas
INDC	Intended Nationally Determined Contribution

PSMP	Power System Master Plan
FY	Forecasting Year
SREDA	Sustainable and Renewable Energy Development Authority
BPDB	Bangladesh Power Development Board
IRENA	International Renewable Energy Agency
CSP	Concentrating solar power
SHS	Solar Home System
LED	Light Emitting Diode
BCAS	Bangladesh Center for Advanced Studies
BRAC	Building Resources Across Communities,
IFRD	Institute of Fuel Research and Development
LPG	Liquefied petroleum gas
LNG	Liquefied natural gas
LEDSGP	The Low Emission Development Strategies Global Partnership
PV	Photovoltaic

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ABSTRACT

This study presents renewable energy resources, availability of energy for power generation and development of renewable energy in Bangladesh. Main aim of this study is to find the growth of renewable energy, renewable energy development challenges and prospects. Some recommendations about better development of renewable energy resources in future discuss in this study. Renewable energy forms and technologies in Bangladesh can be learn from this study. This study reviews different reports, papers, statistical data and policies to assess and present renewable energy development. This study finds that the growth of renewable energy in Bangladesh for power generation is not significant compared to other countries such as India, China. We can know renewable energy issues and challenges in Bangladesh from this study as like there is also a startling, but observable lack of open care engagement in this topic and also those initiatives are not supported by open cooperation programs, particularly in rural areas. Similarly, government affiliations can deal with aid and direct potential recipients. We use the forecasting method for finding the demand forecast and production forecast in Bangladesh and also compare them.

CHAPTER 1

INTRODUCTION

1.1 Energy Background

Over the last two decades, Bangladesh's annual gross domestic product (GDP) has grown exponentially by more than%%, and in recent times access to other socio-economic metrics has been attractive and felt by various global magisterial bodies. Bangladesh's utility power sector has a national grid with an installed capacity of 21,419 MW as of September 2019. The total installed capacity is 20,000 MW (combination of solar power) [1]. But that is not enough. Government and non-government organizations have taken a solemn oath and initiatives to ensure quality power generation and supply at every door by 2020. Lots of policies have been formulated to address the challenges in the energy sector. While the administration sincerely seeks to increase a critical portion of RE (Renewable energy) commitments to the national grid, such expansion must take place if key issues, including RU initiatives, are properly addressed.

1.2 Objective of the Study

i. To study about renewable energy resources and trends in Bangladesh.
ii. To make a spectral analysis of renewable energy resources of Bangladesh.
iii. To know about renewable energy forms and technologies in Bangladesh.
iv. To know about renewable energy issues and challenges in Bangladesh.
v. To make some recommendations about better development of renewable energy resources in future.

1.3 Renewable Energy for Sustainable Growth and Development

Most of the economic activities in the country generate energy from Electric RES (Renewable energy source) the top source of electricity, for example, solar-based, wind, biomass, thermal or hydropower are considered renewable because everyone can achieve one measure of energy without energy. The uses of energy produced by these sources are not new and have been used successfully by the ancients. For example, the Egyptian blue civilization used air to move ships, grain-grinding facilities, and boatmen. Even the Chinese and Japanese began using wind-powered water pumping systems in the windy historical past, resulting in dramatic reductions in costs. Later civilizations preferred to use windmills as an alternative source, as it was accessible and relatively inexpensive. Indeed, in recent times, the growing energy crisis and the strict enforcement of carbon emissions laws to reduce GHG (Greenhouse Gas) emissions have forced many countries to consider alternative energy supplies [2].

1.4 Energy Consumption in Bangladesh

Electricity is the basic needs of human life and today's 20 trillion KWh electricity consumed around the world [3]. Currently Bangladeshi gas being consumed by the power (41%), Fertilizer (7%), Industry & Tea-Estate (17%), Captive Power(17%), CNG (5%), Commercial (01%), and Domestic (12%) and advancing with 2.5 million of consumers in Bangladesh. Whereas sector wise others electric power consumed by domestic, industry, commercial, irrigation and others which percentage of 50.07%, 34.47%, 9.09%, 4.58%, and 1.79% respectively this is shown in figure 1[4]

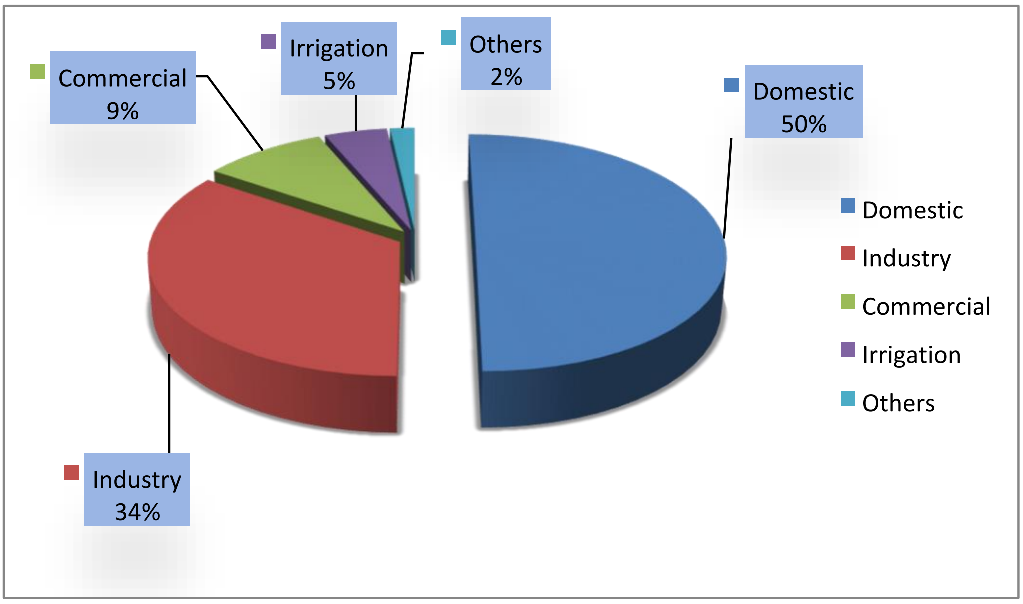


Figure 1.1: Electricity consumption in Bangladesh [4]. (Design by Author)

All components of the electricity bill such as electricity cost, tax-free distribution, inclusion, the price of electricity for households and non-households in Bangladesh are shown in Figure 1.2.

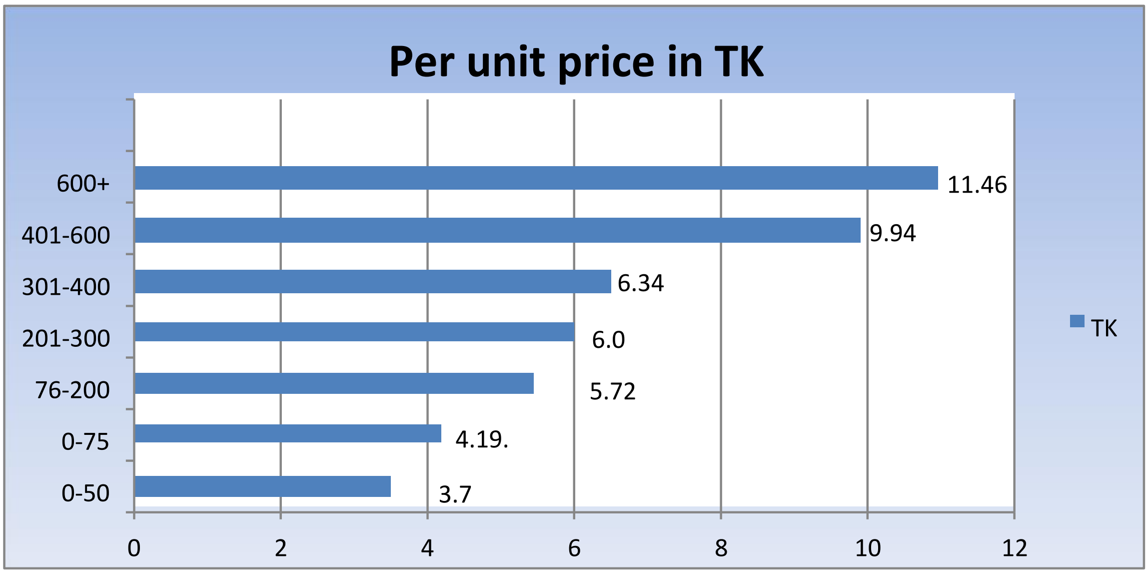


Figure 1.2: Retail price for electricity for householders in Bangladesh BERC 2019 and Design by Author)

1.5 Power System Master Plan of Bangladesh

Bangladesh plans to generate 100% of total electricity generation by 2020 from renewable energy sources such as wind, waste and solar energy. The country plans to increase its share of renewable energy to 17% by 2041 in line with its Innovative National Assigned Contribution (INDC) pledge to reduce greenhouse gas emissions by 5% by 2030. [5] Power System Master Plan (PSMP) -2030 Long-term plans for power generation have been presented so far. In PSMP-2010, the demand forecast was based on the %% GDP growth rate. The development of electricity needs to be accelerated to increase access and achieve economic development. The desired economic growth rate will be around %% P.A. Based on this survey, the maximum demand in FY20 will be around 1,304 MW and in 2030 it will be 33,707 MW. However, the Bangladesh government plans to increase the country's power generation to 40,000 MW by 2030, exceeding its projected demand. [6]

Chapter 2

LITERATURE REVIEWS

2.1 Introduction

Renewable energy is an energy market in Bangladesh that has potential for expansion. According to the World Bank, Bangladesh is among the top six global economies in terms of annual GDP growth as of 2019. The nation currently relies primarily on natural gas and biofuels to meet its energy consumption needs.

2.2 Available Energy Sources

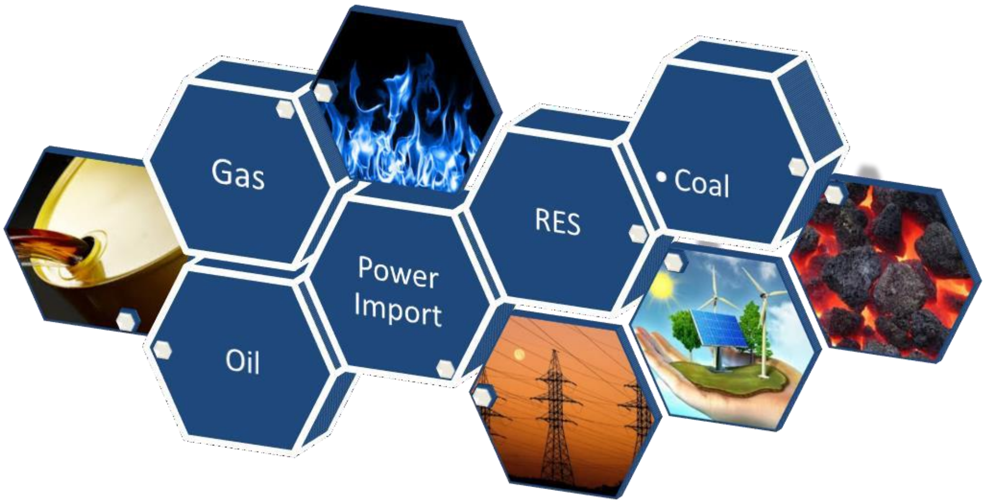


Figure 2.1: Available energy sources

The current age is vigorously based on non-renewable energy sources as appeared in Figure 2.2 and 2.3; petroleum gas represents 8,530 MW of absolute limit, trailed by heater oil 2,629 MW, diesel 1,028 MW, power import 660 MW, coal 250 MW, hydro 230 MW, hostage 2200 MW and solar 245 MW, (SREDA 2017).

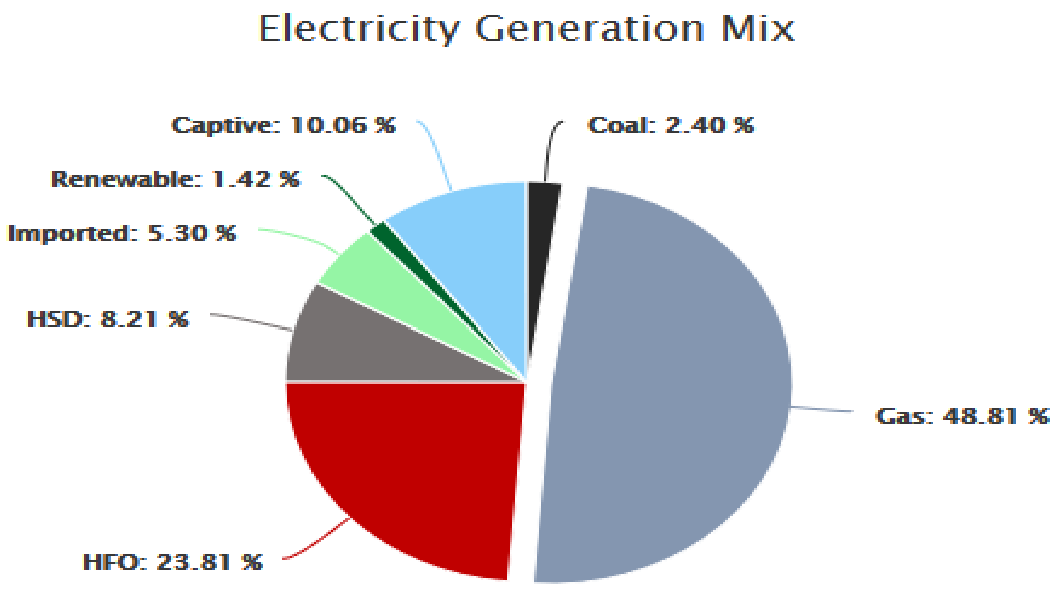


Figure 2.2: Electricity power generation mix(SREDA 2020)

Regarding age, natural gas generates 35,822 GWh. The rest is created by heater oil 8,673 GWh. 16, power import 3,822 GWh, diesel 2,067 GWh., hydropower 962 GWh, coal 847 GWh, solar 224 GWh. (BPDB 2017)

