STUDY OF POWER GENERATION 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

By

1. Mohammad Nur Uddin (ID #: 153-33-2938)

2. MD. Al-Amin (ID #: 153-33-3027)

Supervised by

Dr. A K M Alamgir

Associate Professor

Department of EEE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FACULTY OF ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

December 2018

Certification

This is to certify that this project and thesis entitled "STUDY OF POWER GENERATION 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 on 30 December 2018.

Signature of the candidates

03/01/2019

Name: Mohammad Nur Uddin

ID #: 153-33-2938

Al Amin 03.01.19

Name: Md Al Amin

ID #: 153-33-3027

3.1.19

Dr. A K M Alamgir
Associate Professor
Department of EEE

The project and thesis entitled **"**Study of Power Generation of Bangladesh,**"** submitted by Mohammad Nur Uddin & Md Alamin, ID No: 153-33-2938 & 153-33-3027, Session: Fall 2015 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering on 30 december 2018.

BOARD OF EXAMINERS

_____

Dr. Engr. … **Chairman**
Professor
Department of EEE, DIU

_____

Dr. Engr. --- External Member

Professor
Department of EEE, DIU

_____

Dr. Engr. --- Internal Member

Professor
Department of EEE, DIU

Dedicated to

Our Parents

CONTENTS

List of Figures vii

List of Tables viii

List of Abbreviations ix

Acknowledgment x

Abstract xi

Chapter 1: INTRODUCTION 1-3

1.1 Introduction 1

1.3 Objectives 2

1.5 Thesis Methodology 2

1.6 Thesis Outline 3

Chapter 2: Overview of Electric power generation 4-10

2.1 Introduction 4

2.2 Electricity Demand in Bangladesh 5

2.3 Cost of Power Generation in Bangladesh 6

Chapter 3: Sources of Electrical energy 11- 20

3.1 Introduction 11

3.2 Common Forms of Energy 13

3.3 How Energy Sources Compare? 13

3.4 Important Terms for Calculation 14

3.5 Relative advantages and disadvantages 16

3.6 Comparison of the calorific values of fuels 19

Chapter 4: Generation of Electrical Power 21-37

4.1 Introduction 21
4.2 Classification, description and comparison 22
4.3 Crude Oil & Petroleum based products 31
4.4 FUTURE ENERGY SCENARIO 32

Chapter 5: Electrical Power Generation in Bangladesh 38-47

5.1 Different utilities 38
5.2 Various companies 39
5.3 Generation capacity 40
5.4 Voltage ranges 42
5.5 Public Vs Private 44
5.6 Power demand 44
5.7 Challenges 46
5.8 Progress 46

Chapter 6: Nuclear Power Plant in Bangladesh – A review 48-59

6.1 Introduction 48
6.2 STATUS OF POWER SECTOR 48
6.3 WORLD ENERGY CONSUMPTION 54
6.4 GLOBAL TRENDS TO NUCLEAR POWER 55
6.5 CONCLUSION COST COMPARISON 56
6.6 PRESENT STATUS OF NUCLEAR POWER PLANT 57

Chapter 7: Recommendation 60

Chapter 8: Calculation 61

Chapter 9: Reference 62-65

LIST OF FIGURES

Figure #	Figure Caption	Page #
2.1	Electricity Demand in Bangladesh	6
2.2	Cost demand	8
4.1	Renewable energy scenario in Bangladesh	22
4.2	Irrigation system using solar Energy	23
4.3	The highest and lowest intensity of direct radiation	24
4.4	Cumulative generation from Solar Energy	24
4.5	Wind mill project in southeastern Feni	25
4.6	Kaptai Hydro-electric Dam	27
4.7	Production process of Eastern Refinery in 2015-16	31
4.8	Gas production scenario of Bangladesh in mmcfd	31
4.9	Gas distributions in different fields in the year 2017-18	32
4.10	Rooppur proposed nuclear power plant	37
6.1	Installed Capacity of electricity in Bangladesh from FY2000-2008	49
6.2	Year wise power generation, load shedding & system loss	50
6.3	Maximum daily generation (MW)	50
6.4	Energy flow diagram	51
6.5	Year wise power Natural gas production (BCF)	52
6.6	Sector wise Demand for Natural gas (BCF)	52
6.7	Estimated natural gas reserve (Tcf) with GDP reserve gas	53
6.8	World oil production	54
6.9	World primary energy consumption growth	54
6.10	World energy consumption growth	55
6.11	Average US power (nuclear) production cost	56
6.12	The impact of fuel costs on electricity generation costs	57

LIST OF TABLES

Table #	Table Caption	Page #
4.1	Wind condition at different places of Bangladesh	25
4.2	Potential small hydro sites identified by BWDB and BPDB	26
4.3	Summery of Sandwip project	27
4.4	Coal deposits in Bangladesh	30
4.5	Planned nuclear power reactors	36
5.1	public vs private	44

List of Abbreviations

DC	Direct current
AC	Alternating current
PV	Photovoltaic
STE	Solar thermal energy
TFSC	Thin-film solar cells
A-Si	Amorphous silicon solar cell
CdTe	Cadmium Telluride solar cell
CPV	Concentrated Photovoltaic
HCPV	High concentration Photovoltaics
GDP	Gross Domestic Product
MW	Mega Watts
GW	Giga Watts
SHS	Solar home system
SREDA	Sikkim Renewable Energy Development Agency
IDCOL	Infrastructure Development Company Limited
ARC	Antireflection Coating
PPA	Power purchase agreement
LoIs	Letter of Intents

ACKNOWLEDGEMENT

First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor Dr. A K M Alamgir, Associate Professor of Department of EEE for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

We also want to convey our thankfulness to Dr. Engr. Name, Professor and Chairperson of the Department of EEE for his help, support and constant encouragement.

Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

Accessibility of electric power has been the most amazing vehicle for encouraging monetary, mechanical and social advancements of any country. Electric power is transmitted by methods for transmission lines which convey mass power from creating stations to stack focuses and buyers. Accordingly, it is basic to check the execution of intensity transmission organize. This exploration endeavors to build up the structure and characterize parameters, which can be utilized to assess the operational (budgetary and specialized) execution of Bangladesh control transmission framework. A lot of execution markers are chosen and used to assess the execution of the Power Grid Company of Bangladesh (PGCB). The chose key execution parameter involves framework accessibility pointers (Transmission line and transformer accessibility, framework normal recurrence of blackouts of transmission line and transformer), transmission framework control quality markers (transmission misfortunes, voltage and recurrence deviation record), supply security pointers (vitality not provided, framework minutes lost), transmission framework resource usage markers (limit factor, transmission transformer use factor), monetary pointers (Current proportion, intrigue and obligation benefit inclusion proportion and so forth.), business markers (money due days, income development rate, awful obligations and so forth.), support cost related pointers and social effect pointers. All these KPI's have explicit standard conditions to quantify their esteem. This proposal likewise assesses the chose key execution pointers (KPIs) amid last three monetary years (2013-2014 to 2015-2016) of Bangladesh Power Transmission Grid. The acquired outcomes are dissected and clarified as far as KPIs. By examining these outcomes an organization can screen the pattern of various KPIs, take vital activities, plan for future extension, set focuses for forthcoming years and correlation can be made with universal benchmarks. Eventually which will enhance the transmission framework execution.

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Strategic maneuvers an extraordinary job wherever individuals live and works in industry, agribusiness, and transportation and so on. The expectation for everyday comforts and flourishing of a country fluctuate straightforwardly with increment being used of intensity. As innovation is propelling the utilization of intensity is relentlessly rising. Adequate and solid wellspring of power is a noteworthy essential for a supported and effective financial improvement exertion and destitution decrease. In Bangladesh, 90 million of the populaces out of 140 million don't have guide access to power and remaining 50 million individuals approach however solid and quality power is still past their compass (BPDB, 2007). So as to accomplish the development rate, accessibility of a sensibly evaluated and solid wellspring of power is an essential. Present age of electric power in Bangladesh isn't adequate to take care of the buyers developing demand. So it is preposterous to expect to guarantee a steady supply of electric capacity to all customers all through the nation. Additionally, the interest is expanding step by step. So it is fundamental to set up all the more creating station for over requesting load. Then again, the current power stations have lost their lifetime; they are not dependable for unfaltering age. So it must be supplanted old creating units in different power stations. Lack of intensity is not kidding issue and solid obstruction for the improvement of our nation. Administration of Bangladesh has such a significant number of impediments to set up adequate power station. The Government has given best need to advancement of the part thinking about its significance in general improvement of the nation. The administration has defined the objective of giving power to all nationals by 2020. Bangladesh's vitality foundation is very little, lacking and inadequately oversaw. The per capita vitality utilization in Bangladesh is one of the most minimal (136 KWh) on the planet. Non-business vitality sources, for example, wood fuel, creature waste and product deposits are evaluated to represent over portion of the nation's vitality utilization. Bangladesh has little saves of oil and coal however substantial gaseous petrol assets. Business vitality utilization is for the most part flammable gas (around 66%), trailed by oil, hydropower and coal. Power is the significant wellspring of intensity for the vast majority of the nation's monetary exercises. Bangladesh's introduced electric age limit was 8525 MW in 2013; just three-fourth is viewed as 'accessible'. Just 40% of the populace approaches power with a for each capita accessibility of 136 KWh per annum.

1.2 Objectives

The goals of this proposition are to examine the development important and distinguish the rooms and approaches to enhancing sunlight based cell proficiency. Productivity is the most indispensable issue for sunlight based vitality since same forces sun based cell has distinctive effectiveness despite the fact that the cost stays same. In this paper, we talk about in quickly that how to enhance productivity and what factors relies upon enhancing effectiveness. A portion of the elements are sun based following, dust cleaning, covering and so forth another motivation behind this proposition is the way to structure proficient sun powered board and what sorts of materials we should utilize. For the creating nation like Bangladesh, we are more worry about expense and productivity. Along these lines, our centering objective was choosing development materials, plan materials, and effective sun powered board inside least expense. Be that as it may, researchers are endeavoring to enhance sun oriented cell materials and effectiveness. Consequently, this was our real worry of our postulation paper. I trust that our investigation will be useful for sustainable power source henceforth sunlight based vitality in Bangladesh.

1.3 Thesis Methodology

The goals of this paper are to investigation of sun based vitality development and effectiveness enhancement. In this way, we have attempted to assemble data about sun powered development, for example, materials determination process, board plan materials, effective sunlight based vitality generation. Right off the bat, we are contemplating that how to plan effective board materials and development process and also information gathering, sites, diaries, articles and other measurable sources are utilized.

1.4 Thesis Outline

This Thesis is organized as follows:

Chapter 1 Overview of Electric power generation

Chapter 2 Sources of Electrical energy

Chapter 3 Generation of electrical power

Chapter 4 Electrical power generation in Bangladesh

Chapter 5 Nuclear Power Plant in Bangladesh – A review

Chapter 6 Recommendation

Chapter 7 Conclusion

Chapter 8 References

CHAPTER 2
INTRODUCTION

2.1 Introduction

Strategic maneuvers an incredible job wherever individuals live and works in industry, agribusiness, and transportation and so forth. The expectation for everyday comforts and success of a country change specifically with increment being used of intensity. As innovation is propelling the utilization of intensity is consistently rising. Adequate and dependable wellspring of power is a noteworthy essential for a continued and effective financial improvement exertion and neediness decrease. In Bangladesh, 90 million of the populaces out of 140 million don't have guide access to power and remaining 50 million individuals approach however dependable and quality power is still past their scope (BPDB, 2007). With the end goal to accomplish the development rate, accessibility of a sensibly estimated and dependable wellspring of power is an essential. Present age of electric power in Bangladesh isn't adequate to take care of the shoppers developing demand. So it is beyond the realm of imagination to expect to guarantee a consistent supply of electric capacity to all purchasers all through the nation. In addition, the interest is expanding step by step. So it is basic to set up all the more producing station for over requesting load. Then again, the current power stations have lost their lifetime; they are not solid for consistent age. So it must be supplanted old creating units in different power stations. Lack of intensity is not kidding issue and solid obstruction for the improvement of our nation. Administration of Bangladesh has such a large number of constraints to set up adequate power station. The Government has given best need to advancement of the division thinking about its significance in generally speaking improvement of the nation. The legislature has defined the objective of giving power to all subjects by 2020.

Bangladesh's vitality foundation is very little, lacking and inadequately oversaw. The per capita vitality utilization in Bangladesh is one of the most reduced (136 KWh) on the planet. Non-business vitality sources, for example, wood fuel, creature waste and yield deposits are evaluated to represent over portion of the nation's vitality utilization. Bangladesh has little holds of oil and coal however substantial petroleum gas assets. Business vitality utilization is for the most part flammable gas (around 66%), trailed by oil, hydropower and coal.

Power is the significant wellspring of intensity for the greater part of the nation's monetary exercises. Bangladesh's introduced electric age limit was 8525 MW in 2013; just three-fourth is viewed as 'accessible'. Just 40% of the populace approaches power with a for every capita accessibility of 136 KWh per annum.

Issues in the Bangladesh's electric power area incorporate debasement in organization, high framework misfortunes, delays in fulfillment of new plants, low efficiencies, flighty influence supply, power burglary, power outages and deficiencies of assets for influence plant upkeep. By and large, the nation's age plants have been not able take care of framework demand over the previous decade.

2.2 Electricity Demand in Bangladesh

The utility power part in Bangladesh has one national matrix with an introduced limit of 16,048 MW starting at July 2018. Bangladesh's vitality segment is blasting. As of late Bangladesh began development of the 2.4-gigawatt (GW) Rooppur Nuclear Power Plant anticipated that would go into activity in 2023.According to the Bangladesh Power Development Board in July 2018, 90 percent of the populace approached power. Anyway per capita vitality utilization in Bangladesh is viewed as low.

Power is the significant wellspring of intensity for the vast majority of the nation's financial exercises. Bangladesh's aggregate introduced power age limit (counting hostage control) was 15,351 megawatts (MW) as of January 2017.As of 2015, 92% of the urban populace and 67% of the rustic populace approached power. A normal of 77.9% of the populace approached power in Bangladesh. Bangladesh will require an expected 34,000 MW of intensity by 2030 to continue its monetary development of more than 7 percent.

Issues in Bangladesh's electric power segment incorporate high framework misfortunes, delays in fruition of new plants, low plant proficiency, sporadic influence supply, power burglary, power outages, and deficiencies of assets for influence plant support. By and large, the nation's age plants have been not able take care of framework demand over the previous decade.

On 2 November 2014, power was reestablished following multi day-long across the nation power outage. A transmission line from India had fizzled, which "prompted a course of disappointments all through the national power matrix," and feedback of "old network framework and poor administration." However, in an ongoing main driver investigation report the contributing group has cleared up that blame was in reality because of a need in power the

board and poor transmission and conveyance wellbeing foundation that caused the power outage.

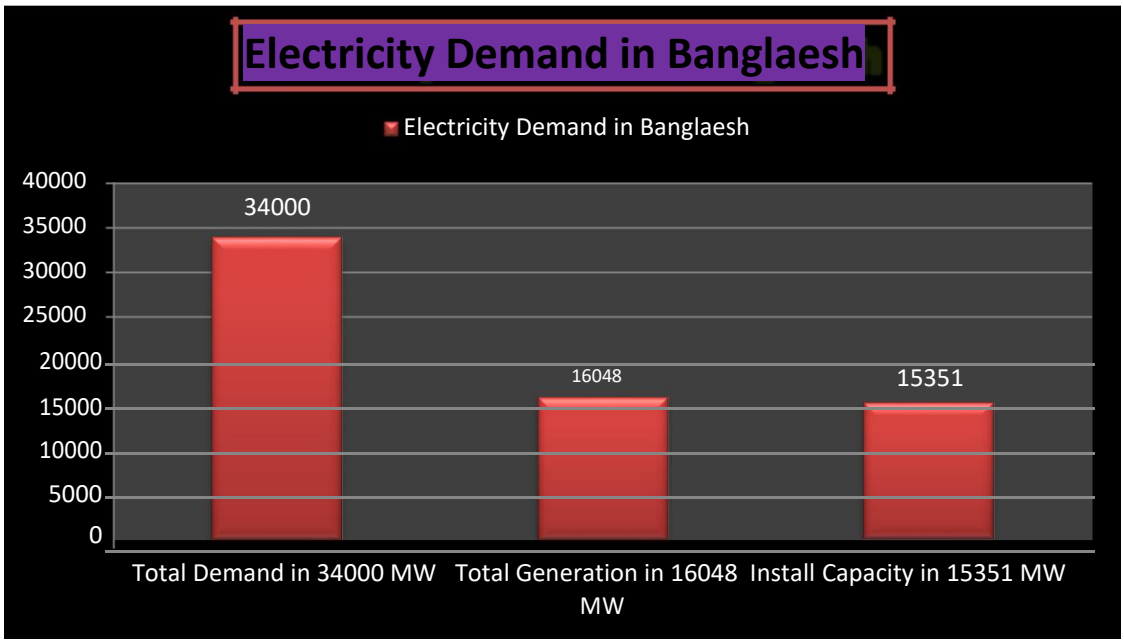


Figure 1.1: Electricity Demand in Bangladesh

2.3 Cost of Power Generation in Bangladesh:

The Bangladesh Power Development Board (BPDB) was made as an open area association to help the nation's capacity segment after the rise of Bangladesh as an autonomous state in 1972. The association is in charge of arranging and building up the country's capacity framework and for working quite a bit of its capacity age offices.

The BPDB is in charge of the significant bit of age and appropriation of power for the most part in urban zones of the nation. The Board is currently under the Power Division of the Bangladesh Ministry of Power, Energy and Mineral Resources.

Bangladesh's capacity age limit was 4,942MW when the government took office in 2009. Throughout the years, the limit has expanded to over 13,000MW. With expanded power creation, the cost was additionally raised ordinarily, prompting disappointment among buyers. Be that as it may, in spite of all the progress, individuals keep on experiencing standard power cuts. Retail power cost was last expanded by Tk0.35 per unit, or 5.3% on a weighted normal on November 23. In any case, there were control slices enduring six to eight hours by and large consistently amid the late spring. There was an everyday interest for 12,000MW while the power age was minimal over 8,000MW. The officeholder government has been effective in expanding power age, circulation and transmission line, raising the quantity of intensity plants, expanding the quantity of customers, and raising per capita control creation limit since 2009. As indicated by the Power Division, the right now introduced power age limit is 13,621MW however is just fit for creating 12,922MW on account of decreased power age limit of some power plants. The administration as of late stepped up with regards to set up 20 oil-based little scale control plants of 100MW limit each, rather than building bigger ones to manage stack shedding. Specialists, in any case, say the move will raise power age cost and specifically repudiate the administration's declared approach of leaving oil-based power age. A Power Development Board (PDB) official said in view of the forthcoming decision, the administration wanted to produce about 2,000MW extra power by April 2018. "Power age limit has dramatically multiplied from 4,942MW in 2009 to 13,621MW at present," Mohammad Hossain, chief general of the Power Cell, under the Power Division of Ministry of Power, Energy and Mineral Resources, told the Dhaka Tribune. "Fifty-four percent of the power is produced by the legislature, 41% originates from private division and the remaining 5% are transported in from India," he said. Hossain asserted that around 83% of the aggregate populace approaches power, including sustainable power source, and the per capita age had expanded to 433 kWh from 220 kWh. "We have the most astounding rate of sun powered home framework establishments on the planet," he said. "We have effectively actualized 100% charge in 26 upazilas as a major aspect of the Electricity for all by 2018 program." He noticed that the aggregate transmission and dispersion framework misfortunes had been essentially lessened to 12.19% from 16.85% amid the officeholder government's residency. "We trust the under-development oil-based power plants will go into tasks inside next June. At that point the power cuts will be lessened," the chief general of the Power Cell said. Hossain said the administration was organizing new power associations and development of the power dissemination line, predominantly in rustic zones. Dr Ijaz Hossain, a teacher of

concoction building at Bangladesh University of Engineering and Technology, said the under-development little plants would just raise creation cost. "Power age is getting to be costly since expensive power plants are being introduced," he called attention to. In the interim, the administrations intend to set up extensive scale coal-let go control plants are gaining almost no ground. In spite of low universal oil costs, the economy is as of now battling with the surprising expenses of oil-based power. A unit from a gas-run plant costs under Tk2 while per unit power from a diesel or heater oil-run plant costs Tk14-18. PDB authorities asserted that oil-based plants were at present an appealing alternative as the cost of fuel oil was low in the global market. State-possessed Power Development Board confronted lost Tk41,521 crores over the most recent a long time since the general power creation cost expanded in light of the fact that the expense of oil-based power is higher to control delivered by gas-based plants. The PDB had been pitching power at lower costs to buyers in the wake of getting it at more expensive rates from the administration makers. This has prompted gigantic monetary misfortunes. As of now, the mass and retail control costs are not synchronized. Additionally, the measure of power created by oil-based plants has expanded due to gas supply crunch

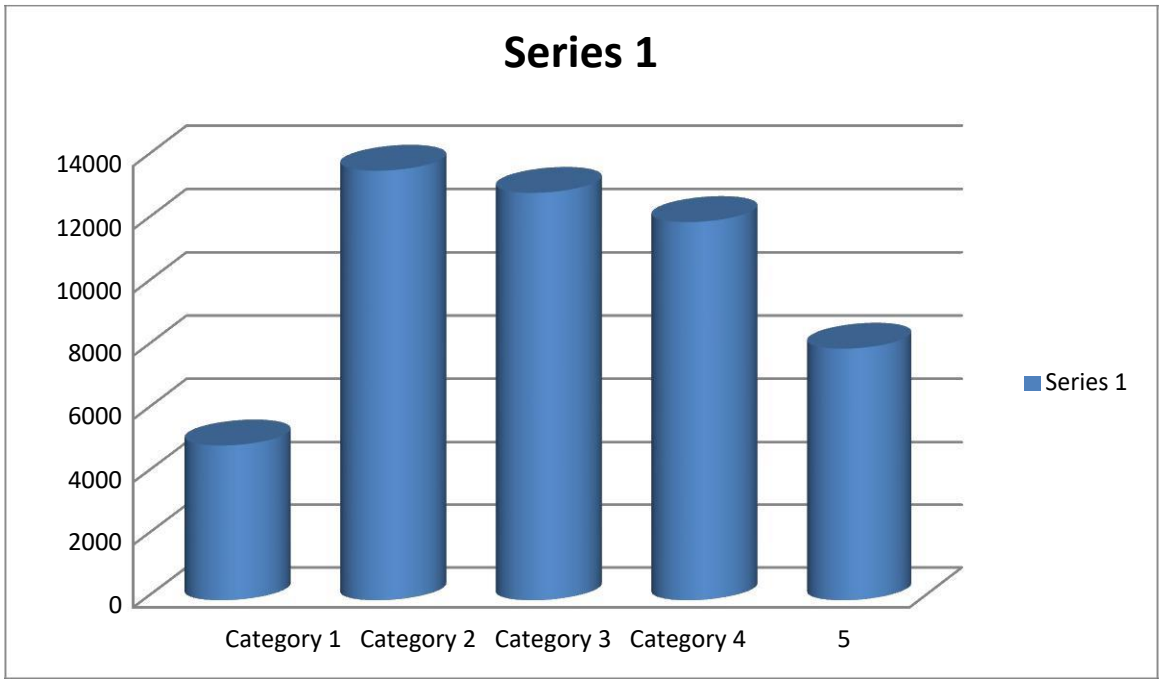


Fig2.2: Cost demand

Cost type:

1.Project cost

2.Fixed cost

3.Variable cost

Project Cost:

Used and Useful Assets:

In making application for a tax rate, or an adjustment in the duty's terms and conditions, the electric age licensee must record a calendar which demonstrates the first procurement cost of the benefit, the aggregated devaluation, the net resource esteem after decrease for amassed deterioration, and the measure of the flow devaluation to be incorporated into the Tariff Rate application for the test year.

By and large, these advantages must be utilized and valuable for serving the licensee's clients. The benefit accounts considered for an age licensee are broken into three classes –

- Intangible Plant.
- Production plant.
- General plant.

Intangible Plant:

An advantage that isn't physical in nature. Corporate licensed innovation (things, for example, licenses, trademarks, copyrights, business approaches), altruism and brand acknowledgment are for the most part basic immaterial resources in the present commercial center. An elusive resource can be delegated either uncertain or unmistakable relying upon the points of interest of that benefit. An organization mark name is viewed as an inconclusive resource, as it remains with the organization as long as the organization proceeds with tasks. Be that as it may, if an organization enters a legitimate consent to work under another organization's patent, without any plans of broadening the assertion, it would have a constrained life and would be delegated a clear resource.

Elusive Assets speak to rights, benefits, and upper hands claimed by a business. They are immaterial just as in they have no physical substance. All the time, their lawful status might be of basic significance to the life span of an organization. Instances of immaterial resources

include: licenses, copyrights, establishments, trademarks, and generosity. Like plant resources (Which devalue) and common assets (Which drain), intangibles are amortized. Ordinarily, in any case, no Accumulated Amortization account is utilized; the credit is made to the Asset account itself. Impalpable plant would comprise of association, establishments and assents, and incidental immaterial plant.