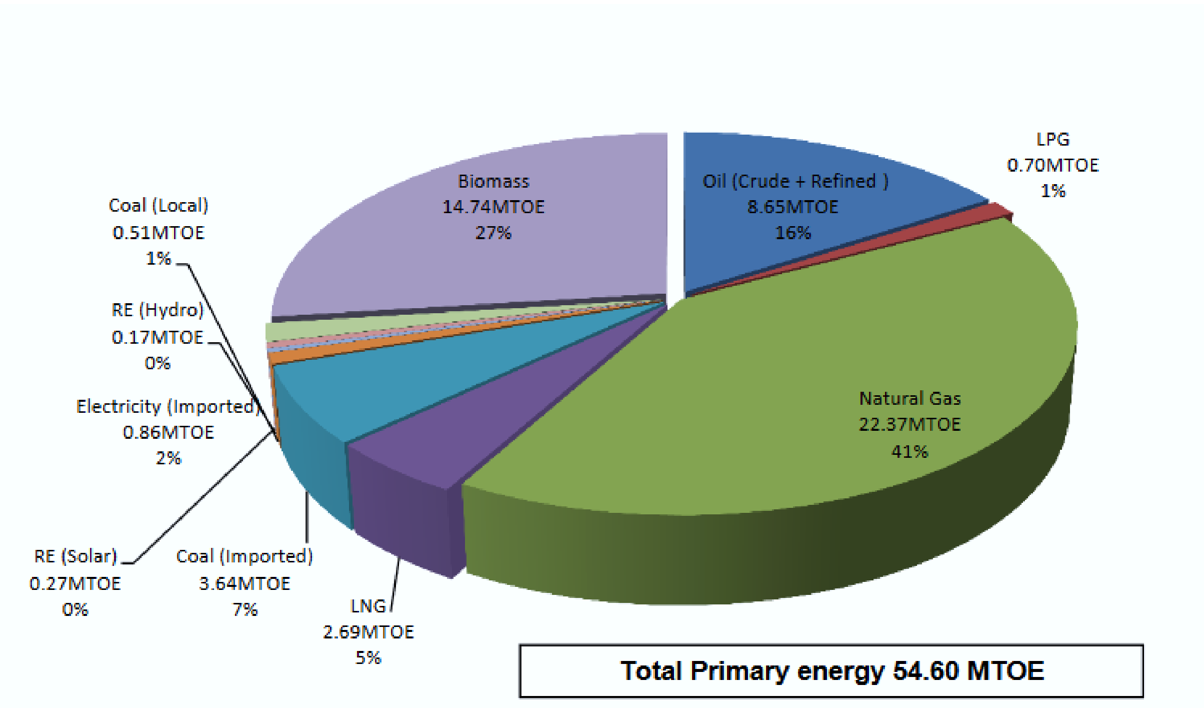


Figure 2.3: Share of total primary energy2018-19(Energy and Mineral resource division)

2.3 Available Renewable Energy Sources

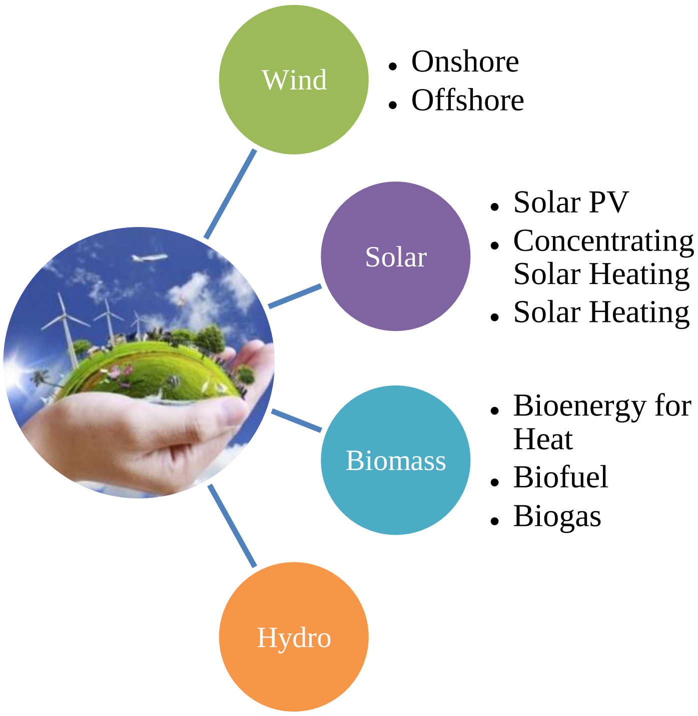


Fig: 2.4 Renewable Energy Sources

Total Renewable energy installed capacity in Bangladesh of 2018 is 439 MW as of 2018.The capacity of solar, wind, hydro and biomass are 201 MW, 3 MW, 230 MW and

5 MW respectively shown in the below figure 2.4 (irena.org).

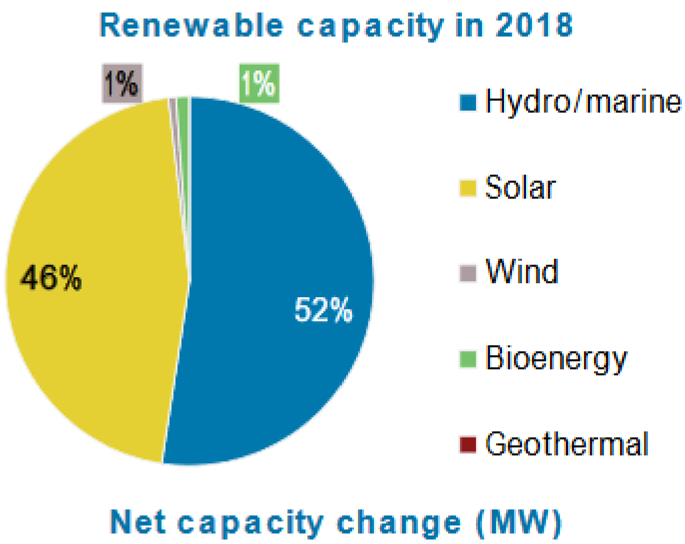


Fig: 2.5 Renewable capacity 2018

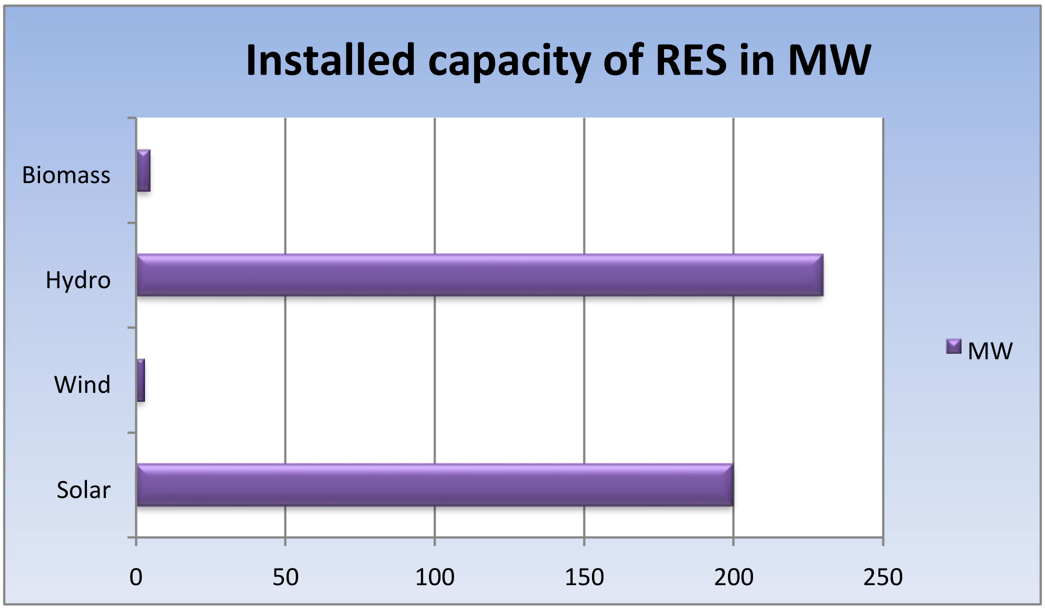


Figure 2.6 Renewable energy installed capacity in Bangladesh of 2018 in MW (IRENA and design by Author)

Total Renewable energy generation capacity in Bangladesh is 1315 GWh as of 2017.The capacity of solar, wind, hydro and biomass are 274 GWh, 5 GWh, 1029 GWh and 8 GWh respectively shown in the below figure 3.7 (irena.org).

Generation in 2017	**GWh**	**%**
Non-renewable	66345	98
Renewable	**1316**	**2**
Hydro and Marine	1029	0
Solar	274	0
Wind	5	0
Bioenergy	8	0
Geotharmal	0	0
Total	**67662**	**100**

Table 2.1: Energy capacity 2017

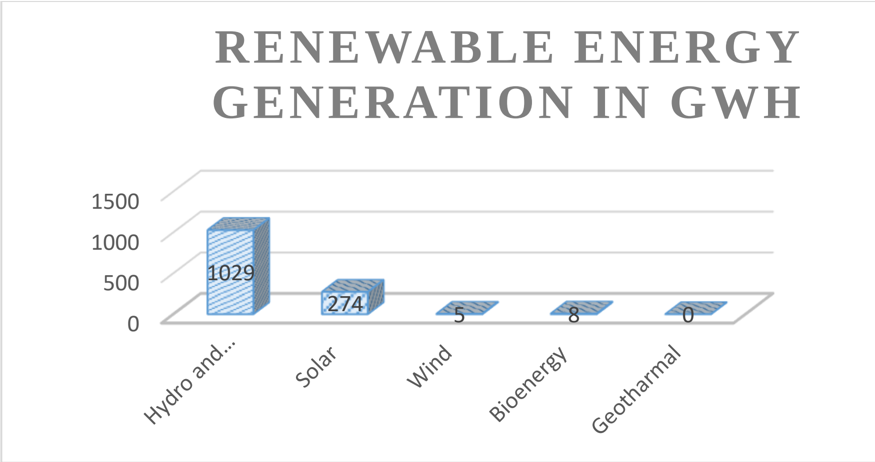


Figure 2.7: Renewable energy generation in Bangladesh of 2017 in GWh (IRENA and design by Author)

2.4 Renewable Energy Investment Opportunities for Bangladesh

As per the information of the figure above (figure1) over half of electricity is devoured by homegrown buyers followed by enterprises 34%. Bangladesh is as yet an agriculture-based nation accordingly, the vast majority of the people groups are living in provincial regions. In spite of the fact that the interest and gracefully of the urban areas are steady however imbalanced in towns. Other than Bangladesh is nation of topographical assorted varieties where the uneven territory Covering 13,295 square kilometers, which is one-10th of the complete region. So there is a tremendous open door for venture for sustainable power source, for example, Solar PV and CSP which will execute country zap a lot quicker than petroleum product tasks and help the administration's 'Electricity for All' focus by 2021.

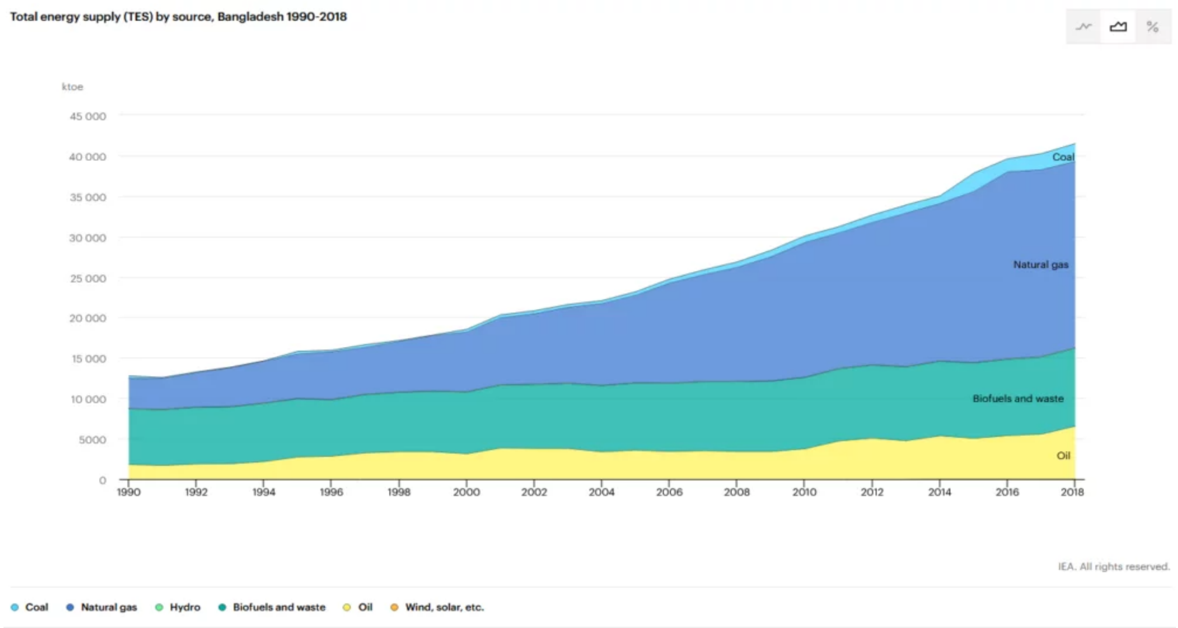
Figure 2.8: Renewable Energy Capacity additions & Total investment by sector Power (irena.org)

Genuine: arriving at 10% of inexhaustible electricity by 2020 and scaling up the capability of sun based water system siphons (USD 600 million) just as sun powered smaller than normal and nano networks (USD 620 million) (Source: IRENA)

Restrictive: By 2030, creating 400 MW of wind (USD 600 million) and 1000 MW of utility-scale sun oriented (USD 1.3 billion), scaling up biomass creation from sugar (USD 200 million), and growing the Solar Home Program (USD 1.2 billion) (Source: IRENA)

2.5 The Growth of Renewable Energy in Bangladesh

Just 0.016 percent of residents had access to power in 1980. In 40 years, that percentage has risen to 85%. It is, however, the only other country in the area with an electrification rate of less than 90%, along with Mongolia. Bangladesh has made slow but steady progress since the Ministry of Power, Oil, and Mineral Resources released the renewable energy policy guidance in 2008. Natural gas reportedly accounts for over 65 percent of total electricity production. Wind, hydropower, and solar PV, on the other hand, are all on the rise. At the end of 2018, Bangladesh had 579 MW of installed renewable power capacity, which included both on-grid and off-grid installations. Solar PV (59.5%), small-scale hydropower (39.7%), biomass and biogas have the following percentages (0.8%)\



Total 2.9 Energy Supply by Source, Bangladesh, 1990 – 2021, IEA

2.6 Bangladesh's Renewable Energy Potential

Bangladesh has unveiled a National Solar Energy Action Plan that includes three scenarios for complete solar energy capability by 2041. Business-as-usual (8 GW), medium (25 GW), and ambitious (50 GW) are among them (40 GW).