Production Plant:

Steam creation plants would moreover incorporate evaporator plant hardware, motors and motor driven generators and turbo generator units. Hydroelectric plant would additionally incorporate stores, dams and conduits, water wheels, turbines and generators, streets, railways and spans. Sun based warm creation units would also incorporate concentrating gatherers, sun powered radiation checking gear, motors and motor driven generators and turbo generator units. Sun powered photovoltaic generation units would incorporate the photovoltaic boards, mounting racks, sun based radiation checking hardware, equalization of framework gear and vitality stockpiling gadgets. Wind creation units would incorporate the breeze fueled generators, towers, wind observing hardware and parity of framework gear.

General Plant:

General plant would incorporate land and land rights, structures and upgrades, office furniture and gear, transportation hardware, stores hardware, instruments, shop and carport hardware, research center hardware, control worked hardware, correspondence hardware, incidental hardware and other substantial property. [6]

VARIABLE COST:

Fuel Cost:

In power age, fuel cost is the measure of cost that figure for per unit age. Every age unit will have a tax rate part which is fuel cost, engaged with the age of the power. [6]

Total Fuel Cost = Fuel Price × Fuel Consumption

Non-Fuel or Operation & Maintenance Cost:

This is the yearly expense related with the Salary and Allowance or Personnel Expenses, Repairs and Maintenance of Plant and Machineries, Lube oil, Grease and Vaseline, Administrative and others costs of a power plant. Included are costs identified with Operation and Maintenance, Employee Expenses and Miscellaneous costs, for example, Administrative Expenses.

Chapter 3

Sources of Electrical energy

3.1. Introduction

Electrical power is the foundation of national economy. Power can be produced from numerous sources. Petroleum derivative – oil, coal and gaseous petrol rules control age. World hold of petroleum derivative asset is quick exhausting. In addition, consuming of non-petroleum derivative is activating an Earth-wide temperature boost through greenhouse gas emanation. Surges, draft, violent winds, tornados, bushfires are causing huge decimation in various nations. Individuals are swinging to sustainable sources – sunlight based, wind, wave, geothermal, hydroelectricity, atomic power age is additionally getting notoriety. A large portion of the nations have all around created and expertly overseen vitality approach. Numerous nations have local vitality lattice for vitality exchanging.

Bangladesh is exceptionally fortunate that it has considerable gaseous petrol save and critical however relatively undiscovered astounding coal asset. There is likewise a lot of degree to create sunlight based power, wind power and vitality from bio powers. Numerous nations of the world like Japan, Korea don't have any petroleum derivative asset yet they are among the best created countries. They import nearly their whole necessity of the fuel for vitality age from exceedingly aggressive vitality showcase. A few nations don't have enough fundamental

fuel to take care of their enormous demand. These nations import vitality from vitality rich nations to fuel their economy.

Shockingly our little nation Bangladesh of 160 million individuals has no fitting technique. There is a vitality strategy which isn't legitimately regulated.

Power age in Bangladesh is overwhelmingly gas based. In excess of 85 percent of night crest request is cooked by flammable gas. This is pursued at a removed by fluid fuel, and coal with age offers of 6.76 percent and 5.41 percent separately. Hydropower represents inconsequential 2.45 percent of age. The fuel blend whenever recalculated utilizing the derated age limit, offer of gas based age lessens barely to 83.45percent; offer of fluid fuel and hydro based age increments to 7.55 percent and 4.60 percent individually.

The generation and supply of gaseous petrol is terribly insufficient. Petroleum gas is additionally utilized as feedstock for compost generation, as fuel for some enterprises, as compacted gaseous petrol for cars. It is likewise utilized by business and local customers. It is said that against a national interest of 2200 MMCFD our creation limit is 1880MMCFD Consequently the deficiency is truly affecting upon power age and task of compost plants and different gas utilizing ventures. For quite a long while some global oil organizations having investigation rights in a few investigation squares did not do any work and now the greater part of them are giving up these squares. Petrobangla organizations likewise neglected to execute repository reassessment of real gas fields and extend generation. So It isn't in a situation to do every one of its duties. In this circumstance the staying 6tcf hold of gaseous petrol may run out by 2015 if no new revelation is made soon

Bangladesh is currently experiencing the most exceedingly bad vitality emergency of its history. Whole nation is experiencing 8-10 hours stack shedding on the normal regardless of the way that just 35% of its 15 million individuals have guide access to control supply. Mechanical development has arrived at nearly stop because of insufficient gas supply. Existing ventures can't be worked appropriately because of temperamental supply of vitality.

The coal holds in five fields of Bangladesh are assessed at 3.0 billion tons proportionate to 67 tcf of gas, which can advantageously serve the vitality needs of Bangladesh for a long time. Recuperation rate of coal from stores changes with the decision of innovation and technique for mining. On the off chance that cutting edge mining innovation can be received guaranteeing solid administrative supervision and checking about 85% coal from Barapukuria, Phulbari and Dighipara can be recouped. Khalaspir can be perfect contender for

Coal Seam methane while we can sit tight for a few years for mechanical advancement for mining monster Amalgam coal mine.

Presently, suitable procedure ought to be embraced to investigate and abuse coal, the main other real vitality asset. In the present emergency circumstance, it is felt judicious to examine about coal circumstance in Bangladesh. From the data displayed in an ongoing dialog in Dhaka we discover Bangladesh does not have any decision but rather to begin coal mining immediately receiving actually proper and monetarily possible and naturally well-disposed mining strategy.

Electric vitality is made by the stream of electrons, regularly called "flow," through a conveyor, for example, a wire. The measure of electric vitality made relies upon the quantity of electrons streaming and the speed of the stream. Vitality can either be potential or motor. A chunk of coal, for instance, speaks to potential vitality that winds up active when it is singed

3.2 Common Forms of Energy:

Here are the six most normal types of vitality.

Substance vitality: This is put away, or "potential," vitality. Discharging concoction vitality from carbon-based powers for the most part requires ignition like the copying of coal, oil, flammable gas, or a biomass, for example, wood.

Warm vitality: Regular wellsprings of warm vitality incorporate warmth from underground hot springs, ignition of petroleum derivatives and biomass (as noted above) or mechanical procedures.

Motor vitality: Active vitality is development, which happens when water moves with tides or streams downstream, or when air moves twist turbines in the breeze.

Atomic vitality: This is the vitality put away in the bonds within particles and atoms. At the point when atomic vitality is discharged, it can emanate radioactivity and warmth (warm vitality) also.

Sunlight based vitality: Vitality emanates from the sun and the light beams can be caught with photovoltaics and semiconductors. Mirrors can be utilized to think the power. The sun's warmth is additionally a warm source.

Rotational vitality: This is the vitality gotten from turning, ordinarily created by mechanical gadgets, for example, flywheels.

3.3 How Energy Sources Compare

There's a great deal of discussion about great and terrible vitality sources and how (or in the event that) they add to environmental change. Before you turn into a piece of the discussion, here's a gander at how vitality sources pile up in the U.S. as indicated by the Institute for Energy Research (IER).

Petroleum derivatives 67% (coal 41%), oil (5.1%), flammable gas (21%)

Sustainable power source 16% (predominantly hydroelectric (92%), wind (6%), geothermal (1%), and sun oriented (1%)

Atomic power 13%

Different sources 3% (i.e., biofuels and biomass)

What Lies Ahead

At the point when the Natural Resources Defense Council was established during the 1970s to ensure the earth, a worldwide temperature alteration wasn't on anybody's radar. Today, you can't get away from the issue. As per the IER, somewhere in the range of 2013 and 2040, gaseous petrol utilization is relied upon to increment by 13.4% and coal utilization by 5.6%. The IER predicts petroleum derivatives keeping up their status as America's driving wellspring of vitality utilization in any event up until 2040, providing 80% of our country's vitality needs.

3.4 Important Terms for Calculation:

Accessibility Factor: It implies the proportion of (a) the quantity of hours a creating unit is mechanically ready to deliver control in an offered period to (b) the quantity of hours in the period. A factor under 100% demonstrates arranged or spontaneous blackouts for support. A

plant's accessibility factor will be higher than its ability factor, on the grounds that a plant isn't utilized in consistently it is accessible.

Limit Factor: It implies the proportion of (a) the net measure of power a plant really creates in a given day and age to (b) the sum that the plant could have delivered on the off chance that it had worked constantly at full power activity amid a similar period. Limit factor is reliant on both the mechanical accessibility of the plant and the monetary attractive quality to run the plant given the specific expense to run it.

Commission: It implies the Bangladesh Energy Regulatory Commission.

Compelling Date: Means the date on which a proposed levy plan with rates is allowed by the Commission to end up viable.

Free Power Producer/Small Power Producer (IPP/SPP): Independent Power Producer/Small Power Producer (IPP/SPP) is a non-government claimed Generation Company. The Government of Bangladesh requests, chooses and contracts with Independent Power Producers (IPP) and Small Power Producers (SPP) under the terms and states of its strategies as distributed. Under the terms of the Bangladesh Energy Regulatory Commission (BERC) Act, all IPP/SPP are required to acquire a permit from the BERC and have tax rates charged-to-shoppers endorsed by the BERC.

Kilowatt (KW): Means a proportion of power characterized as a unit of interest or limit, estimated as 1 kilowatt (1,000 watts) of intensity produced.

Kilowatt-Hour (KWh): It implies a proportion of power characterized as a unit of work or vitality, estimated as 1 kilowatt (1,000 watts) of intensity used for 60 minutes.

Load Factor: Load Factor implies the proportion of the normal load to crest stack served by a plant or power framework amid a predetermined time interim. A higher load factor demonstrates higher utilization of the producing assets.

Rate: It implies the approved charges, per unit or dimension of utilization, for a predetermined era for any of the classes of age licensee administrations gave to a client.

Directions: Means any controls created and proclaimed by the Commission as per the Bangladesh Energy Regulatory Commission Act, 2003 (Act No-13 of 2003), including resulting corrections to the Act.

Calendar: It implies an announcement of the valuing organization of power and the terms and conditions administering its applications.

Terms and Conditions of Service: Means a distributed report included as a major aspect of a licensee's tax that sets up the licensee's terms and conditions for giving support of a client, talking about such issues as the conditions under which association will be given to a client metering, separation arrangements, installment directions, buyer protestations techniques, and so forth

3.5. Relative advantages and disadvantages

Gaseous petrol advantages:

- Burns clean contrasted with cola, oil (less contaminating)
- 70% less carbon dioxide contrasted with other petroleum products
- helps enhance nature of air and water (not a poison)
- does not create fiery remains after vitality discharge
- has high warming estimation of 24,000 Btu for each pound
- inexpensive contrasted with coal
- no smell until included

Gaseous petrol disadvantages:

- not an inexhaustible source
- finite asset caught in the earth (a few specialists oppose this idea)

- inability to recoup all set up gas from a producible store in light of troublesome financial matters and absence of innovation (It costs more to recuperate the staying gaseous petrol in view of stream, get to, and so on.)

Other data

- 5,149.6 trillion cubic feet of gaseous petrol hold left (more than oil yet not as much as coal)
- 23.2% of aggregate utilization of petroleum gas is in the United States
- WATER POWER Pros
- Provides water for 30-30% of the world's inundated land
- Provides 19% of power
- Expands water system
- Provides drinking water
- Supplies hydroelectric vitality (falling water used to run turbines)
- Easier for underdeveloped nations to produce control (if water source is accessible)
- It is less expensive
- Destabilizes marine biological communities

CRUDE OIL Advantages:

- Oil is a standout amongst the most bounteous vitality assets
- Liquid type of oil makes it simple to transport and utilize
- Oil has high warming worth
- Relatively reasonable
- No new innovation expected to utilize

CRUDE OIL Disadvantages:

- Oil consuming prompts carbon emanations

- Finite assets (some oppose this idea)
- Oil recuperation forms not sufficiently proficient—innovation should be produced to give better yields
- Oil boring imperils nature and biological systems
- Oil transportation (by ship) can prompt spills, causing natural and environmental harm (real oil slick close Spain in pre-winter 2002)
- The world expends in excess of 65 billion barrels of oil every day. By 2015 the utilization will increment to 99 billion barrels for every day.
- Fossil powers, for example, oil take billions of years to frame.
- In 1996, the Energy Information Administration evaluations of raw petroleum saves were 22 billio nbarrels. In 1972, the gauge was 36.3 billion barrels.
- Cost of oil has dropped since 1977. It was $15 per barrel at that point. It was $5 at the time the writers composed the book.

NUCLEAR POWER Advantages:

- Clear power with no environmental emanations
- Useful wellspring of vitality
- Fuel can be reused
- Low cost control for the present utilization
- Viable type of vitality in nations that don't approach different types of fuel
- Potential of high hazard catastrophe (Chernobyl)

NUCLEAR POWER Disadvantages:

- Waste created with no place to put it
- Waste created from atomic weapons not being used
- Earthquakes can cause harm and breaks at plants
- Contamination of nature (long haul)

- Useful lifetime of an atomic power plant
- Plant development is very politicized

WIND POWER Advantages:

- Continuous wellsprings of vitality
- Clean wellspring of vitality
- No discharges into the air
- Does not add to warm weight of the earth
- Produces no wellbeing harming air contamination or corrosive rain
- Land can be sued to deliver vitality and develop edits all the while
- Economical
- Benefits nearby networks (occupations, income)

WIND POWER Disadvantages:

- For most areas, wind control thickness is low
- Wind speed must be more noteworthy than 7 mph to be usable in many regions
- Problem exists in variety of intensity thickness and span (not dependable)
- Need better approaches to store vitality
- Land utilization

3.6. Comparison of the calorific values of fuels

COAL pros:

- One of the most bottomless vitality sources
- Versatile; can be scorched specifically, changed into fluid, gas, or feedstock
- Inexpensive contrasted with other vitality sources

- Good for recreational use (charcoal for grilling, drawing)
- Can be utilized to deliver ultra-clean fuel
- Can bring down by and large measure of ozone depleting substances (liquefaction or gasification)
- Leading wellspring of power today
- Reduces reliance on outside oil
- By-result of consuming (fiery remains) can be utilized for cement and roadways
- Source of contamination: radiates squander, SO2 , Nitrogen Oxide, fiery debris
- Coal mining damages the scene
- Liquefaction, gasification requires a lot of water
- Physical transport is troublesome
- Technology to procedure to fluid or gas isn't completely created
- Solid is more hard to consume than fluid or gases
- Not sustainable in this thousand years
- High water content lessens warming quality
- Dirty industry—prompts medical issues
- Dirty coal makes more contamination and discharges

Other

o Two types of coal—low rank (pollutes more), and high rankzz

Chapter 4

Generation of Electrical Power

4.1 Introduction

Bangladesh is a thickly populated nation with a tiny region and here numerous individuals live beneath the destitution line. Relatively 17% of the populace can be said significantly impecunious because of the lower salary . We have numerous common assets, some are customary and some are non-traditional. Customary wellsprings of vitality are normally used and for the most part non-inexhaustible wellsprings of vitality, which are being utilized since quite a while and can't be supplanted because of the natural harm, absence of maintainability. Then again, non-customary wellsprings of vitality are viewed as sustainable sources on the grounds that their fuel sources can be interminably renewed.

Non-renewable energy sources, gaseous petrol, atomic vitality, water powered vitality and so on are viewed as traditional wellsprings of vitality though the breeze, rain, sunlight based, tidal, geo-warm, hydropower, biomass and so forth. are considered non-customary wellsprings of vitality. Vitality indicates thing that can do something or having the capacity to make any change and which is the real substance for maintainable monetary improvement of a nation.

The need of power has been on the raise because of developing populace and augmenting financial exercises. Engenderment of petroleum gas, fuel, coal, peat and other non-sustainable power sources are attempting to perfect the legitimate mandate. Sustainable power sources are withal come up to oblige in various ways and the measure of sustainable power source expended has increased amazingly as a result of the augmentation of populace.

4.2. Classification, description and comparison

As indicated by wellspring of vitality, there are two kinds of vitality:

1. Renewable energy

2. Conventional energy

Renewable energy: The vitality induced from normal assets i.e. from our inclination and circumventions is called non-regular vitality. Non-ordinary vitality can be recharged at indistinguishable rate from it is used. Wind, rain, sunlight based, tides, geothermal, hydro-control and a few types of biomass, these are energies which are normally renewed and naturally protected. Non-traditional wellsprings of vitality are Solar Energy, Wind Energy, Tidal Energy, Hydro-electric Energy, Geothermal Energy, Ocean wave Energy, Ocean warm Energy, Biomass.

Conventional energy: Conventional energy is energy extracted from limited resources that will eventually dwindle, becoming too sumptuous and too environmentally damaging to retrieve. This type of energy cannot be superseded once it is utilized or energy that is not 22

being superseded as expeditious as it is being utilized. Conventional energy resources are those, which have been in utilization since a long time. Conventional sources of energy include fossil fuels, natural gas, nuclear energy and hydroelectric energy. Fossil fuels include fuels which are most commonly used such as wood, coal, peat and petroleum. Conventional sources of energy are Fossil Fuel, Nuclear Power and Crude Oil.

Bangladesh has a lot of customary non-regular vitality assets and fittingly using can take care of the required vitality demand. The customary non-regular vitality innovation is growing continuously which makes the usage of such innovation increasingly down to earth, financially attainable and the routine of Bangladesh has focused on using the traditional non-ordinary vitality assets, for example, sunlight based vitality, wind vitality, smaller scale hydro, biomass, biogas.

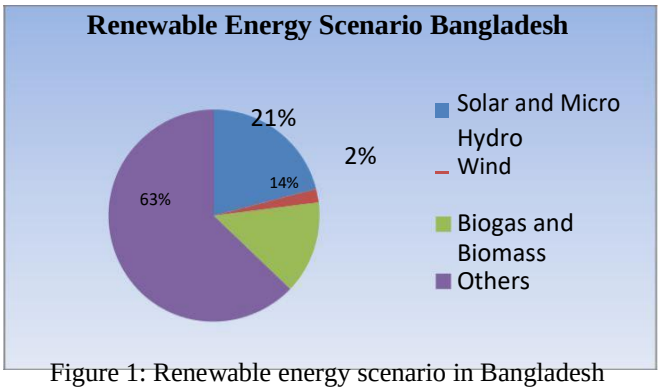


Figure 1: Renewable energy scenario in Bangladesh

Solar Energy: Since, sunlight based power is sheltered, clean and Non-customary, it is all the more generally used lately. Numerous neighborhood routines give motivating forces to the engenderment of sun based innovation and its establishment in habitations. Since, Bangladesh is a subtropical nation; around 70% of year daylight is dropped in Bangladesh. The area of Bangladesh is somewhere in the range of 20.30 and 26.38 degrees' north scope and 88.04 and 92.44 degrees east which is appropriate for sunlight based vitality usage.

Figure 2: Irrigation system using solar Energy

These days NGO's are buckling down so as to give sun powered boards to the provincial individuals at a thrifty cost. Non-customary vitality objective has just been taken for provincial individuals by the routine that incorporates 100% Non-regular first-time power for 6 million family units by 2017. Inside the end of 2014, 3.5 million family units have just

achieved 100% Non-ordinary first-time power with sun oriented and batteries that mean around 15 million individuals. Besides, control inducing of Bangladesh from sustainable power sources has turned out to be 176 MW in October 2015, of which: 150 MW was incited from sunlight based home framework, 16 MW was radiating from housetop sun oriented, 1.614 and 1.562 MW was caused from sun based smaller than expected network and sun based water system individually. In any case, there are roughly three sun oriented water system extends in Rajshahi and one sun based water system venture in Naogaon. Additionally, 5.16 kW photovoltaic boards are straightforwardly using so as to run 5hp AC submersible siphon under the Rajshahi Solar water system venture built up by KOICA and 11.2 kW photovoltaic boards are using so as to run 10 hp submersible siphon in Naogaon Solar water system venture set up by Grameen Shakti in particular Grameen Shakti Solar Pump Pilot Project. Additionally, ten sun powered water system ventures have been introduced by IDCOL in Jessore where 10 HP submersible siphons are controlled by 11.84 kW photovoltaic boards. Additionally, around 5000 Km Street is lightning utilizing sun based vitality and it's likewise use as the simple bicycle vitality. In the remote region of Bangladesh , the general population utilize just utilize the vitality from sun to satisfy the power request.

Fig. 3 and 4 show the highest and lowest intensity of direct radiation in W/m^2 and cumulative generation from solar energy respectively.

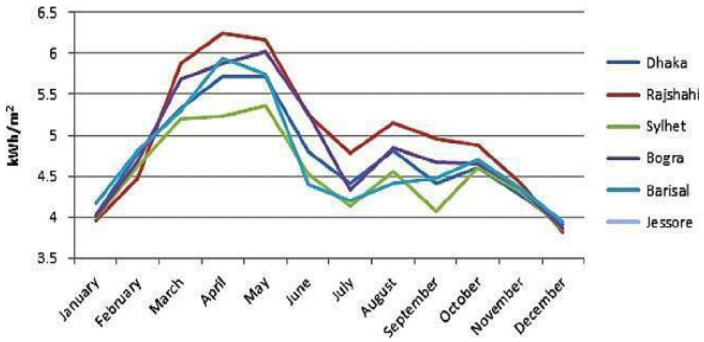


Figure 3: The highest and lowest intensity of direct radiation

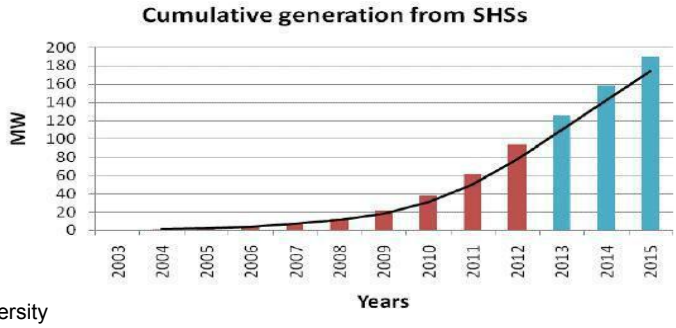


Figure 4: Cumulative generation from Solar Energy

Wind Energy:

Wind vitality is unadulterated, Non-customary, out of risk and can be changed over to utilizable power. It is a sort of dynamic vitality which can turn turbines. In addition, the power is straightforwardly reliant on the breeze speed. Sizably voluminous-scale wind ranches are associated with the nearby power transmission connect with moment turbines so as to give power to segregated territories. Bangladesh has a 724 km long drift line and numerous humble islands in the Bay of Bengal, where lively south-westerly exchange wind and ocean breeze blow in the mid-year months and in the winter months, there is delicate north-easterly exchange wind and land breeze. In addition, the yearly mean breeze speed is more noteworthy than 5 m/s which is determined at 30m stature. It has been discovered that breeze speed is above 4.5 m/s in the northeaster parts of Bangladesh yet if there should be an occurrence of different parts, it is around 3.5 m/s. Be that as it may, F. Rahman took a few estimations and found higher estimations of twist speed than the metrological division which gives a year-long deliberate breeze speed at a stature of 25 m in 1996 - 97 at seven waterfront locales. As of late, a 900 KW plant has been built up which is Bangladesh's first-since forever power age from the breeze. The power plant is situated in the southeastern Feni region close to the Muhuri Dam which has four separate breeze turbine of 225 KW each. It is completely arranged to create power and supply to the national network and Muhuri Irrigation Project. Eleven little breeze turbines have just been introduced in different beach front destinations by BRAC, two breeze generators of 1 KW and 300 W have been introduced at Chakoria Shrimp Farm by Grameen Shakti, four little breeze generators (3xl.5KW + ONE 10 KW) have been introduced in Barguna area. Besides, control tornado covers have been built up along the drift and power has been given to fish and prawn cultivates in Cox's Bazar by Grameen Shakti. In addition, 2 MW of intensity has been caused from twist control till October 2015.

Figure 5: Wind mill project in southeastern Feni

Table 1 shows feasibility of wind condition at different places of Bangladesh.

Table 1: Wind condition at different places of Bangladesh

Site	Reference height (m)	Annual average wind speed (m/s)
Cox's Bazar	10	2.42
Cumilla Airport	6	2.21
Bhola Island	7	2.44
Patenga Airport	5	2.45
Khepupara	10	2.36
Hatia Island	6	2.08
Sandip Island	5	2.16
Kutubdia Island	6	2.09
Teknaf	5	2.16

Little scale hydro control vitality

Little scale hydropower ends up mainstream because of minimal effort, dependability and condition well disposed. Table 2 demonstrates little scale hydro control vitality situation is given beneath.