For the time being, the last one seems difficult to attain, given the renewables' current share of the national power mix. They were 1.5 percent in 2019, and are now at 3 percent. However, the authors of the strategy are unsure if the country should go ahead with the aggressive scheme. It will ensure the following capability if it is effective:

- 16 GW solar hubs;
- 4 GW electric utilities;
- 5 GW private developers;
- 2.5 GW irrigation pumps;
- 12 GW rooftop installations.

The potential for a swift transition and a diversified renewable energy mix is there. Utilizing only 1% of the Kaptai dam's water surface for floating solar will ensure nearly 500 MW of solar capacity. Additional unexplored potential is also laying in the river banks and islands like the Meghna estuary.

There are also over 20 000 km2 of land where wind speeds range between 5.75 and 7.75 m/s, according to the National Renewable Energy Laboratory (NREL). This corresponds to an installed output of over 30 000 MW. Figure 2.2 shows that about 4% of total land required for Bangladesh for 100% renewable energy-based generation. (https://energytracker.asia/renewable-energy-in-bangladesh-current-trends-and-future-opportunities/)

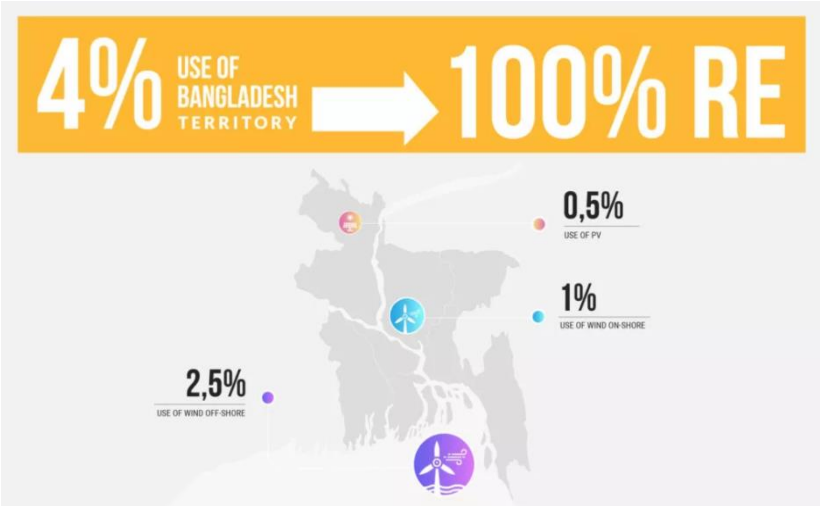


Figure: 2.10 Bangladesh's Renewable Energy Potential, World Future Council

2.7 Review of Literature:

The evidence can be evaluated by taking the sales figures of Grameen Shakti on a yearly basis (Fig 2.3). The number of customers increase every year. At the end of 1997, there were only 228 solar systems installed, but by the end of 2015 the number had increased to 1,655,201 (Fig 2.3).The most typical application of SHS is to illuminate areas like as houses and stores. Radios, TVs, cassette players, and cellular phones are all powered by solar energy. [7]

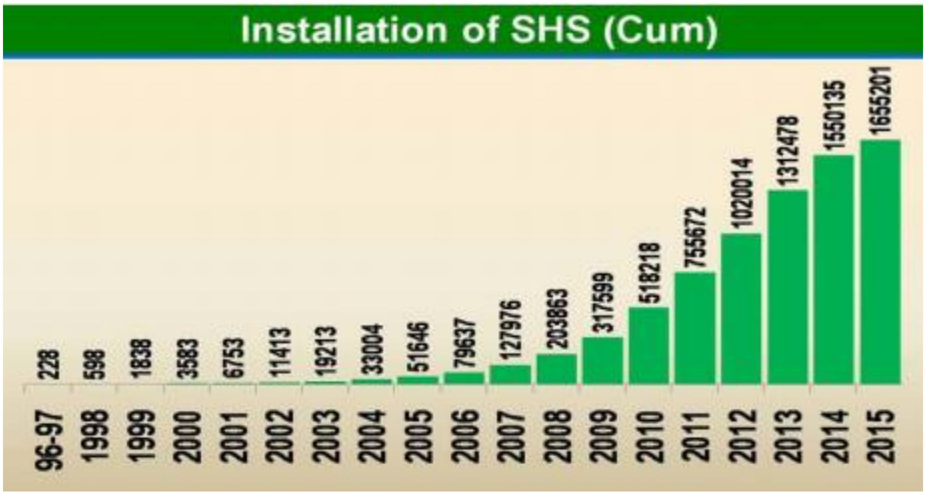


Fig 2.11: Year wise installation of Solar Home Systems.

The usage of solar power as an alternative source of energy is becoming increasingly widespread due to its dependability and appeal. Solar energy is simple to install, has low maintenance costs, and requires no monthly payments. Grameen Shakti teaches local people about solar power technology so that they may establish their own business utilizing their abilities, which creates new jobs and eliminates unemployment. [7]

Although the use of renewable energy is not new in Bangladesh, renewable power generation has remained at the demonstration stage. Solar (PV) as SHSs; solar cookers, dryers, water heaters, and tunnel dryers for crops; biogas; biomass briquetting machines; and improved cooking stoves are all examples of current renewable energy technology. A 62 kW system in the Narsingdi area was the first and largest solar PV installation. The early results of this demonstration project suggested that there was room for other applications. [7]

Due to the global and Bangladeshi shortages of fossil fuels, a complete switch to alternate energy sources is required. Solar energy necessitates a significant investment in costly silicon panels. Solar panels covering a home's rooftop would be insufficient to meet the household's needs (without air conditioning), necessitating the usage of large batteries at night. Wind energy might be a viable alternative energy source for Bangladesh.

Because the power generated by wind energy is related to the wind speed, The wind's velocity this indicates that the higher the wind velocity, the more power is generated. Bangladesh has a 724-kilometer coastline along the Bay of Bengal. It blows across Bangladesh with an average speed of 3 to 6 m s1 from March to September. Winds are present in Bangladesh mostly during the monsoon and for one to two months before and after the monsoon, with wind speeds being quiet or too low from October to February. [1] The Kaptai Hydro-electric Power Station, which is located near to the seashore, generates the most electricity. As a result, the wind power plant may be utilized to assist the Kaptai power plant from March to September, when the load is crucial. There are several islands in the Bay of Bengal where the wind is very strong. Kuakata, Sandwip, and St. Martin are among the towns with suitable wind turbine locations. The majority of the individuals that live in this region are fishermen. They have a little probability of getting energy from the national grid because carrying the line through this location is difficult. This difficulty may be solved by using wind energy. [7]

Although not a new concept, tidal power offers an alternative to satisfy current energy demands. Tidal energy is generated as the sea level rises and falls. Bangladesh is a flood plain delta with a 710-kilometer shoreline along the Bay of Bengal. Along the seashore, tidal power installations can be developed. Tidal stream generators are like underwater wind turbines shown in (fig 2.4).

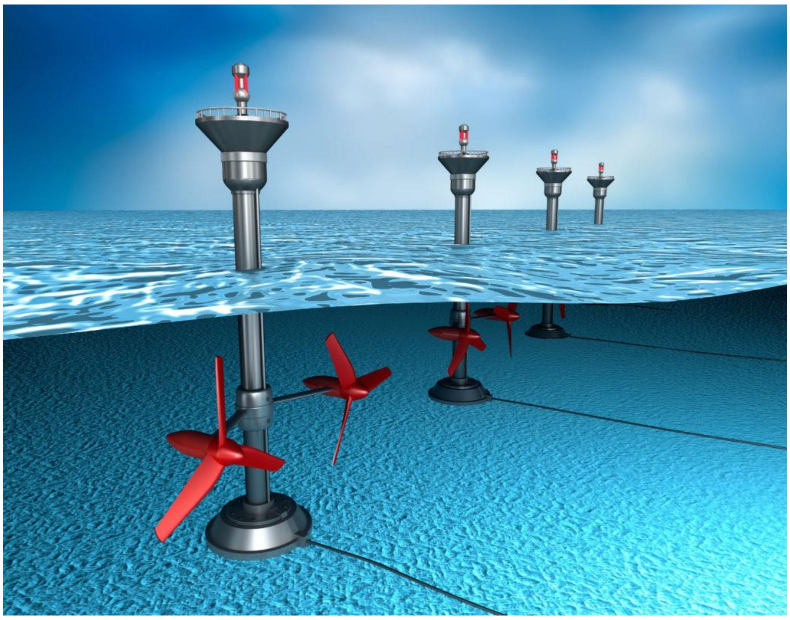


Fig 2.12: Tidal stream generators.

They can meet energy demands when they are all functioning at the same time, and they are also employed to protect coastal areas from storms. Infrastructure (embankments, barrages, sluice gates) may also be utilized to generate energy from the Bay of Bengal's 2–8 m tidal head. A paddlewheel under the shot to drive the water, a generator connected or geared with the wheel to create energy, and some electronic controls to manage the power output with varying water flow are also required. When needed, tidal power can be promptly shut down and restored with little losses. As a result, tidal power has the potential to be a valuable source of renewable energy for Bangladesh. [7]

Biomass is the world's fourth biggest source of energy, and it meets the fundamental energy needs of rural communities in developing nations for cooking and heating. Biomass refers to all types of organic matter, including everything from fuel wood to marine plants. Biomass energy generation is a fantastic way to help the environment by minimizing the production of common greenhouse gases. There are a variety of ways for converting biomass into energy, including heat and electricity (Fig 2.5).

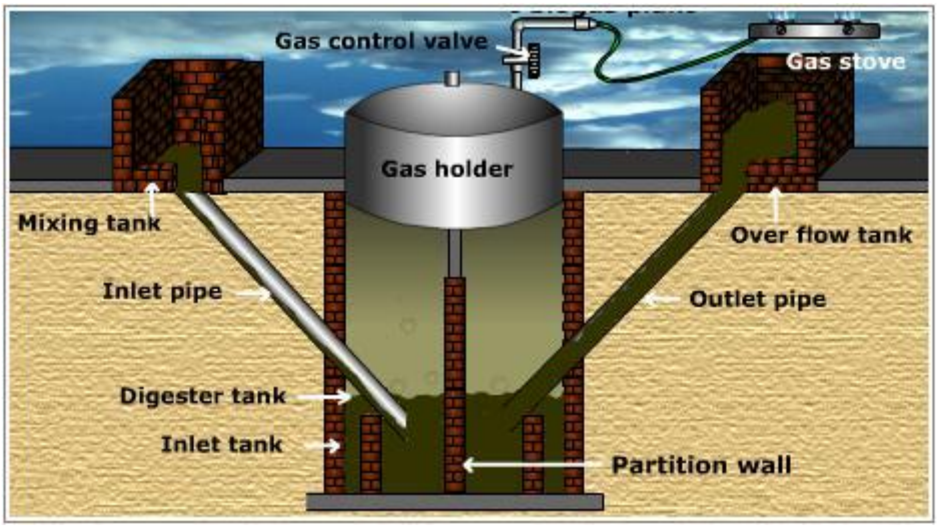


Fig 2.13: Construction and Installation of Biogas plant.

It is a combination of greenhouse gases created by animal dung, poultry droppings, and other biomass wastes, including CH4 (40–70%), CO2 (30–60%), and other gases (1–5%). This is a gas. It's combustible and can generate electricity. Biogas may be used to cook and generate electricity. Biogas, derived mostly from animal and urban waste, may be one of Bangladesh's most promising renewable energy sources. [7]

2.8 Potential for Sustainable Energy Application:

This section examines the existing use of renewable energy technologies in Bangladesh, as well as their potential. The benefits and lessons learned from previous renewable energy implementations are also discussed. The state of CDM in Bangladesh is also discussed in this section. Renewable energy technologies are now in use. Although the use of renewable energy is not new in Bangladesh, renewable electricity generation has mostly remained at the demonstration stage. Solar photovoltaic (PV) as solar home systems (SHSs); solar cookers, dryers, water heaters, and tunnel dryers for crops; biogas; biomass briquetting machines; and improved cooking stoves are only a few examples of current sustainable energy technology. A 62 kW system in the Narsingdi area was the first and largest solar PV installation to date. The early results of this demonstration project suggested that there was room for other applications. However, due to poor maintenance systems and poor enforcement of customer payments, the operation of this facility has been problematic (Biswas, Diesendorf, & Bryce, 2004). In Bangladesh, however, 800 kW of solar PV applications and over 45,000 SHSs are now operational (Infrastructure Development Company Limited [IDCOL], 2005; Sarkar et al., 2003). In 2004, 19,500 biogas plants were installed (S. Islam, Islam, & Rahman, 2006), 100,000 upgraded cook stoves were installed (S. Islam et al., 2006), and 60 biomass briquetting machines were installed (S. Islam et al., 2006). (S. Islam et al., 2006). In Bangladesh, renewable energy applications including solar cookers, water heaters, and crop tunnel dryers are still in the research, development, and demonstration stages. [8]

Renewable energy has the potential to improve. Bangladesh has a lot of potential for renewable energy sources including biomass, solar PV, wind, and modest hydropower, to name a few (S. Islam et al., 2006; Sarkar et al., 2003; Uddin, 2001). In 2004 (I. Hossain & Tanim, 2005), biomass accounted for over half of total energy supply and 98 percent of total renewable energy (IEA, Organization for Economic Cooperation and Development, 2004). In addition, as compared to other renewable energy technologies like better cooking stoves and biomass briquetting, activities involving the installation of SHSs are thriving (Siddiqui, 2003). This is primarily due to Grameen Shakti's original microcredit program (Timilsina, Lefevre, & Uddin, 2001) and IDCOL's recent efforts to promote SHSs under the Rural Electrification and Renewable Energy Development Project (REREDP; IDCOL, 2005). IDCOL's solar energy program is one of the world's fastest-growing renewable energy initiatives, with 50,000 SHSs built between 2003 and 2005, much ahead of the planned completion date of 2008. By 2009, IDCOL aims to fund an additional 200,000 SHSs using the same initiative (IDCOL, 2005). In addition, IDCOL aims to develop 60,000 household biogas units under the National Program of Domestic Biogas from 2006 to 2010. (IDCOL, 2005). These projects are designed to improve living conditions in Bangladesh's distant, rural areas by giving access to clean energy for cooking and green power for illumination (Uddin et al., 2006). [8]

2.9 Economy and energy context of Bangladesh

Bangladesh is a south Asian country with a population density of 1222 people per square kilometer, located between 20°34″ and 26°38″ north latitude and 88°01″ to 92°41″ east longitude. Over the previous decade, the country's economy grew at a pace of 6.2 percent, well above the worldwide average. Bangladesh's economy remained stable and grew at a rate of 6.5 percent of GDP (Gross Domestic Product) in 2015, while being untouched by global volatility.