Table 2: Potential small hydro sites identified by BWDB and BPDB

District	River/chara/stream Name	Potential of electrical energy in KW
Chittagong	Foy's Lake	4
	Hinguli Chara	12
	Hoto Jumira	15
Chittagong Hill Tracts	Sealock	81
Chittagong	Lungi Chara	10
	Budia Chara	10
Sylhet	Ranga Pani Gung	626
	Nikhari Chara	26
Rangpur	Bhuri Khora Chikli	32
	Fulkumar	48
Dinajpur	Dahuk	24
	Chawai	32
	Talam	24
	Tangn	48
	Pathraj	32
	Punarbhaba	11
Jamalpur	Bhgai-Kongsa	69 & 48 KW for 10 & 2 month respectively
	Marisi	35 & 20 KW for 10 & 2 month

		respectively

Tidal Energy:

Tidal vitality is a sort of hydropower which can change over the vitality of tides into electrical power. As tides are more prognosticable than wind and daylight, tidal vitality can easily be caused from the transmuting ocean levels. Tidal rising and falling along the beach front of Bangladesh is between 2 to 5 meters. Among the 5 meter tides experienced seaside territories, Sandwip has the best prospect to cause tidal vitality. Bangladesh can incite tidal power from these beach front tidal assets by applying low head tidal types of kineticism and medium head tidal types of kineticism. Additionally, low head tidal types of kineticism which utilizes tides of stature inside 2m to 5m can be used in territories like Barisal, Khulna, Satkhira, Bagerhat, Mongla, Cox's Bazar and so on areas and the tallness tidal types of kineticism which use more than 5m of tides can be mostly used in Sandwip. Be that as it may, a surge control torrent subsists around the whole island which contains 28 floodgate doors and the nation can induce roughly 16.49 MW from Sandwip .

Table 3: Summery of Sandwip project

Parameter	Value
Tidal range	4.86m
No. of sluice gates	28
No. of turbine uses	05
Basin area	$4*10^6$ m^2
Construction time	4 years
Cost	US $10.37millions
Output power	16.49 MW

Hydro-electricity:

Hydroelectric vitality is a term usually held for cosmically huge scale hydroelectric dams. Hydropower is caused by damming streams and using the ebbs and flows to turn turbines. In spite of the fact that hydro-electric power plant requires high capital expense than different kinds of intensity plants however running expense is nearly low. Major streams of Bangladesh have high water stream rate amid summer season yet it is decreased in this way in winter. At present, Bangladesh has just hydro-control plant arranged at Karnaphuli,

Rangamati with a limit of 230 MW which is worked by BPDB. Two destinations have just been winnowed for another two Hydro control plants at the Matamuhuri and Sangu waterways; one assigned The Mata-muhuri venture (140MW) and the other The Sangu Project (75MW). In addition, a 20kW miniaturized scale hydro control plant has been structured by BPDB in a joint effort with RET Screen, created by CANMET Energy Diversification Research Laboratory of Canada (CEDRL) at Barkal cascade.

Figure 6: Kaptai Hydro-electric Dam

Biogas Energy & Biomass:

Since Bangladesh is an agrarian nation, biomass is accessible in a giant sum. Farming buildup, poultry dropping, rice husk, water hyacinth, steers excrement and so on used for biomass control age are accessible in Bangladesh. The figure appeared beneath betokens that the measure of rice engenderment in Bangladesh has been increased lately and this measure of engenderment has made us increasingly hopeful in using the rice husk as a biomass fuel which is all things considered a perfect wellspring of sustainable power source with regards to Bangladesh. The temperature in Bangladesh routinely fluctuates from 6ºC to 40ºC and withal the crude materials for biogas are easily and cheaply accessible wherever in this nation Since the perfect temperature for biogas is around 35ºC, Bangladesh has a great atmosphere for biogas engenderment. The Regime alongside a few NGOs is teaming up for the advancement of intensity engenderment from Biogas. Grameen Shakti which is a standout amongst the most articulated NGO in the field of biogas has culminated 13,500 biogas plants. As of late a 25 kW Biogas based Power Plant has been proposed in Rajshahi by Seed Bangla Foundation. IDCOL which is a Regime possessed Investment Company settled an objective of building up 37,669 biogas plants in Bangladesh by 2012, under its National Domestic

Biogas and Manure software engineers (NDBMP). Other than working in association with IDCOL, household biogas plants have been built by a few associations utilizing their own assets. Grameen Shakti, BRAC and some other private associations advance biogas plants autonomously. IDCOL and its accomplice associations have introduced 18,713 biogas plants until May 2011. In addition, 5 MW of intensity has been caused from biogas and 1 MW from biomass till October 2015.

Geothermal Energy:

Geothermal vitality is a sort of warm vitality which is caused and put away inside the earth surface. It is especially cost viable and naturally heartfelt. Utilizing this innovation, it is conceivable to use the steam and boiling water incited inside the earth surface to cause power. In any case, geothermal vitality is caused in the world's center which is around 4,000 miles beneath the surface. In reality, this procedure happens in the all stones on account of the moderate rotting of the radioactive particles, engenderment of high temperature inside the earth Around 10,715 megawatts (MW) of geothermal vitality is induced in 24 nations ecumenical The northern regions of Bangladesh demonstrate the prospect to investigate the geothermal assets.

Ocean Energy:

Sea wave vitality is induced specifically from seas wave. It is another unique sort of sustainable power source which profits to decrement the malicious outflows of nursery gasses related with the age of intensity. As a matter of fact, it very well may be conceivably a fundamental wellspring of power for Bangladesh. Despite the fact that the principle implies of sea wave vitality is power age, it can also be used for the siphoning of water, water desalination and so forth. Be that as it may, the Oscillating Water Column technique is in fact practical and getting to be enrapturing in this imply. This kind of wave vitality tackling contraption is being appointed by a few nations, for example, India. Bangladesh has a plausibility of tackling sea wave vitality from the Bay of Bengal. As of late, sizably voluminous sea territory has been picked up by Bangladesh from two neighbor nations India and Myanmar which is an incredible triumph for Bangladesh and because of this extraordinary triumph, it tends to be feasible for Bangladesh to build up rights more than 118,813 square kilometers or regional ocean. Presently, Bangladesh has a 200 nautical miles'

selective monetary zone and access to vast ocean, in this manner deflecting it from transforming into an ocean bolted nation. Be that as it may, this selective monetary zone is a sort of ocean zone over which it has been workable for Bangladesh to set up sovereign rights for the use and investigation of marine assets, including oil and gas. Also, cosmically colossal potential vitality is accessible in this sizably voluminous ocean zone which can be used by inciting power.

Fossil Fuel:

Piece of non-renewable energy sources happened numerous years' prior when creatures, plants and different animals kicked the bucket and covered under the earth. Their remaining parts step by step transmuted throughout the years on account of the weight and warmth in the world's covering and created to coal, oil and gas.

Coal Sector:

Coal is a principal vitality now in Bangladesh. The subsistence and improvement of the coal business have exceptionally principal importance to the national financial security. As late as 2009-10, gas sharing for the age of power was 89% however coal and oil sharing were 3.5% and 5% individually. In this circumstance, it would be a decent option if gas could be supplanted by Coal. Be that as it may, it was unrealistic, on the grounds that coal issue endured on account of sincere administration emergency. No one over the most recent couple of decades gave coal mining a conceivable idea. That left the nation completely spontaneous for an emergency when gas was hard to come by. 28% of our essential vitality is provided by coal Save of coal in five fields of Bangladesh is assessed at 3.0 billion tones equipollent to 67 tcf of gas, which can advantageously suit the vitality desiderata of Bangladesh for a long time.

Name of coal deposits	Year of discovery	Depth of Coal layer (m)	Area (Km^2)	Reserve (million MT)	Type of coal
Phulbaria	1997	4150	24	572	Bituminous
Dighipara	1995	250	15	600	Bituminous
Jamalgonj	1962	640-1158	11.7	1053	Bituminous
Khalaspir	1989	257-451	5.75	400	Bituminous
Barapukuria	1985	118-506	6.68	390	Bituminous

Table 4: Coal deposits in Bangladesh

Diverse coal-based power plants have just been arranged, for example, Barapukuria third unit by Bangladesh Power Development Board, BPDB, Chittagong control station by Orion gathering, Khulna south power station by Orion gathering, Maowa control station by Orion gathering, Munshiganj control plant by Orion gathering, Mongla control station by Bangladesh Power Development Board, BPDB, Rampal control station by Bangladesh Power Development Board, BPDB and National Thermal Power Corporation and so on.Barapukuria third unit is a proposed 250-megawatt continuation of the subsisting plant at Phulbari, Dinajpur which is affirmed by the Cabinet Purchase Committee. A report which was made in October 2015 states that development take a shot at the task had started which have an ability to devour 600,000 tons of coal for each year, with 75 percent radiating from Barapukuria Coal Mining Company. A report which was made in April 2013 states that proposed 282.67-megawatt Chittagong control station has been converged with Orion's 283-megawatt Khulna control station into a solitary 565 MW plant at Khulna . No new report was found on Orion's site about Khulna control station and Maowa control station since 2014. Besides, because of ecumenical weight and open restriction, plans for the Khulna plant have all the earmarks of being repealed. A report made on April 26, 2016, states Maowa, Chittagong, Khulna control plant as under executed. Besides, as indicated by the report, an arrangement has been marked for 635 MW coal-based power plant in Gazaria, Munshianj which will be in task inside 45 months. UNESCO has asked Bangladesh to annul the Rampal 1320 MW plant on October 20, 2016, verbalizing it risks the close-by Sundarbans.

4.3 Crude Oil & Petroleum based products:

Unrefined petroleum is a combination of hydrocarbons that subsists in a fluid stage in common underground repositories and stays fluid at barometrical weight in the wake of going through surface dissevering offices. Just noteworthy oil hold of Bangladesh is the Haripur oil save which was found in 1989 at the northwest of Sylhet area. Also, 0.84 Mtoe hold should be recovered as of the year 2004 among the assessed save of 1.4 Mtoe however the abuse was neglected because of the nearness of water in the oil zone and poor oil quality. Bangladesh to a great extent relies upon imported rough and refined oil based commodities for transport, modern warming, and tiny scale control age. At present, 4.87 million metric tons (MT) refined oil is required for Bangladesh with a yearly amplification rate of 5%. Creation example of Eastern Refinery in 2014-15 is appeared.

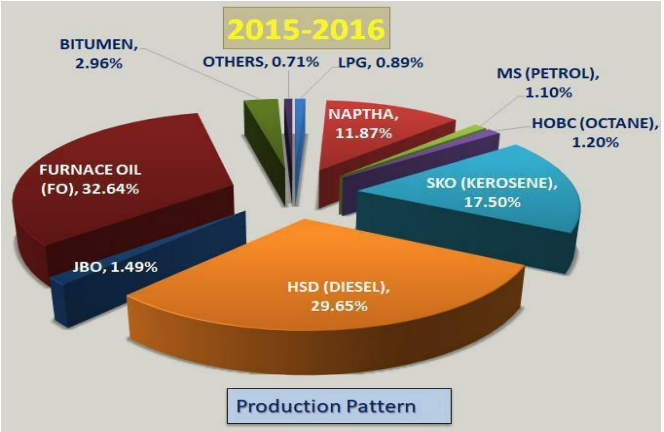


Figure 7 Production process of Eastern Refinery in 2015-16

Natural Gas:

Flammable gas is one of the significant wellsprings of metal vitality. The principal gas field was found in Sylhet at 1955. A report made on 16 January 2017 has communicated the ongoing gas engenderment situation of Bangladesh [20].

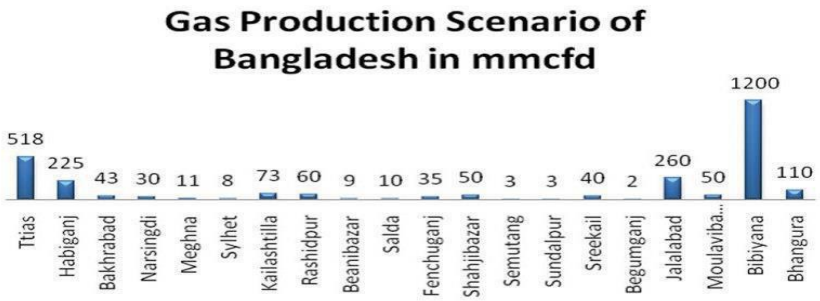


Figure 8: Gas production scenario of Bangladesh in mmcfd

The fig. 8 demonstrates an ongoing situation of gas engenderment of 20 gas fields in mmcfd. Here, it tends to be outwardly seen that Bibiyana gas field has the most noteworthy measure of engenderment while Begumganj has the least measure of engenderment. Bangladesh has 27 TCF flammable gas saves among which 18 TCF is demonstrated hold. Around 2380 mmcfd gas is investigated against the goal of 3800 mmcfd gas each day. Day by day lack of gas engenderment in Bangladesh was 600 mmcfd against assessed objective of 3300 mmcfd gas

.Fig. 9 represents gas distributions in different fields in the year 2017-18 .

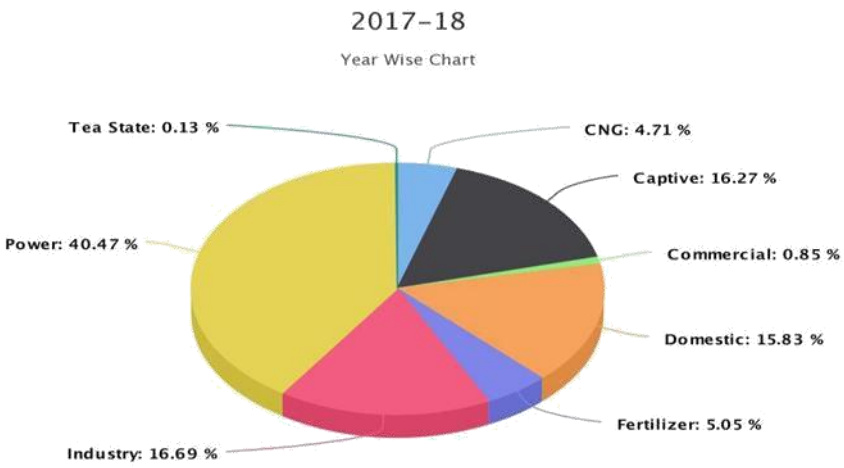


Figure 9: Gas distributions in different fields in the year 2017-18

4.4 FUTURE ENERGY SCENARIO

Bangladesh can dream a lustrous future, where customary and non-ordinary assets are the major add to our vitality commix. The Bangladeshi Government has set an objective to have 3,168 MW of sustainable power source limit introduced by 2021. The Government likewise intends to have a 5% offer of sustainable power source in power age by the discontinuance of 2015, which is wanted to addition to 10% by 2021. The Government intends to incorporate 1,740 MW of sun oriented power, 1,370 MW of wind vitality limit, 100% power access to country regions by 2021, with the rest of the equalization to be to a great extent made out of biomass-predicated control age advances. Under 10 MW each will be coordinated through biogas and smaller than expected hydro control ventures. Government moreover made sundry strides for non-sustainable assets in various power stations.

Solar Energy:

Sun oriented vitality can be likely the best answer for our vitality needs in not so distant future. Amplification in the sun based vitality segment will lessen the encumbrance on gas. In addition, zapping PC focuses and different work environments can be conceivable by using sun oriented power. Since sun powered vitality can give harmless unending vitality supply, huge load shedding can be limited by further amplification of nearby planetary group. At any rate half of our capacity emergency can be destroyed by developing increasingly sun based

boards in our country region. Since country individuals don't have appropriate savviness about sun powered vitality, legitimate data must be given to them so as to comprehend the significance of sunlight based boards. In addition, routine must make basic strides so as to keep sun oriented boards among the purchasing limit of provincial individuals. Supplanting half breed framework instead of sun based water system framework will be particularly beneficial for Bangladesh. Around five locale utilize this sun oriented water system framework. The interest is expanding step by step. Eco-accommodating sunlight based controlled rickshaws must be presented for illuminating force emergency of Bangladesh

Wind Energy:

Wind vitality can be one of the powerful answers for explain our vitality needs. Little Wind Turbine (SWT) is viewed as the most ideal alternative for Bangladesh to settle vitality emergency which can be passed on and introduced with least land and framework imperative. The upside of introducing little breeze turbine is that it can induce power at the very least cost just 10 to 15 taka for every kW though on the off chance that we introduce sun based photovoltaic cell, it will take roughly 50 taka for each kW. Thus, it will be especially financially agreeable. Besides, expansive breeze turbines might be set up in the beach front and higher height territories. It tends to be particularly backup for raising water and causing of power in the waterfront area of Bangladesh, which may settle vitality dilemmas all through the nation to some degree. Once more, by using wind capacity to drive water siphons, can possibly settle the watering difficulty in the croplands as it were. Be that as it may, wind plants ought to be spread to the clients and the proprietors ought to be enlivened to develop them with locally accessible materials.

Tidal Energy:

Most extreme individuals living in the waterfront regions need to pass their ordinary monetary emergency by drifting, angling, etc. which is certainly not a settled arrangement. Yet, by using tidal power they can inundate and can make their life monetarily wealthy than previously. Through building up of a tidal power plant requires a high startup expense, yet upkeep cost is low. Also, running expense is low, so building up of a tidal power plant is particularly gainful. Foundation of tidal floods can anchor a city from unsafe tide amid a tempest. It tends to be said that setting up tidal power plants in the beach front regions like Sandip will be especially assistant so as to comprehend control emergency. Spot separate can be the most significant factor for building a tidal power inciting plant and accessibility of high tide waves which is lucky for dike must be winnowed for tidal power inducing. Extensive dependability of separated spot, for example, stable tsunami, the scarcest

likelihood of cataclysmic event and so on for making a tidal power inducing plant must be considered and the spot ought to moreover be far from the area and have effortless change framework. In any case, improvement of creative tidal turbine framework and seaside foundation, the advancement of tidal vitality can be normal in our nation which will be particularly auxiliary for comprehending our capacity emergency and taking care of our increasing force demand in future.

Hydro-electricity:

Since, hydro-power is a manageable sustainable power source and due to having great potential for the use of this vitality so as to meet the everyday necessities, it can acquire gigantic flourishing the vitality area in not so distant future. In addition, waterways of Bangladesh have a low stream rate in winter, so it will be a decent origination to incite a preoccupation channel along the extension, redirection structure over the waterway channel and the powerhouse at an appropriate area so as to offer an apt head. On account of increasing interest for power in the nation, it is viewed as crucial that hydro-control capability of the Sangu and the Matamuhari and also the Brahmaputra River Basins, being wellsprings of non-regular vitality, be given need for their improvement. There is additionally sizably voluminous potential for Bangladesh to tap in to Nepal and Bhutan's colossal potential hydroelectric age limit. In any case, the routine must complement that any hydro-control venture must be exposed to thorough ecological and gregarious effect evaluation.

Biogas Energy:

Biogas can be one of the successful answers for comprehend our vitality needs. Through high transmission and appropriation costs, transmission misfortunes, intensely financed evaluating are incredible issues for providing power in the provincial zones, biomass fills can be the best savvy arrangement in such manner. Biogas engenderment from biomass is a demonstrated innovation and there is no danger of disappointment of gas engenderment from biomasses if fortunate structure and supervision can be found out. In this way, need must be gone up against scattering of biomass fuel all through the nation so as to explain vitality emergency. Besides, Bangladesh has a giant potential in using biogas innovation. In the event that appropriate advances can be taken, the nation will be able to use around 29.7 million m3 biogases from the domesticated animals of the nation which is indistinguishably equivalent to

1.5 million tons of lamp fuel. Nonetheless, every one of the groups of Bangladesh must be related with biogas plants so as to induce colossal measures of biogas from human squanders. Additionally, the metropolitan squanders can be a potential wellspring of biogas engenderment crosswise over Bangladesh and Organic putrescent part can be used for Biogas engenderment.

Ocean Energy:

Sea wave and sea warm vitality can be especially helper to comprehend our vitality essentials. There is a plenty of potential outcomes to cause power from Sandwip Island, Kutubdia Island and Saint Martin Island using OWC framework and it will appear the cheapest wellspring of network quality sustainable power source of our nation in not so distant future. Additionally, the augmentation of vitality security and framework steadiness will diminish the general cost of sustainable power source.

Geothermal Energy:

Since geothermal power satisfies the criteria for a fitting vitality framework for Bangladesh and if our routine sends this vitality source, it will be an extraordinary hotspot for understanding the present vitality emergency of our nation. Government and private associations must approach so as to develop geothermal power plants in Bangladesh in an early conceivable time. Despite the fact that setting up a geothermal power plant will require mind-boggling expense in light of the surprising expense of penetrating wells, it tends to be decreased by using the neglected on-shore dry wells which have sufficient high temperature inclination.

Petroleum gas, Coal, and Fuel:

Bangladesh has encountered a few scrapes because of the thorough power emergency for proximately 10 years. Mindful holds, for example, coal and flammable gas of business essential vitality sources are the main saves in Bangladesh yet they are repressed contrasted with the improvement necessities of the country. By recognizing a few activities of the routine and progressing in the direction of them fortunately, Bangladesh will be able to fathom exceptional vitality requests. Since the centrality of gaseous petrol is augmenting never-endingly, mandatory advances must be taken so as to decrement the use of petroleum gas. Also, moving the vitality of petroleum gas into sustainable power source can be a solid

arrangement. Something else, there will be an incredible lack of petroleum gas in not so distant future. Since incognizance on the coal-predicated control plant establishment may exacerbate the condition, routine must make irreplaceable strides in such manner. The Power System Master Plan 2016 expects an expected 60 million tons of coal to be foreign by 2041 to discover a relentless supply for the arranged power stations in a way that decreases both efficient and gregarious expense, perhaps through a different port for coal imports. On the off chance that National Coal Policy work with a sorted out arrangement, it will be conceivable to illuminate vitality issue inside the decided period.

Nuclear Energy:

Rooppur Nuclear Power Plant is a coordinated 2.4 gigawatt atomic power plant of Bangladesh which will be the nation's first atomic power plant and the first of two units is relied upon to go into activity in 2023. It will be developed by the Russian Rosatom State Atomic Energy Corporation and the atomic power plant will be worked at Rooppur which is 200 km north-west of Dhaka, at Paksey association on the bank of the stream Padma in the Ishwardi sub-area of Pabna region, in the northwest of the nation.

Unit	Type	Capacity	Construction start	Operation
Rooppur 1	AES-2006/V-392M	1200 MW	2019	2023
Rooppur 2	AES-2006/V-392M	1200 MW	2019	2024

Table 5: Planned nuclear power reactors

Figure 10: Rooppur proposed nuclear power plant

Chapter 5
Electrical Power Generation in Bangladesh

5.1. Different utilities:

An electric utility is a company in the electric power industry (often a public utility) that engages in electricity generation and distribution of electricity for sale generally in a regulated market.The electrical utility industry is a major provider of energy in most countries.

Electric utilities include investor owned, publicly owned, cooperatives, and nationalized entities. They may be engaged in all or only some aspects of the industry. Electricity markets are also considered electric utilities—these entities buy and sell electricity, acting as brokers, but usually do not own or operate generation, transmission, or distribution facilities. Utilities are regulated by local and national authorities.

Electric utilities are facing increasing demands including aging infrastructure, reliability, and regulation.

List of Utilities of power generation in Bangladesh:

1) Solar energy
2) Renewable energy
3) Thermal Energy
4) Wind energy
5) Coal Energy
6) Gas Energy
7) Petroleum Energy
8) Water energy

9) Nuclear Energy

Bangladesh has 15 MW solar energy capacity through rural households and 1.9 MW wind power in Kutubdia and Feni. Bangladesh has planned to produce 5% of total power generation by 2015 & 10% by 2020 from renewable energy sources like wind, waste & solar energy.

5.2. Various companies:

Bangladesh Power Development Board (BPDB):

Bangladesh Power Development Board (BPDB) is a statutory body created in May 1, 1972, by presidential Order No. 59 after bifurcation of erstwhile Bangladesh Water and Power Development Authority. BPDB started its operation with Installed Generation capacity of only 200 MW. Installed Generation capacity (April' 2016) has increased to 12,339 MW.

As part of reform and restructuring a number of Generation and Distribution companies have been created. The subsidiaries of BPDB are:

- Ashuganj Power Station Company Ltd. (APSCL)
- Electricity Generation Company of Bangladesh (EGCB)
- North West Power Generation Company Ltd. (NWPGCL)
- West Zone Power Distribution Company Ltd. (WZPDCL)

The BPDB is responsible for major portion of generation and distribution of electricity mainly in urban areas except Dhaka and West Zone of the country. The Board is under the Power Division of the Ministry of power, Energy and Mineral Resources, Government of Bangladesh.

BPDB has taken a massive capacity expansion plan to add about 11600 MW Generation capacity in next 5 years to achieve 24000 MW Capacity according to PSMP-2010 by 2021 with the aim to provide quality and reliable electricity to all the people of Country for desired economic and social development. The power system has been expanded to keep pace with the fast growing demand.

5.3. Generation capacity:

Bangladesh's total installed electricity generation capacity has reached nearly 16,000 megawatts (MW).

The Bangladesh Power Development Board (BPDB) official told Xinhua that "installed generation capacity (as of Aug. 30) has increased to 15,761 MW."

Despite a robust rise in the capacity, the official who declined to be named, said the current power generation is, to some extent, insufficient to meet increasing demand.