[9] This was made feasible by increased growth in both the industrial and service sectors. Bangladesh has similarly progressed from a low-income to a lower-middle-income country. In 2015, the export industry grew at a slower pace (3.3 percent) than the year before (12.1 percent). This was due to the country's poor development in garment exports, despite the fact that it is the world's second largest garment exporter behind China. Agriculture, industry, and the service sector account for 17.2%, 28.9%, and 53.9 percent of the country's GDP, respectively. [10] The agriculture sector's contribution to GDP is declining as agricultural land is rapidly depleted. On the other hand, the service and industry sectors are growing in importance as a result of urbanization and rapid advancement in business and commerce. It is expected that each 1% increase in per capita energy consumption will result in 0.23 percent rise in GDP. [11] Even though Bangladesh's energy consumption climbed by 4.5 percent between 1990 and 2012, which is close to the greatest percentage rise among Asian nations, per capita energy consumption remains low. Figures 2.6 and 2.7 depict per capita energy consumption and the rate of increase in energy usage in various Asian nations. When China, India, Pakistan, and Sri Lanka have per capita energy consumption of 2143 kgoe (kilograms of oil equivalent), 624 kgoe, 524 kgoe, and 554 kgoe, respectively, Bangladesh has just 214 kgoe (see Fig. 4), which is among the lowest in the world. [13]

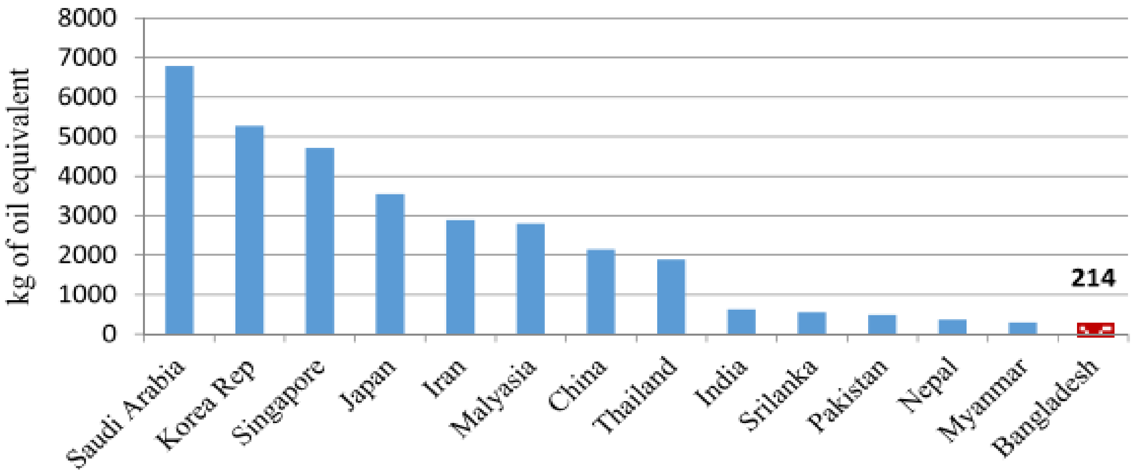


Fig 2.14: Per capita energy use in different Asian countries. [12]

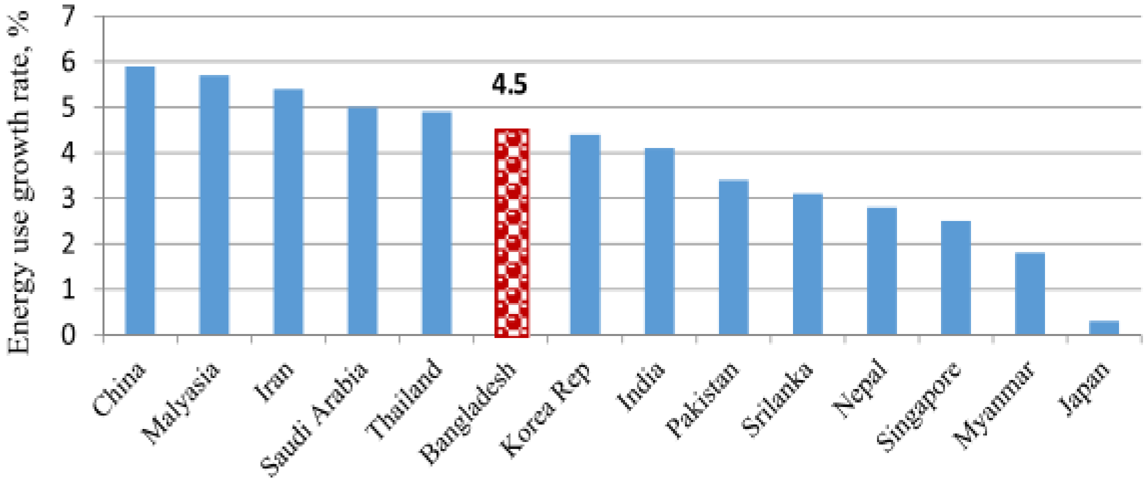


Fig 2.15: Energy use growth rate in different Asian countries (from 1990 to 2012). [12]

Figures 2.8 and 2.9 illustrate the breakdown of power generation by source in the globe and Bangladesh, respectively. Although several nations are already generating the majority of their power from renewable sources, as shown in Figure 4, only 16.8% of the world's power is generated from renewable sources (hydro).

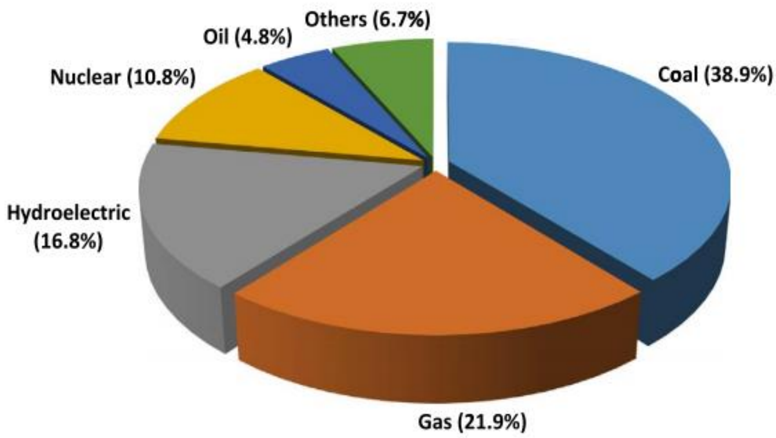


Fig 2.16: Breakdown of world electricity capacity (by type of source)

Other renewable energy sources provide very little electricity. Renewable energy sources account for a small percentage of overall power output in Bangladesh. Renewable energy accounts for just 423 MW of the total 12,261 MW. Other renewable energy sources, aside from hydropower and solar energy, provide even less electricity. In Bangladesh the main source of electricity is natural gas. Natural gas contributes almost 63 percent of the total installed capacity and 72 percent of the actual electricity generation as of 2014. Aside from electricity, natural gas is the primary energy source in several of Bangladesh's other industries. It accounts for 75% of the world's principal commercial energy source. Electricity plants consume 41% of total natural gas usage, whereas industry consumes 17%, captive power consumes 16%, the home sector consumes 12%, fertilizer consumes 8%, and transportation (CNG) consumes the remaining 6%. [7]

The reliance on natural gas is growing by the day. Between 1992 and 2012, it climbed by 300 percent. Another important source of energy is oil. Bangladesh is mostly reliant on refined and unrefined petroleum fuels in terms of oil. These are mostly utilized in the transportation and agriculture industries. The transportation sector consumes 45 percent of total oil, while irrigation uses 21 percent. The remainder is utilized in the electricity industry (19%) and the household sector 9 percent. [8]

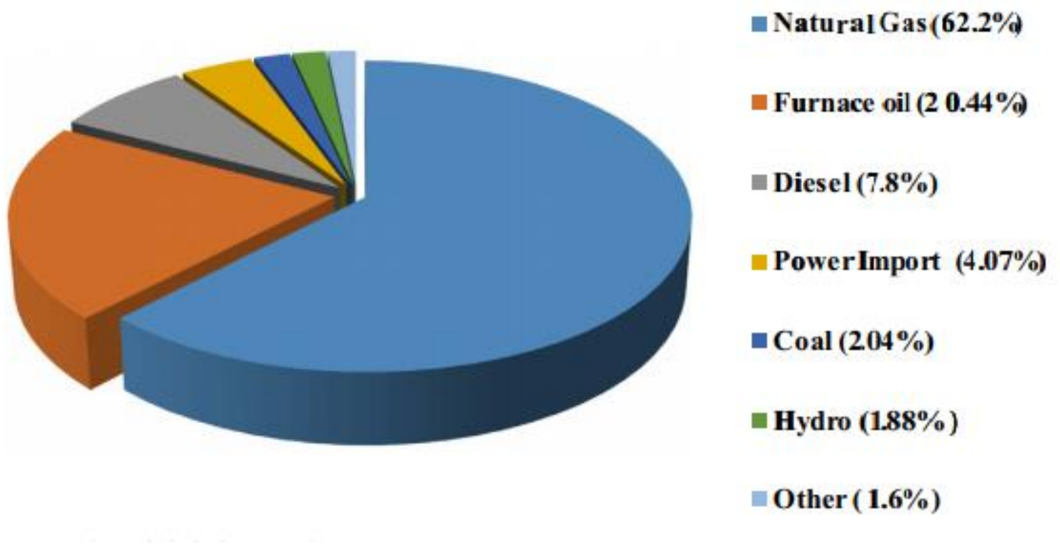


Fig 2.17: Breakdown of electricity capacity of Bangladesh (by type of source). [7]

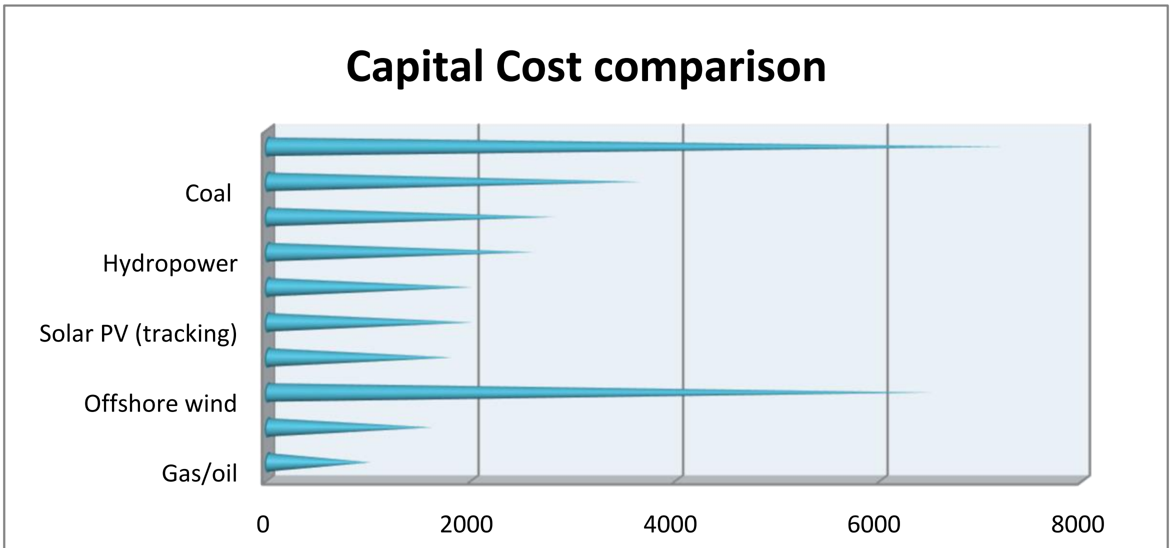
CHAPTER 3
TRENDS IN RENEWABLE ENERGY

3.1 Introduction

Renewable generation has historically been more costly than traditional power, necessitating the use of discounts and subsidies. Wind and solar are becoming commercially attractive as a result of technical advancements.

3.2 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 figure 4.1 all the renewable sources are costlier than any other form of energy.



	Gas/oil	Onshore wind	Offshore wind	Solar PV (fixed)	Solar PV (tracking)	Battery storage power	Hydropower	Geothermal	Coal	Nuclear
USD	950	1600	6400	1800	1950	2000	2600	2750	3650	7250

Figure 3.1: Capital cost for power generation capacity of Global in USD/KWh (IRENA And design by Author)

The world is presently heading towards putting resources into exploration to investigate new advances and mounting the advances to increase colossal turn of events. The principle subject behind these is natural angles, expanding request and costs of petroleum derivative and decreasing the danger of atomic innovations.