He said power plants in Bangladesh Tuesday generated 9,891 MW of electricity against the total demand for about 10,000 MW.

Regarding generation of power less than the installed capacity, the BPDB official attributed to shortage of gas supplies to the power stations.

BPDB has taken a massive capacity expansion plan to add about 11,600 MW generation capacity in next 5 years to achieve 24,000 MW capacity with the aim to provide quality and reliable electricity to all Bangladeshi people.

The power system is being expanded to keep pace with the fast growing demand, he added.

Sources said the number of power connection receivers in Bangladesh have risen to some 26 million so far this year.

On the other hand, the transmission lines reportedly rose to 10,436 km while the distribution line to 401,000 km.

To improve its nagging electricity situation, Bangladesh has been getting support from the country's development partners and the Asian Infrastructure Investment Bank (AIIB), which last year approved 165 million U.S. dollars in loans for a Bangladesh power sector project - the first batch of loan for the country from the China-based development bank.

The project is designed to expand electricity coverage by providing 2.5 million new service connections in rural areas and upgrade grid substations and convert overhead distribution lines into underground cables in northern Dhaka.

The AIIB said the project will supplement other development partner efforts by providing additional financial resources to connect more rural and urban consumers, further reduce distribution losses, and improve the quality and reliability of power supply in Bangladesh.

"The project, upon completion, is expected to benefit about 12.5 million people in rural areas," it added.

Officials said Bangladesh is looking to AIIB as the country, which has already identified inadequate electricity supply as a major constraint on GDP growth and overall economic development, is in a dire need for more funds to develop mega infrastructure projects.

In this connection, he said Bangladesh is interested to build a grid line with Myanmar.

Bangladesh and Myanmar can build a grid line between them, it will pave the way for exchanging electricity with China and ASEAN countries bolstering cooperation among the Bay of Bengal Initiative for Multi-Sectorial Technical and Economic Cooperation (BIMSTEC) and Bangladesh-China-India-Myanmar Forum for Regional Cooperation (BCIM) nations.

5.4. Voltage ranges:

Transmission voltage usually above 230KV is usually referred to as Extra High voltage.

The existing transmission voltage levels in Bangladesh are 66KV, 132KV, 230KV, and 400kV (under construction). Transmission line of 132 kV is 6066.44 Circuit km and of 230kV is 2647.3 Circuit km.

Primary distribution:

Primary distribution voltages range from 4 kV to 35 kV phase-to-phase (2.4 kV to 20 kV phase-to-neutral) Only large consumers are fed directly from distribution voltages; most utility customers are connected to a transformer, which reduces the distribution voltage to the low voltage "utilization voltage", "supply voltage" or "mains voltage" used by lighting and interior wiring systems.

Secondary distribution:

Electricity is delivered at a frequency of either 50 or 60 Hz, depending on the region. It is delivered to domestic customers as single-phase electric power. In some countries as in Europe a three phase supply may be made available for larger properties. Seen with an oscilloscope, the domestic power supply in North America would look like a si**ne wave, oscillating between −170** volts and 170 volts, giving an effective voltage of 120 volts RMS.Three-phase power is more efficient in terms of power delivered per cable used, and is more suited to running large electric motors. Some large European appliances may be powered by three-phase power, such as electric stoves and clothes dryers.

A ground connection is normally provided for the customer's system as well as for the equipment owned by the utility. The purpose of connecting the customer's system to ground is to limit the voltage that may develop if high voltage conductors fall down onto lower-voltage conductors

which are usually mounted lower to the ground, or if a failure occurs within a distribution transformer. Earthing systems can be TT, TN-S, TN-C-S or TN-C.

Electric power distribution:

Electric power distribution is the final stage in the delivery of electric power; it carries electricity from the transmission system to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage ranging between 2 kV and 35 kV with the use of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near the customer's premises. Distribution transformers again lower the voltage to the utilization voltage used by lighting, industrial equipment or household appliances. Often several customers are supplied from one transformer through secondary distribution lines. Commercial and residential customers are connected to the secondary distribution lines through service drops. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the subtransmission level.

Generation and transmission:

Electric power begins at a generating station, where the potential difference can be as high as 33,000 volts. AC is usually used. Users of large amounts of DC power such as some railway electrification systems, telephone exchanges and industrial processes such as aluminum smelting use rectifiers to derive DC from the public AC supply, or may have their own generation systems. High-voltage DC can be advantageous for isolating alternating-current systems or controlling the quantity of electricity transmitted. For example, Hydro-Québec has a direct-current line which goes from the James Bay region to Boston.

From the generating station it goes to the generating station's switchyard where a step-up transformer increases the voltage to a level suitable for transmission, from 44 kV to 765 kV.
Once in the transmission system, electricity from each generating station is combined with electricity produced elsewhere. Electricity is consumed as soon as it is produced. It is transmitted at a very high speed, close to the speed of light.
Note:
Transmission voltage usually above 230KV is usually referred to as Extra High voltage.

The existing transmission voltage levels in Bangladesh are 66KV, 132KV, 230KV, and 400kV (under construction). Transmission line of 132 kV is 6066.44 Circuit km and of 230kV is 2647.3 Circuit km.

5.5. Public Vs Private:

A private company is a firm held under private ownership. Private companies may issue stock and have shareholders, but their shares do not trade on public exchanges and are not issued through an initial public offering (IPO).

	Public Sector	
	SL	Generation Capacity(MW)
1	BPDB	15761
2	APSCL	777
3	EGCB	412
		SUBTOTAL= 16,950MW
	Private Sector	Generation Capacity
1	SIPPs	5823
2	SIPPs(BPDB)	3719
3	SIPPs(REB)	266
4	15 YR. Rental	168
5	3/5 YR. Rental	1613
		SUBTOTAL=11,589 MW

Fig: public vs private

5.6. Power demand

Demand Supply Situation:

Generation: 5000 – 5300 MW (Capacity- 7119 MW)

Highest so far: 5244 MW (August 29, 2011)

Gas shortage causes 400 - 600 MW less Power Generation

Peak Demand: 6000 MW (with DSM)

Load shedding up to 800 MW during hot summer days (with DSM)

Shortage and unreliable power supply has constrained

economic growth.

The utility electricity sector in Bangladesh has one national grid with an installed capacity of 16,525 MW as of 13 September 2018. Bangladesh's energy sector is booming. Recently Bangladesh started construction of the 2.4-gigawatt (GW) Rooppur Nuclear Power Plant expected to go into operation in 2023.According to the Bangladesh Power Development Board in July 2018, 90 percent of the population had access to electricity. However per capita energy consumption in Bangladesh is considered low.

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.As of 2015, 92% of the urban population and 67% of the rural population had access to electricity. An average of 77.9% of the population had access to electricity in Bangladesh.

Bangladesh will need an estimated 34,000 MW of power by 2030 to sustain its economic growth of over 7 percent.

Problems in Bangladesh's electric power sector include high system losses, delays in completion of new plants, low plant efficiency, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance. Overall, the country's generation plants have been unable to meet system demand over the past decade.

On 2 November 2014, electricity was restored after a day-long nationwide blackout. A transmission line from India had failed, which "led to a cascade of failures throughout the national power grid," and criticism of "old grid infrastructure and poor management." However, in a recent root-cause analysis report the investing team has clarified that fault was actually due to a lack in electricity management and poor transmission and distribution health infrastructure that caused the blackout.

5.7. Challenges

Primary fuel supply:

Enhanced Gas Exploration, Production

Domestic coal development

Coal Import (long term contract) and deep sea port for coal handling

LSafe Nuclear TechnologyNG import.

Project Financing:

Ensuring financing for Public and Private sector projects

Availability of foreign currency

Transportation of fuel and equipment:

Infrastructure development by Railway and R&H

Dredging of river routes by BIWTA

Capacity builds up of BPC, Railway, R&H and BIWTA etc.

Human Resources Development:

Development of skilled manpower: adopt and operate new technology.

5.8. Progress:

Electric power generation system development is reviewed with special attention to plant efficiency. It is generally understood that efficiency improvement that is consistent with high

plant reliability and low cost of electricity is economically beneficial, but its effect upon reduction of all plant emissions without installation of additional environmental equipment, is less well appreciated. As CO2 emission control is gaining increasing acceptance, efficiency improvement, as the only practical tool capable of reducing CO2 emission from fossil fuel plant in the short term, has become a key concept for the choice of technology for new plant and upgrades of existing plant. Efficiency is also important for longer-term solutions of reducing CO2 emission by carbon capture and sequestration (CCS); it is essential for the underlying plants to be highly efficient so as to mitigate the energy penalty of CCS technology application. Power generating options, including coal-fired Rankine cycle steam plants with advanced steam parameters, natural gas-fired gas turbine-steam, and coal gasification combined cycle plants are discussed and compared for their efficiency, cost and operational availability. Special attention is paid to the timeline of the various technologies for their development, demonstration and commercial availability for deployment.

Chapter 6
Nuclear Power Plant in Bangladesh – A review

6.1 INTRODUCTION

Power is the key element for financial advancement of any nation. Regularly per capita utilization of power and vitality is considered as one of the improvement sign of a country. Be that as it may, in Bangladesh (in June 2009) just around 47% of the populace approaches power, and per capita business vitality utilization is 182kWh, the most reduced on the planet. In this unique circumstance, Bangladesh is in the prompt need of complex increment of existing power age limit. At present, power creation in Bangladesh is for the most part dependent on existing store of ordinary vitality sources, (for example, non-renewable energy source like gas, coal, oil and so on) won't be accessible following couple of years if the lack control is produced by just that regular sources. Also, age of power from regular sources is expensive and all the more essentially contaminating the earth. Once more, control age from sustainable power source won't be sufficient to satisfy the enormous deficiency of intensity. Introduced electric creating limit of the nation in 2007 was 5269MW and in June 2009 was 5,719MW. In June 2008 is age was 3501MW for the power request of above 5GW and in June 2011 age is close around 4150 MW for interest above 5.5 GW. It is exceptionally basic for Bangladesh to give significant fixation on expansive scale control age. In this unique situation, Nuclear Power Plants could be the best alternative for Bangladesh to Power Plant for power age.

6.2 STATUS OF POWER SECTOR

The introduced age limit was around 6727 MW up to June 2011 (counting 3534 MW in Public segment and 3193 MW in Private part), from a pitiful 88 MW in 1960. Power age developed at about 7% p. a. amid last fifteen (15) years contrasted and normal yearly GDP development rate of about 5.5%. Despite the advancement made to date, Bangladesh's per capita power age and populaces approach power is still low contrasted with many creating nations. The present status of intensity part is introduced in Table 1. From the fig. 1, it is seen that the introduced limit of power in Bangladesh is above 80% is from gas, and others from diesel, heater oil, hydro and coal. Power age stir up to March '06 is 86% from gas, 3% from coal, 8% from fluid fuel and 3% from hydro. So the principle fuel for power creation in Bangladesh is gas. Past this 250 MW is from coal, 230 MW from hydro control and just about 200 MW from fluid fuel. As gas hold isn't sufficient for long haul. Solitary fuel based age arranging isn't suitable for the nation in term of vitality security and maintainable

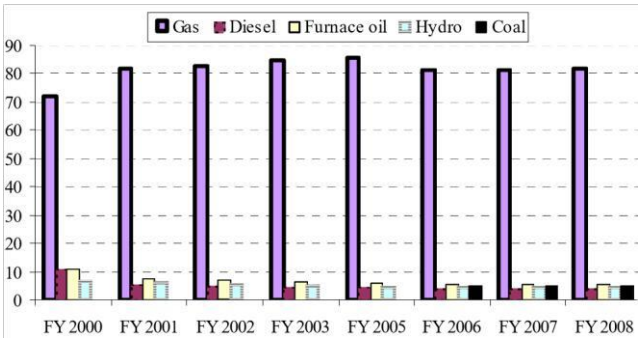


Fig. 1. Installed Capacity of electricity in Bangladesh from FY2000-2008

With gradually increase of power demand power generation should be increased gradually. The fig. 2 , shows with the increase of power generation load shedding is also increased which indicates that the rate of increasing of power generation is always lagging behind the rate of increasing power demand.