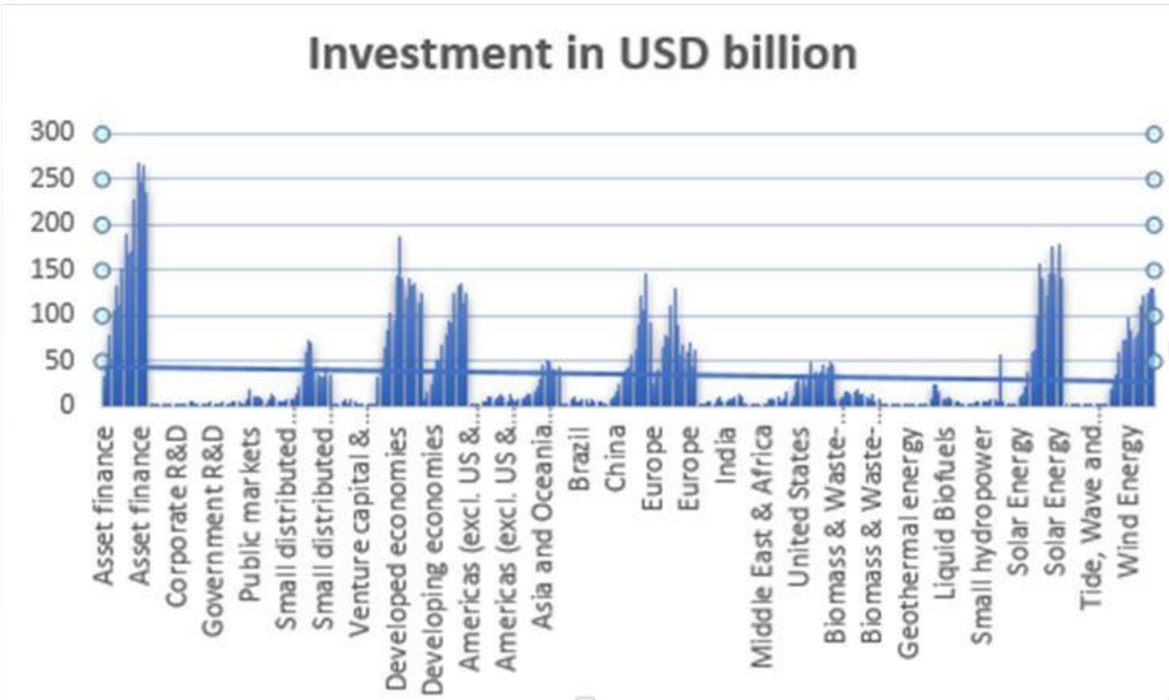


Figure 3.2: Global investment of RES in USD (IRENA)

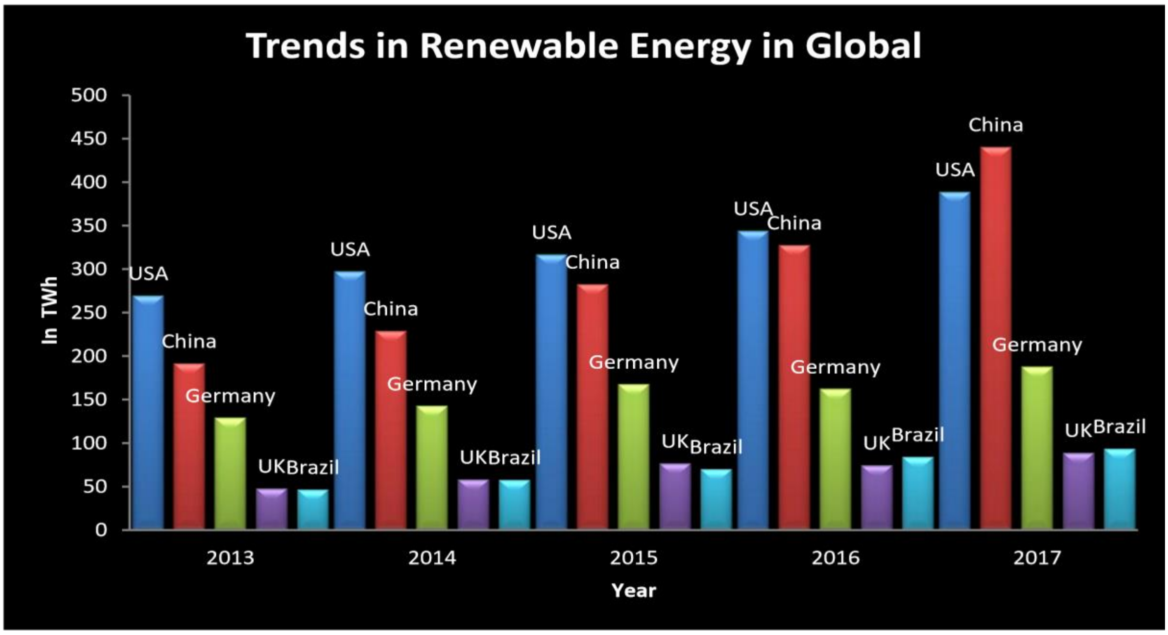


Figure 3.3: Trends in Renewable Energy in Global in TWh (Wawamustats and design by Author)

The following figure featuring the top 5 countires those are gained enormous success in generating energy by RES

3.3 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 has 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 advancement.

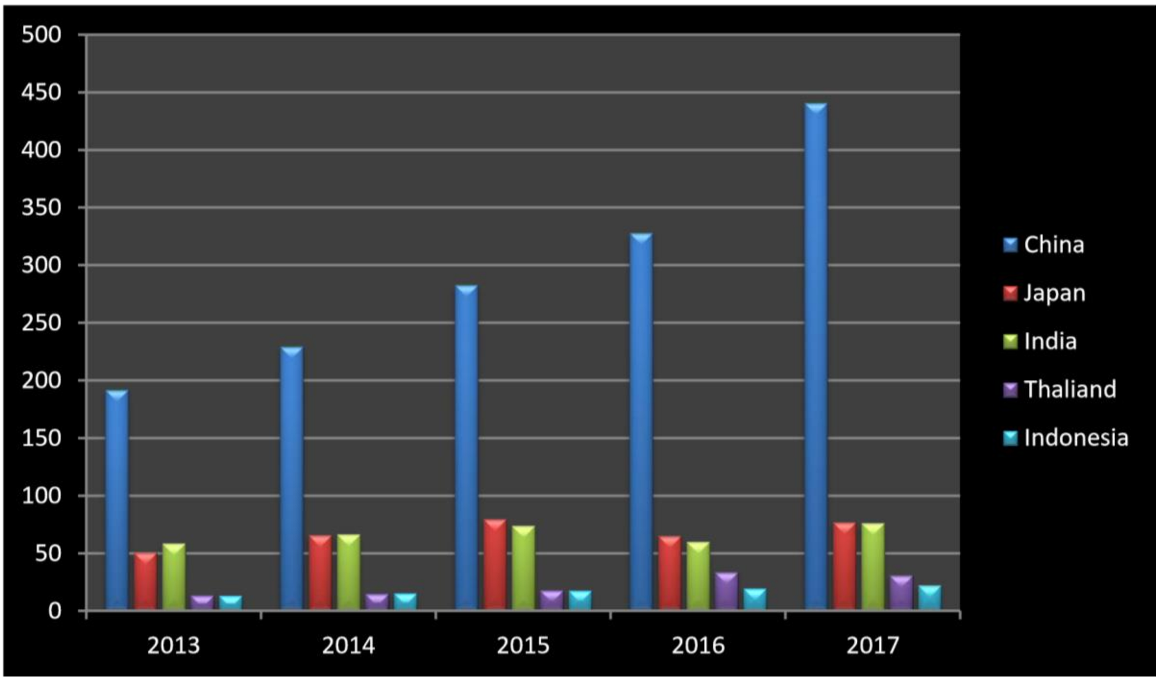


Figure 3.4 : Current scenario of RE generation in Asia in TWh (Wawamustats and design by Author)

3.4 Current Scenario of Bangladesh

In Bangladesh, around 65 percent of vitality is produced from oil gas. Among different fills oil, coal, biomass, etc. are basic. There is a gigantic spare of coal in our country, notwithstanding, coal is less conveyed similarly as less used here. On the other hand, combustible gas isn't excessively huge, notwithstanding, its age and usage are the most significant among the open resources. Other than those, vitality request is being met through imported oil and LPG. Also, the organization has quite recently started acquiring LNG to satisfy extending gas needs. Biomass is being used as a ton of vitality. The imperativeness demand is also being met by getting power from India.

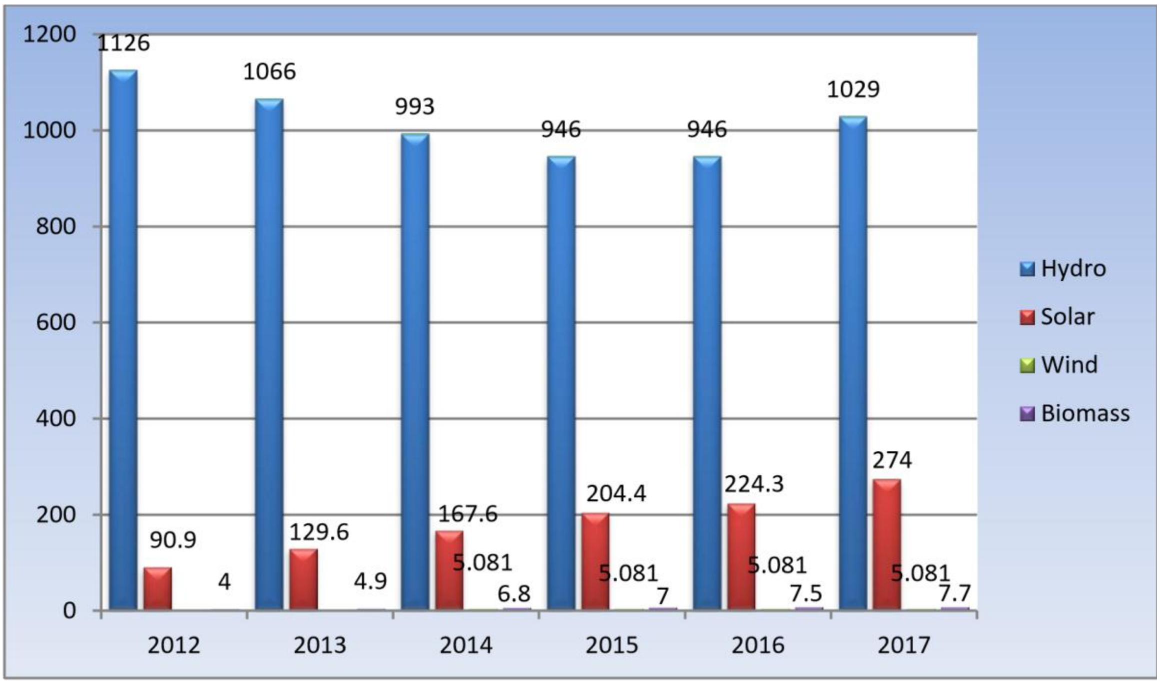


Figure 3.5 Current scenario of RE generation in Bangladesh in GWh (IRENA and design by Author)

CHAPTER 4

RENEWABLE ENERGY RESOURCES AND TECHNOLOGIES IN BANGLADESH

4.1 Introduction

Bangladesh's nonrenewable energy supplies are extremely small. In rural areas, she is dealing with an energy shortage and a major desertification issue. If green energy is used as the main source of energy in rural areas, these problems could be solved. Finding clean energy options and efficient solutions is important for scientists and researchers. Bangladesh has a lot of resources biomass and solar insolation are two examples of large green energy supplies. Hydro and wind power can also be called alternative renewable energy options. Using these services to improve the quality of life for rural villages seems to be a potential approach.

4.2 Solar Energy

Sun based vitality is the most natural, never-ending, and usable vitality source which is very much embraced start to finish the world. Concentrating sun based force (CSP) and sun based PV are promising headways, and the sun based home framework can convey power utilizing sunlight based arranged radiation. On account of Bangladesh, there is an enormous degree of potential outcomes to utilize sun oriented fueled radiation in light of the fact that the nation is arranged in the geological region [7]. The nation gets an ordinary day by day sun based illumination of 4.2–5.5 kWh/m2 that can make generally 1,862.5 kWh/m2 every year (see Figure 3.1) [8].

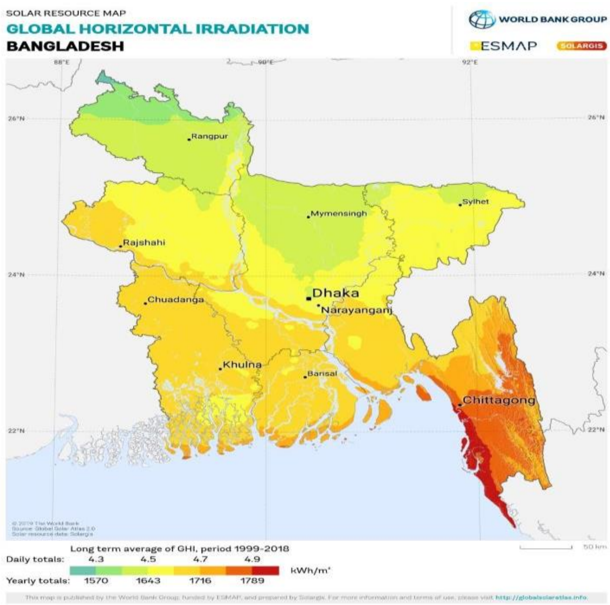


Figure 4.1: Global horizontal solar irradiation in Bangladesh [8]

Bangladesh has recently met several accomplishments and profitable execution of sun-controlled based vitality use. The budgetary practicality of sun oriented photovoltaic as an electricity age hotspot for Bangladesh was additionally evaluated using a proposed 1-MW matrix associated sun based PV framework utilizing RETScreen reproduction programming for 14 far and wide areas in Bangladesh. The specialized capability of network associated sun oriented PV in Bangladesh was determined as around 50174 MW, as shown in Table 1 [9].

Table 4.1: Solar energy potential power in Bangladesh

Technology	Potential power (MW)
Concentrated solar power(CSP)	100
Grid-connected solar PV	50,174
Solar home systems(SHS)	234

With around 5 million Solar Home System (SHS), Bangladesh has the world's biggest SHS, Bangladesh Power Development Board (BPDB) is endeavoring to also present joined sun based cycle plants and LED street light, so as to decrease the important electricity request. Recently, the nation has effectively initiated the biggest sunlight based force plant in the Teknaf region with an ability to create 28 MW, which is equipped for taking care of 20 MW to the nearby substation. [2]

4.3 Wind Energy

Wind vitality is a sort of eco-accommodating nature and trusted as the best feasible force source that teams for future vitality arrangements. The potential electricity is created from the moving air as the active vitality of wind supplies the turbine shaft. Wind power is straightforwardly corresponding to the speed of the breeze. The protracted period wind transition, especially in the islands and southern sea facial of Bangladesh, declare that the normal breeze speed stays somewhere in the range of 3 and 4.5 m/s in the long stretches of March to September and 1.7 to 2.3 m/s for the lingering time of the year [10]. Bangladesh created 900 KW wind power at Muhuri Dam zone of Sonagazi in Feni and 1000 KW Wind Battery Hybrid Power Plant at Kutubdia Island; Grameen Shakti, Bangladesh Center for Advanced Studies (BCAS), BRAC, Bangladesh Army, IFRD, Installed an absolute 19.2 KW at various seaside areas of Bangladesh

[3]. Nonetheless, Bangladesh has the world's longest seaside belt of around 724 km in the line of Bay of Bengal, and charge from wind turbines in Bangladesh needs more techno-financial evaluation. Anyway BPDB as of late recognized 22 locales for wind power age and inland Wind Power Plants along the coastline of waterfront areas of Bangladesh, additionally BPDB has arranged a 50-200 MW wind ages plants Anawara in the Chittagong zone, 15 MW Wind Power Plant in the Muhuri Dam Area of Feni, Mognamaghat of Cox's Bazar, Parky Beach of Anwara in Chittagong, Kepupara of Borguna and Kuakata of Patuakhali [3].

Bangladesh and lights up that the greatest yearly normal breeze speed is 2.42 m/s in Cox's Bazaar and a base 2.08m/s in Hatia Island [11]. Table 2 shows the breeze vitality potential in Bangladesh.

Table 4.2: Wind energy potential in Bangladesh

Site	Reference Height (m)	Annual-Average Wind Speed (m/s)
Cox's Bazaar	10	2.42
Sandip Island	5	2.16
Teknaf	5	2.16
Patenga Airport	5	2.45
Comilla Airport	6	2.21
Khepupara	10	2.36
Kutubdia Island	6	2.09
Bhola Island	7	2.44
Hatia Island	6	2.08

4.4 Biomass Energy

Biogas is a compound of gases that are delivered by the natural interruption of natural issue and it happens to without Oxygen. Dead plant and creature material are biologic squanders. Further, creature fertilizer and kitchen waste can be changed over into a vaporous fuel called biogas.

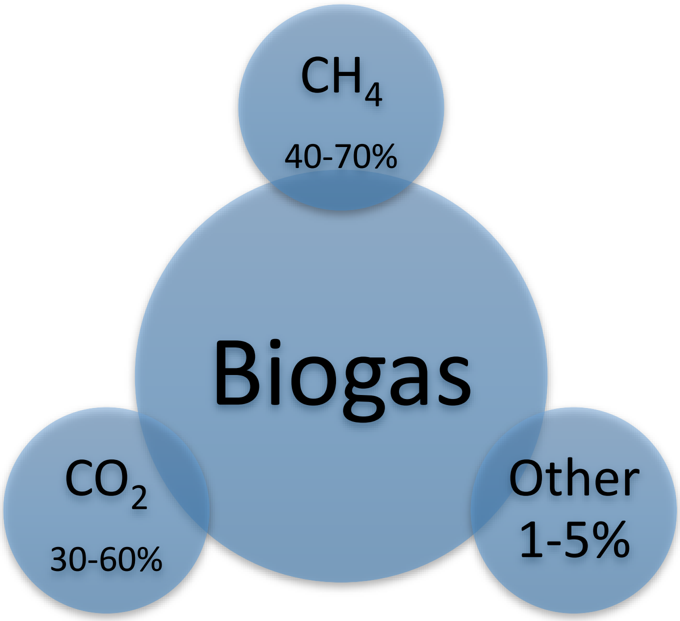


Figure 4.2: Chemical composition of Biogas

Biomass covers a wide range of natural issues from fuelwood to marine vegetation. Biomass is the fourth biggest wellspring of vitality worldwide and gives essential vitality prerequisites to cooking and warming of rustic family units in creating nations. Vitality age utilizing biomass offers a promising answer for ecological issues by decreasing the discharge of regular ozone harming substances. A wide scope of alternatives exists for the transformation of biomass into vitality, for example, heat vitality and electrical vitality [12].

4.5 Hydropower

Hydroelectricity is a characteristic sustainable wellspring of intensity where water stream is utilized to change over active vitality into electrical vitality. In 1849, British-American architect James Francis built up the primary present day water turbine-The Francis turbine-which remains the most broadly utilized water turbine on the planet today[13]. The complete utilization of hydroelectricity around the globe in 2014 was 406.83% and China was the most noteworthy (27.4% of worldwide offer) [3]. While in Bangladesh the creation limit of hydroelectricity in 2014 was 230MW and worldwide sharing is entirely insignificant. Table 3 speaks to the proposed hydroelectricity venture [3].

Table 4.3: Proposed Hydroelectricity project in Bangladesh

Name of the River	Potential of Electrical Energy in MW
Kaptai	100
Shangu river	100
Matamuhuri rive	100
Mohamaya	23-65
Lohajari	4.5

CHAPTER 5

ENERGY CONSUMPTION AND COST ANALYSIS

5.1 Introduction:
Here we calculate the load consumption system for a building. To reduce the cost we find out a way for different load. We calculate the tariff for two different condition in this chapter. We find out daily energy consumption for both summer and winter season for the total load in my design.

5.2 Total load connected in design:
There is a table 5.1 which is given below. We used many appliance in my design and find out the power which are used per day. Lastly we calculate the total load used per day for summer season.

Table 5.1: Total load in design

Total load= 7263 watt per day

Sr. No	Name of the Appliance	Watts (W)	No	Total Watts (W*N)
1	LED	20	24	480
2	S. LED	12	18	216
3	Tube Light	25	18	450
4	Air Exhaust	35	6	210
5	Fan	65	24	1560
6	Television	65	6	390
7	CCTV	25	3	75
8	Lift	200	1	200
9	Water Pump 2hp	746	1	1492
10	Refrigerator	140	6	840
11	Laptop	65	6	390
12	Mobile	40	24	960

Total load= 7.263 kilowatt per day

5.3 First floor room consumption: In the table 5.2 we calculate the power consumption demand per day.

Sr. No	Name of the Appliance	Watts (W)	No	Total Watts (W*N)
1	LED	20	24	480
2	S. LED	12	18	216
3	Tube Light	25	18	450
4	Air Exhaust	35	6	210
5	Fan	65	24	1560
6	Television	65	6	390
7	CCTV	25	3	75
8	Lift	200	1	200
9	Water Pump 2hp	746	1	1492
10	Refrigerator	140	6	840
11	Laptop	65	6	390
12	Mobile	40	24	960

Table 5.2: First floor room consumption

For Room Power Consumption Demand = 20244Wh/day

1st floor To 3rd floor Power Consumption Demand = 20244*3

= 60732 watt/day

5.4 Others power consumption demand: From the table 5.3 we find out the power consumption demand for water pump 2hp and lift. In my design we added 1 water pump and 1 lift.

Sr. No	Name of the Appliance	Watts (W)	No	Total Watts (W*N)	No. Of Hours	Energy (Total Watt* No. Of Hours)
1	Water Pump 2hp	746	1	1492	2	2984
2	Lift	200	1	200	18	3600

Table 5.3: Other power consumption

Others power consumption demand = 6584 watt/day

Consumption Room & Others = (60732+6584) Watt/day

= 67316/1000 Watt/day

= 67.316 kilowatt/day

5.5 Daily energy consumption in summer: From the table 5.4 we find out the total energy consumption daily for the summer season.

Summer	LED	S.LED	Tube Light	Air Exhaust	Fan	TV	CCTV	Lift	Water Pump 2HP	Refrigerator	Laptop	Mobile	Hourly Consumption
5:00AM							75			840			915
6:00AM							75	200		840			1115
7:00AM					1560		75	200	1492	840			4167
8:00AM				210	1560		75	200		840			2885
9:00AM				210	1560	390	75	200		840	390		3665
10:00AM				210	1560	390	75	200		840	390		3665
11:00AM				210	1560		75	200		840			2885
12:00AM				210	1560		75	200		840			2885
1:00PM				210	1560		75	200		840			2885
2:00PM				210	1560		75	200		840			2885
3:00PM				210	1560		75	200		840			2885
4:00PM				210	1560		75	200	1492	840			4377
5:00PM				210			75	200		840			1325
6:00PM	480	216	450	210			75	200		840			2471
7:00PM	480	216	450	210	1560		75	200		840			4031
8:00PM	480	216	450	210	1560		75	200		840			4031
9:00PM	480	216	450	210	1560		75	200		840			4031
10:00PM	480	216	450	210	1560		75	200		840			4031
11:00PM	480	216	450	210	1560		75	200		840			4031
12:00PM	480	216	450	210	1560		75	200		840		960	4991
1:00AM		216		210	1560		75			840			2901
2:00AM				210	1560		75			840			2685
3:00AM				210			75			840			1125
4:00AM							75			840			915
Total	3360	1728	3150	4200	28080	780	1800	3800	2984	20160	780	960	71782

Table 5.4: Daily energy consumption in summer

5.6 Tariff calculation for summer season: Now we calculate the tariff for whole summer season for two different condition.

5.6.1 meter for 6 flat in this building:

Total load=71782 wh /day

=71.782 kwh /day

= (71.782*30) kwh /month

=2153.46 kwh /month

Tariff=(75*4.19)+(125*5.72)+(100*6)+(100*6.34)+(200*9.94)+(1553.46*11.46)

=22054 taka

5.6.2 6 meter for 6 flat in this building:

Total load=2153.46 kwh /month

Total load for 1 flat=(2153.46/6) kwh/month

=359 kwh/month

Tariff=(75*4.19)+(125*5.72)+(100*6)+(59*6.34)

=2003.31 taka

Total Tariff for 6 meter=(2003.31*6)

=12010 taka

5.7 Load curve and load duration curve for the summer season:

In the figure 5.1 we see about the load curve for the whole summer season and in the figure 5.2 we see about the load duration curve for the whole summer season.

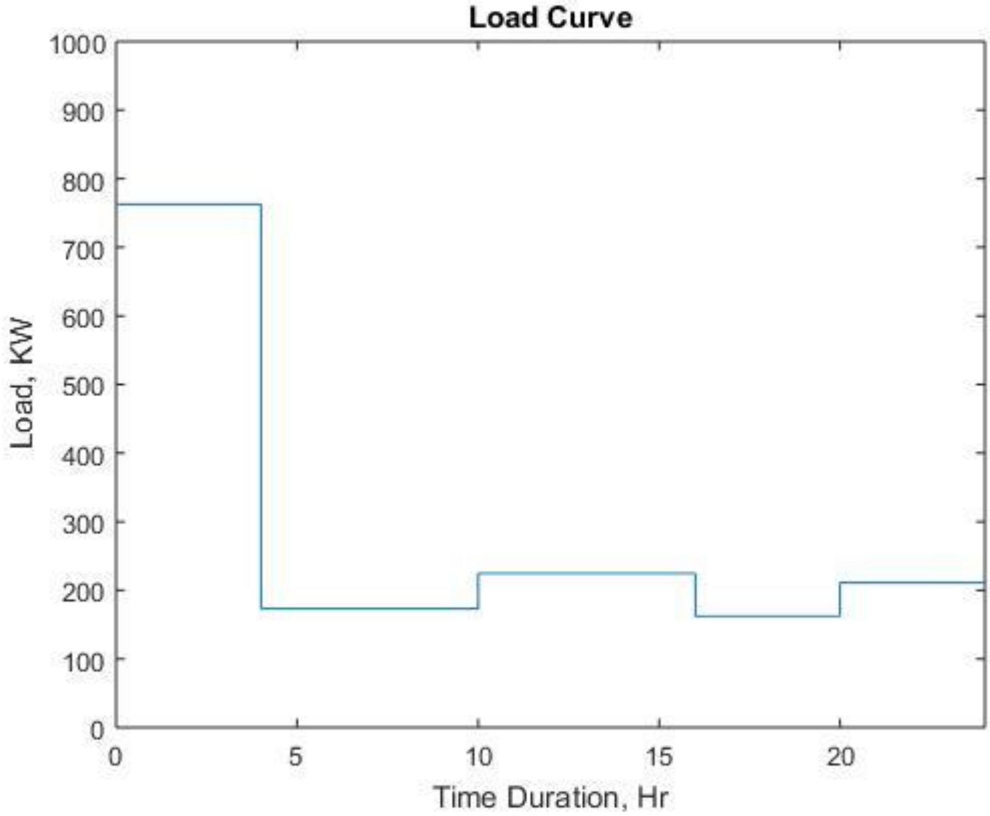


Fig 5.1: Load curve (summer)

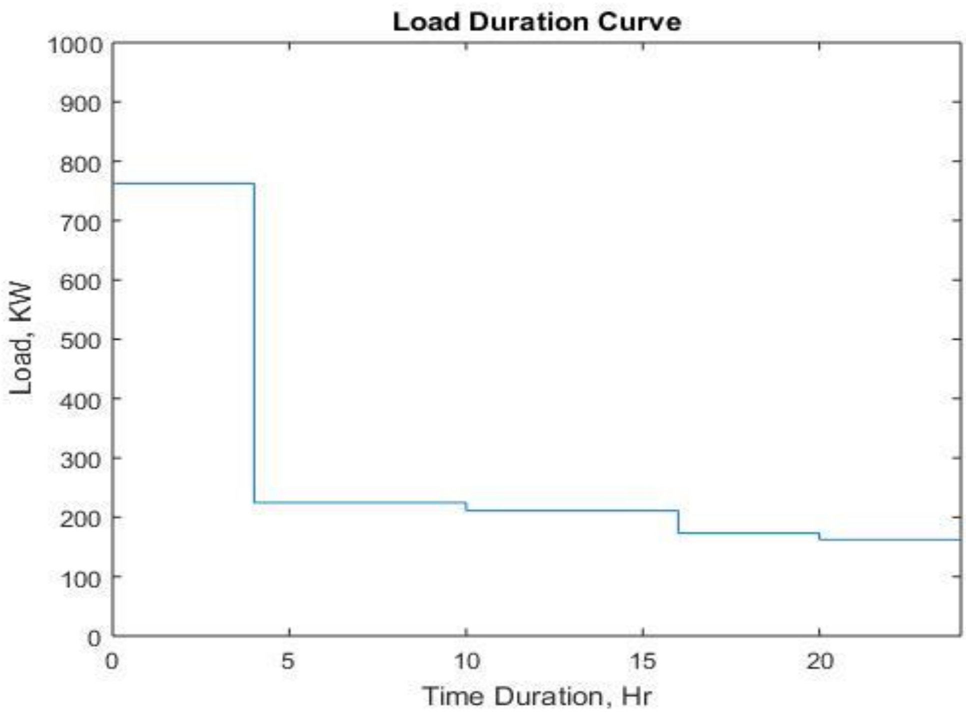


Fig 5.2: Load duration curve (summer)

5.8 First floor room consumption: In the table 5.5 we calculate the power consumption demand per day.

Sr. No	Name of the Appliance	Watts (W)	No	Total Watts (W*N)	No. Of Hours	Energy (Total Watt* No. Of Hours)
1	LED	20	8	160	6	960
2	S. LED	12	6	72	7	504
3	Tube Light	25	6	150	6	900
4	Air Exhaust	35	2	70	6	420
5	Fan	65	8	520	2	1040
6	Television	65	2	130	2	260
7	CCTV	25	1	25	24	600
8	Refrigerator	140	2	280	24	6720
9	Laptop	65	2	130	2	260
10	Mobile	40	8	320	1	320

Table 5.5: First floor room consumption (winter)

For Room Power Consumption Demand = 11984Wh/day

1st floor To 3rd floor Power Consumption Demand = 11984*3

= 35952 watt/day

5.9 Others power consumption demand: From the table 5.6 we find out the power consumption demand for water pump 2hp and lift. In my design we added 1 water pump and 1 lift.

Sr. No	Name of the Appliance	Watts (W)	No	Total Watts (W*N)	No. Of Hours	Energy (Total Watt* No. Of Hours)
1	Water Pump 2hp	746	1	1492	2	2984
2	Lift	200	1	200	18	3600

Table 5.6: Others power consumption demand

Others power consumption demand = 6584 watt/day

Consumption Room & Others = (35952+6584) Watt/day

= 67316/1000 Watt/day

= 67.316 kilowatt/day

5.10 Daily energy consumption in winter: From the table 5.7 we find out the total energy consumption daily for the summer season.

Summer	LED	S.LED	Tube Light	Air Exhaust	Fan	TV	CCTV	Lift	Water Pump 2HP	Refrigerator	Laptop	Mobile	Hourly Consumption
5:00AM							75			840			915
6:00AM							75	200		840			1115
7:00AM							75	200	1492	840			2607
8:00AM							75	200		840			1115
9:00AM						390	75	200		840	390		1895
10:00AM						390	75	200		840	390		1895
11:00AM							75	200		840			1115
12:00AM				210			75	200		840			1325
1:00PM				210			75	200		840			1325
2:00PM				210	1560		75	200		840			2885
3:00PM				210	1560		75	200		840			2885
4:00PM				210			75	200	1492	840			2817
5:00PM				210			75	200		840			1325
6:00PM	480	216	450				75	200		840			2261
7:00PM	480	216	450				75	200		840			2261
8:00PM	480	216	450				75	200		840			2261
9:00PM	480	216	450				75	200		840			2261
10:00PM	480	216	450				75	200		840			2261
11:00PM	480	216	450				75	200		840			2261
12:00PM	480	216	450				75	200		840		960	3221
1:00AM		216					75			840			1131
2:00AM							75			840			915
3:00AM							75			840			915
4:00AM							75			840			915
Total	3360	1728	3150	1260	3120	780	1800	3800	2984	20160	780	960	43882

Table 5.7: Daily energy consumption in winter

5.11 Tariff calculation for winter season:

Now we calculate the tariff for whole winter season for two different condition.

5.11.1 One meter for 6 flat in this building:

Total load=43882 wh /day

=43.882 kwh /day

= (43.882*30) kwh /month

=1316.46 kwh /month

Tariff=(75*4.19)+(125*5.72)+(100*6)+(100*6.34)+(200*9.94)+(716.46*11.46)

=12462 taka

5.11.2 Six meter for 6 flat in this building:

Total load=1316.46 kwh /month

Total load for 1 flat=(1316.46/6) kwh/month

=219.41 kwh/month

Tariff=(75*4.19)+(125*5.72)+(19.41*6)

=1146 taka

Total Tariff for 6 meter=(1146*6)

=6876 taka

5.12 Load curve and load duration curve for the winter season:

In the figure 5.3 we see about the load curve for the whole winter season and in the figure 5.4 we see about the load duration curve for the whole winter season.

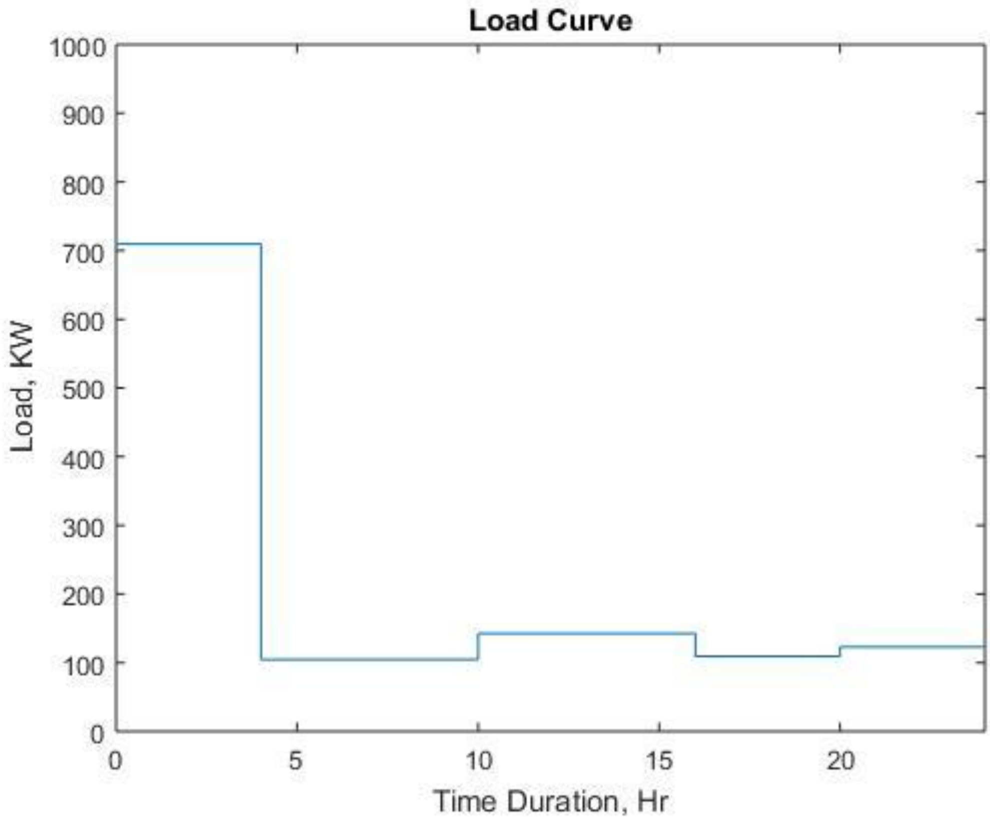


Fig 5.3: Load curve (winter)

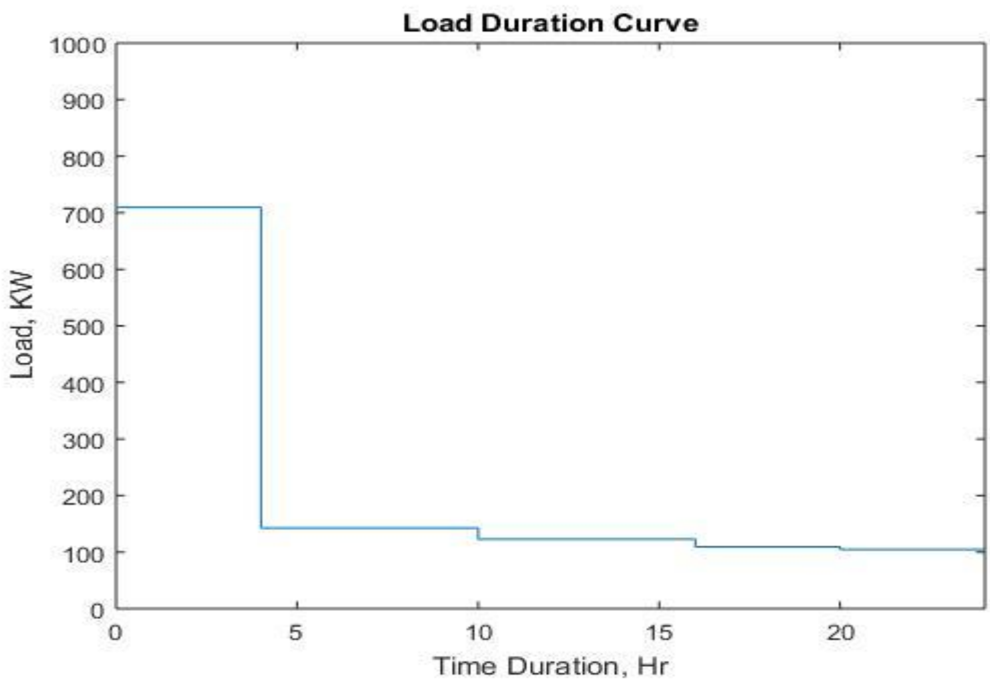


Fig 5.2: Load duration curve (winter)

CHAPTER 6

ENERGY DEMAND FORECASTING

6.1 Introduction

Here limit implies the most extreme that can be acquired or delivered, Production is the sum that has created or created and request alludes to the shopper's longing to purchase merchandise or administration and ability to pay for that. A diagram of limit, creation, and request is appeared in beneath figure 5.1

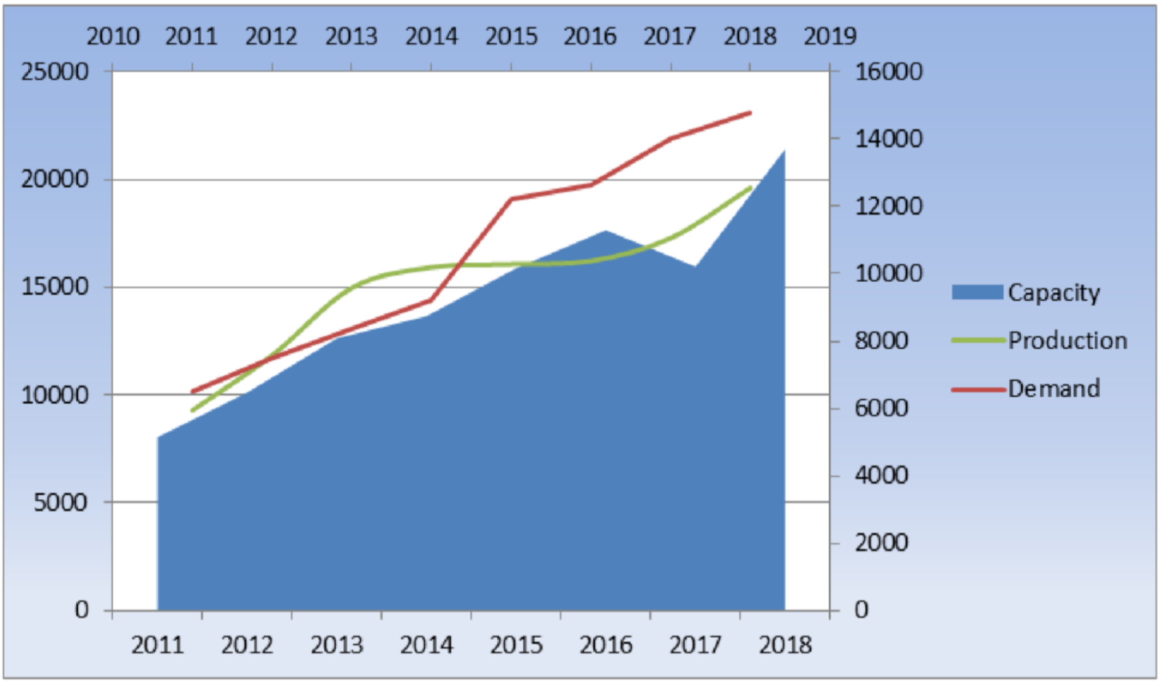


Figure 6.1: Overview of Energy generation, capacity & demand (BPDB and author's calculation)

We have taken data from 2011 to 2018 in order to forecast the future production and demand.

6.2 Demand forecasting

From above data we have analyzed the probable future demand of Bangladesh till 2025.We have used the linear forecasting method as discussed below shown in figure 5.2. 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.

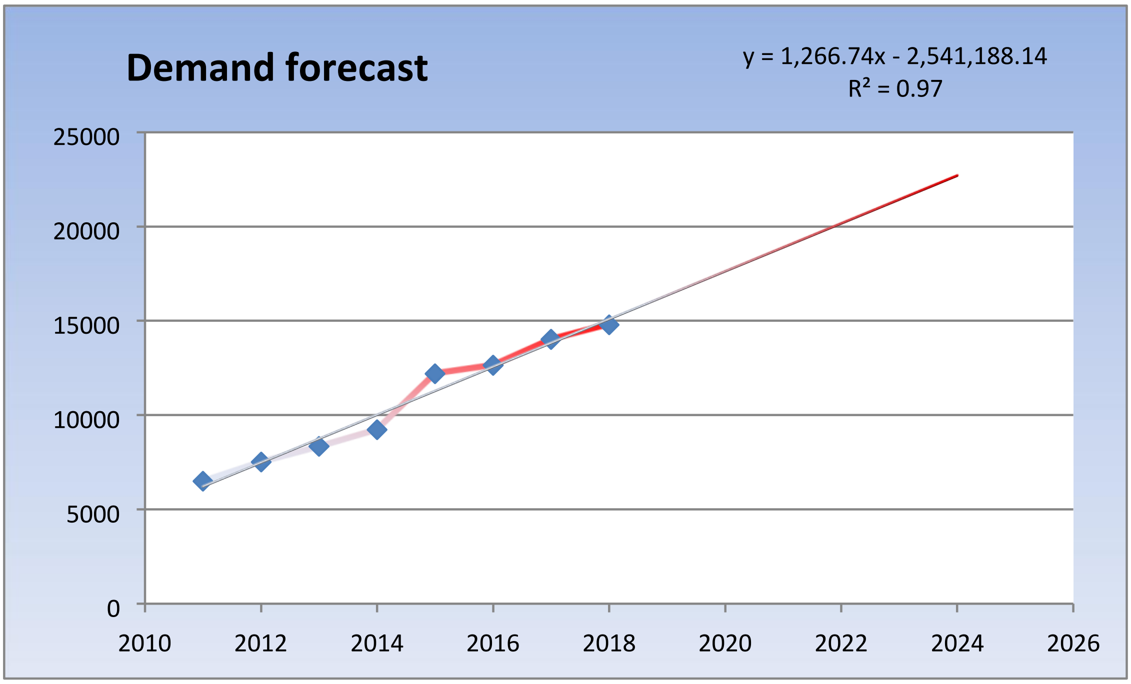


Figure 6.2: Demand forecasting till 2025 in MW (Author's calculation by linear equation)

6.3 Mechanics of forecasting method

We have executed here direct anticipating technique. The Data which are utilized in this investigation is about the creation and limit of the Bangladesh power framework from 2011 to 2018. We have first made a straight pattern line is of the type of,

Y= a+bX (linear equation)

Where,

Y = forecast

a = intercept

b = slope

X = year

Here, Y is the gauge. Graphically 'an' is where the line would hit the Y-pivot and 'b' is the slant. There is one more factor R2 which is in the information here, It's the quality of the relationship. It's known as the co-proficient of the country and shifts between 0 and 1. On the off chance that R2=0, at that point there is no connection between the two elements we are contrasting and on the off chance that R2=1 or close with 1, at that point there is a solid connection between them. From the above condition we got y=1,266.74x-2,541,188.14 R^2 = 0.97. Since here the estimation of R^2 = 0.97 we can accept a decent connection between the year and the vitality.

By processing this condition, we have anticipated the plausible burden request until 2030.Wshown in figure

6.4 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.

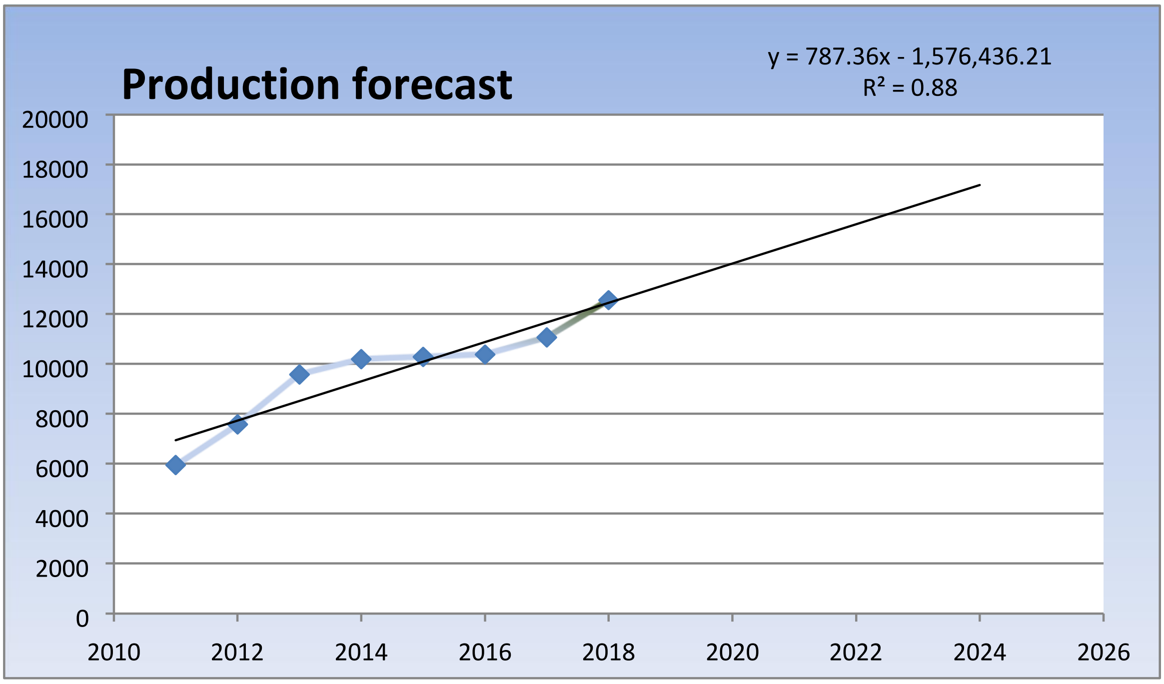


Figure 6.3: Production forecasting till 2025 in MW (Author's calculation by linear Equation)

6.5 Comparison between Demand and Production

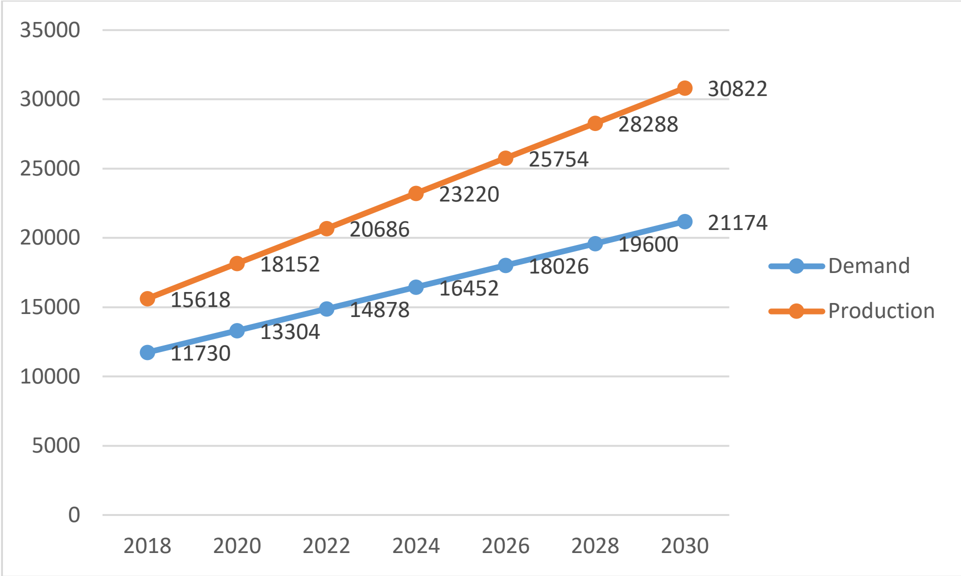


Figure 6.4: Comparison between Demand & Production forecasting till 2030 in MW (Author's calculation)

From the above examination, we can see that the creation esteem in a specific year is consistently underneath the interest line. In spite of the fact that both are expanding step by step there will be as yet a great many MW deficiency among request and creation even in 2030. The slow development of intensity plants and limit won't have the option to convey the remainder of the vitality request. We have ignored the main atomic plant which is going into activity by 2023. As far as possible in the force part can be refined cost-reasonably through clean vitality decisions (renewables and vitality efficiency), which reduce ozone-draining substance releases, yet moreover, increase occupations and improve human prosperity by diminishing air tainting. According to a report from the Low Emission Development Strategies Global Partnership (LEDS GP) and subject to point by point showing examination, the upsides of extending clean vitality in Bangladesh's ability age mix similar with old news' could deliver the join total results by 2030: [14]

CHAPTER 7

RENEWABLE ENERGY ISSUES AND CHALLENGES IN BANGLADESH

7.1 Introduction

Bangladesh has a high potential to move towards a predominant and progressively down to earth country with greener vitality without bartering the country's financial capability, human pride, lifestyles, and budgetary turn of events. Since RE adventures are logically awesome, whimsical, and stacked with unexpected threats and dangers, the examiners in this field may stand up to certifiable cash related challenges having impacts on future improvement and commercialization of the endeavors and advances for the theorists, it is difficult to convince the budgetary foundations and distinctive financers to get a significant assistance. Since they use new advances that are uncertain, this may make the pay time span outperform their wants. For these previously mentioned issues and alongside numerous different difficulties are vital for creating RE in the coming days in Bangladesh.

7.2 Renewable Energy Sources: Importance and Concerns

Broadening the breaking point in the force division can be cultivated cost-sufficiently through clean vitality choices (renewables and vitality profitability), which decline ozone hurting substance spreads, yet moreover, increase occupations and improve human prosperity by decreasing air tainting. As shown by a report from the Low Emission Development Strategies Global Partnership (LEDS GP) and subject to point by point exhibiting examination, the upsides of extending clean vitality in Bangladesh's ability age mix near with 'the same old thing' could make the join consolidated results by 2030:

- lessen ozone depleting substance outflows by up to 20% [14]
- create local work of up to 55,000 full-time comparable occupations [14]
- Potential to deliver extra power of 30 GW from the use of sun oriented PV and 53 gigawatt (GW) of power potential from every single sun powered source. [14]
- Set aside to 27,000 lives, and over US$5 billion (BDT 420 billion). [14]

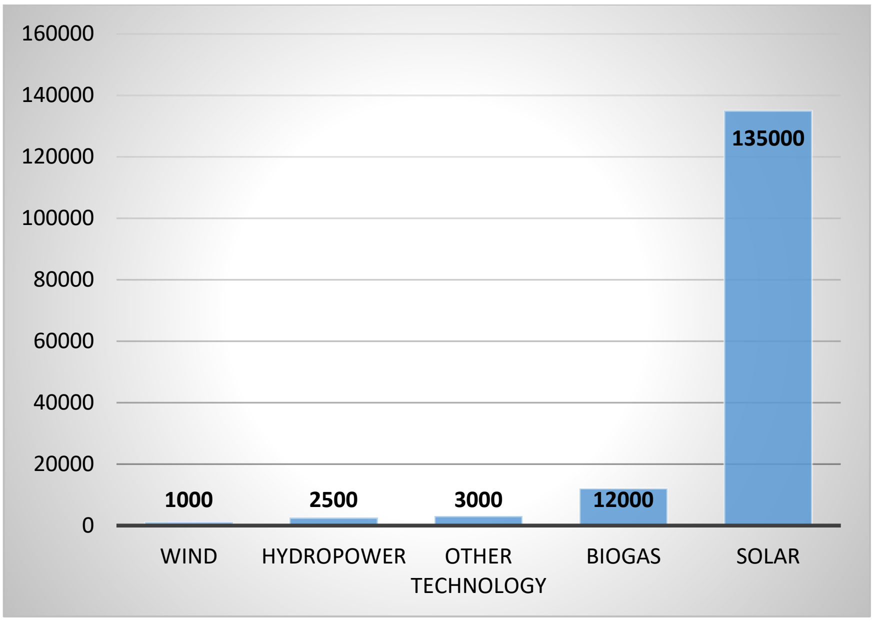


Figure 7.1: Job opportunities for renewable sector in Bangladesh (IRENA)

7.3 Lack of Awareness

There are distinctive social inconveniences relating to RES and green improvements some are portrayed beneath

- There is a shocking, yet discernible non-participation of open care into this issue.
- The open collaboration programs, particularly in the rustic districts don't buy in to those projects. Government affiliations can similarly way to deal with assistance and guide the possible beneficiaries.
- Due to the over population in Bangladesh we can’t have enough space to research for renewable energy.
- The initial cost of renewable energy project is so high that’s why non-government organization can’t take this type of risk.
- Due to the climate change in Bangladesh, spare parts which are used in renewable energy will be hamper.

Renewable energy has gained popularity in recent years, particularly as the world has become more mindful of greenhouse gas emissions. The majority of scientific opinion contends that failing to limit human-caused GHG emissions would result in global warming. Significant worldwide atmospheric temperature rises are expected (and have already occurred). This may cause problems in people's lives. It need rapid attention, particularly in Third World nations where natural resources are being depleted at an alarming rate in order to feed ever-increasing populations. Natural resources are depleting faster than they can be replenished. It's time to consider renewable resources now that the economy has recovered. Regardless of what we do to relieve poverty, we won't be able to do it unless we can assure that developing countries have access to reliable power.

CHAPTER 8

CONCLUSION

8.1 Conclusion

This paper summarized the present renewable circumstances and development trends in Bangladesh. This paper focuses on Bangladesh's utilization and operation of renewable energy sources such as solar and wind. Here, we examine all of our energy possibilities in order to find a solution to the problem of renewable energy. Bangladesh's energy situation is highly expensive, due to nuclear, coal, and other sources of energy. Power plants using natural gas Plants like this are so successful in the environment that they end up harming our ecosystem.

There are three flaws in all three power sources. Coal and fossil petroleum fuels are used less frequently, which reduces the quantity of energy used internally. This fuel is highly polluting and incapable of providing a stable foundation for a community. Hydropower is one of the most important sources of energy. In many waterways, detrimental impacts on local aquatic species have been observed. There is also a need to reduce hydroelectricity capacity by reducing greenhouse gas emissions, which is one of the flaws that we would want to solve in the future as a result of the extinction of earth species. Load curve aids in the selection of the most cost-effective sizes for various generator units. The producing cost is predicted by the load curve. A load duration curve is similar to a load curve, except that the demand data is organized in descending order of magnitude instead of chronologically. Many socioeconomic advantages have a significant impact on the life of our rural people. Bangladesh is the name of the country. Other restrictions include high production costs, insufficient battery support owing to dust, and the wet season. Renewables will offer improved service facilities for school, entertainment, and travel.

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