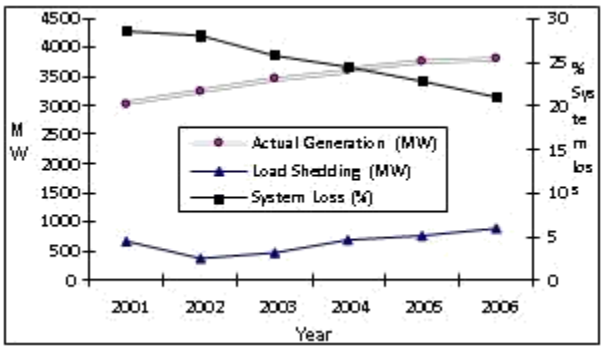
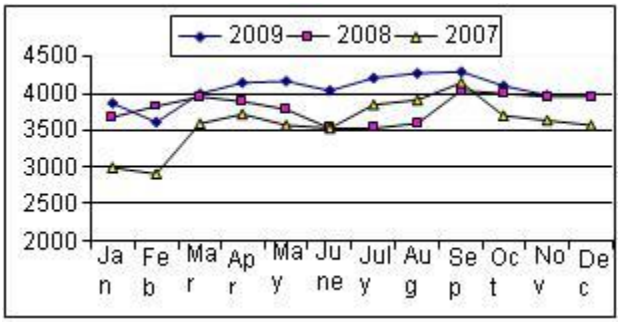


Fig. 2. Year wise power generation, load shedding & system loss

The fig. 3 represents the maximum daily power generation. The fig. shows that power generation varies for the whole year. It also shows that power generation became high in March, April, May, September and October. And low in January, February and December.



. Fig. 3. Maximum daily generation (MW)

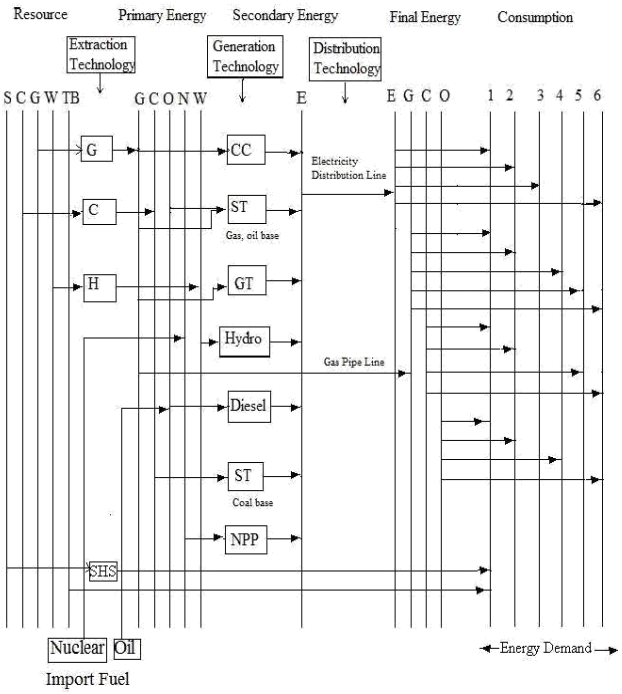


Fig. 4. Energy flow diagram

The vitality chain comprised indigenous essential common assets including gas, coal, hydro, and wind, and imported assets including oil items, for example, diesel and heater oil and atomic vitality. The current power plants are the consolidated cycle (CC), steam turbine (ST), gas turbine (GT), hydro and wind. In the solidly arranged power plant innovation, the coal control plant and the hopeful power plants, for example, the atomic and sun based power plants gives the auxiliary vitality (power), which will be associated with the last dimension through transmission and dispersion lines.

Table 2 [2][3] speak to the vitality assets in Bangladesh. The rest of the hold (demonstrated + likely) of gas in 23 no of gas field is 12.149 Tcf and recoverable coal save is 724 million tons. The fig. 5 [2] speaks to year insightful petroleum gas creation which indicates gas generation rate is expanding shift quickly.

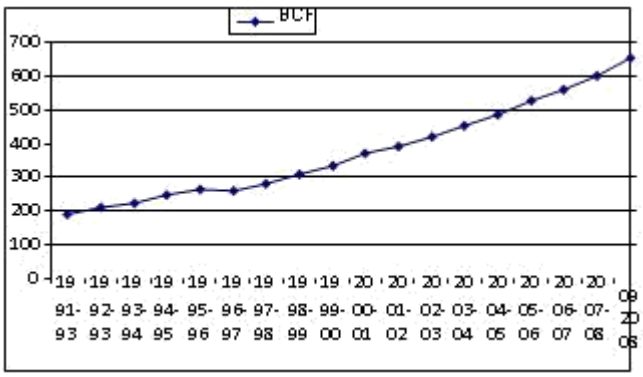


Fig. 5. Year wise power Natural gas production (BCF)

Assuming a percentage of annual growth in domestic consumption, a very fast and probably unsustainable rate, the reserves should last for 15-20 years, represented in fig. 6.

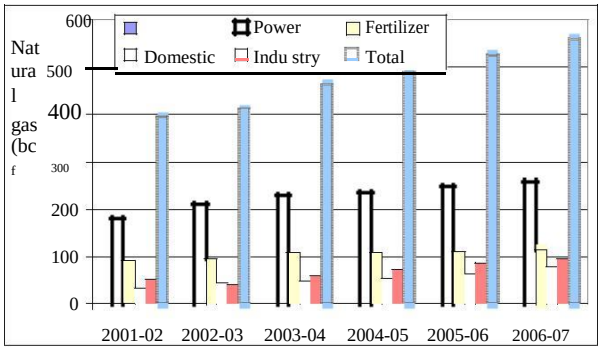


Fig. 6. Sector wise Demand for Natural gas (BCF).

From the year astute gas creation bend the rate of increment of gas utilization is high that will in general decline the hold quickly. Petrobangla effectively announced that it is beyond the realm of imagination to expect to supply gas in new power plant after 2011. Vitality Regulatory Commission prescribes to import gas to lessen the lack fuel issue.

The fig. 7 speaks to the area insightful gas utilization. Starting at 2007, the measure of gas utilized every day is 1,781 mcf. The measure of gas utilized every day in power part is 723 mcf,

manure segment is 201 mcf; industry and other area is 855 mcf. Power part is the biggest and compost segment is the second customer of aggregate gas utilization. Different segments that utilization gas are residential, business, industry, transportation, tea garden.

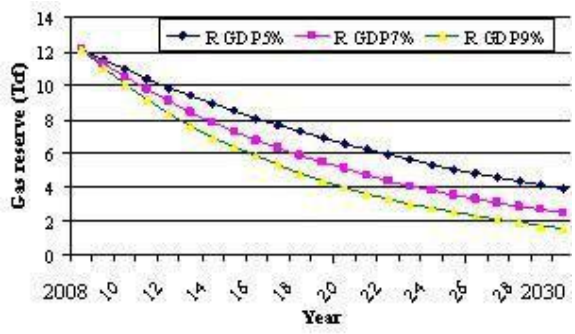
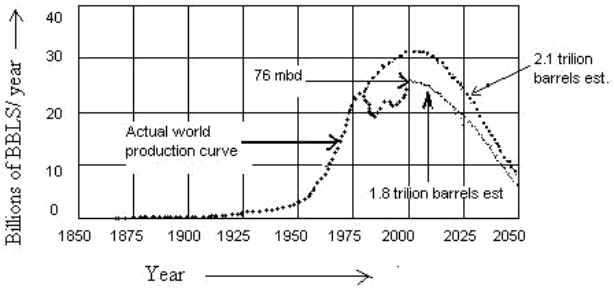


Fig. 7. Estimated natural gas reserve (Tcf) with GDP from present remaining reserve gas 12.149 Tcf.

The save of coal in Bangladesh is great which is evaluated as 3145 million tons. As gas hold isn't sufficient for long haul, presently Govt. is attempting to give real focus on coal. In any case, because of various kind of coal mining the measure of recoverable coal is extraordinary. Thinking about the staggering expense of coal mining, natural effects likely harming impacts of coal mining and also coal consuming on farming area specifically and condition and general wellbeing power age from coal is costly and furthermore hurtful to the earth.

At present year, Govt. is finding a way to create control by bringing in fluid fuel for brief time to conquer the present power emergency. At 2007 the aggregate expense including other related consumption of bringing in fuel oil is 4.5 billion US$ while in the past 2006 it was just 2.1billion US$. As the cost of oil in global market is higher so govt. needs to give gigantic measure of cash as appropriation.



0].

Fig. 8. World oil production

Fig. 8 speaks to the world oil creation. In this fig. it is seen that the oil creation will be top at the very latest 2010 and after 2010 it will diminish and reach to around 33% of the pinnacle. Pinnacle expected at the latest 2010, as 1970 crest, to which it will stay away for the indefinite future. As the oil cost is very expanding on the planet, so it won't be conservative to deliver control by bringing in oil in long haul. As of late Bangladesh Govt. is offering regard for deliver control from sustainable power source. Be that as it may, control creation from sustainable power source isn't adequate to satisfy the present power deficiency.

6.3 WORLD ENERGY CONSUMPTION

Atomic is speaking to 7.64% of World essential vitality utilization in 2000. Ten years back it was just 6.55%. Atomic utilization in EU expanded for 0.6% in the most recent year. Atomic is the main vitality segment that has achieved the dimension before 1990! The expansion of atomic offer has backed off in the most recent year. Fig. 9 and 10 , speaks to the world vitality utilization. From the fig. it is seen that atomic vitality utilization development contrasting and coal, oil, hydro and gas is expanding quickly and in 2000 it is most elevated.

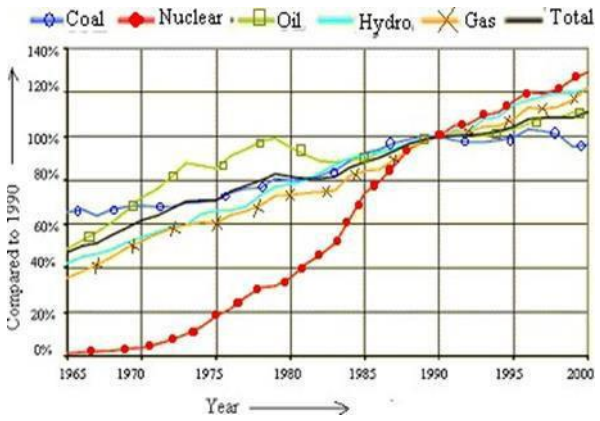


Fig. 9. World primary energy consumption growth

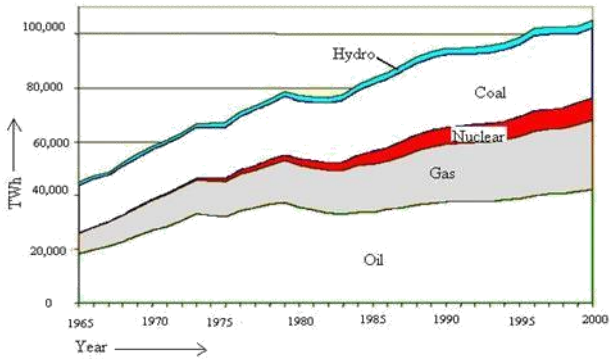


Fig. 10. World energy consumption growth

6.4 GLOBAL TRENDS TO NUCLEAR POWER

Non-renewable energy sources like oil and coal have been rebuked as being in charge of ozone harming substances while atomic power age is by and large viewed as spotless in that standard. Atomic power can make a noteworthy commitment for addressing vitality needs and continuing the world's advancement in the 21st century, for a substantial number of created and creating nations. In 1954, in Russia, Nuclear power was first financially created utilizing a little 5MW plant. Agreeing to IAEA, Nuclear power was anticipated to increment to 17% offer of the world's power generation by 2020. At present, there are 440 atomic power reactors on earth dissipated more than 31 nations. It is anticipated to raise the quantity of atomic power reactors to 200 to 400 amid the following 25 years. France utilizes around 85% of atomic vitality to take care of the national demand. USA 15% of its power (477 BKWH) from 132 atomic reactors. India delivers about 2% of its power (5.5 BKWH) from 9 reactors. Its low ozone depleting substance outflows can bring down the worldwide temperature ascent of 5 degrees to 2 degrees Celsius. It might be referenced that the present 440 atomic reactors are sparing 600 million tons of carbon consistently (double the aggregate sum evaluated to be maintained a strategic distance from by Kyoto Protocol by 2010. In spite of the fact that the establishment cost of atomic power plant is high however the per unit power cost is littler than other power plants.

As indicated by age Nuclear reactor are four sorts. Age I, developed in 1950-60 and not very many are as yet running today. Age II, are most in task elsewhere; ex: Advanced gas cooled reactors (AGCR). Age III, are propelled reactor, initial few of which are working in Japan and others are under development and prepared to be requested; ex. PWR, BWR, PHWR/CANDU. Generation, Electrical power inquire about Institute (EPRI) of USA structured Advanced Passive (AP) PWR; ex: AP600, AP1000. Table 3, speaks to contrast between various kind of atomic reactor.

6.5CONCLUSION COST COMPARISON OF POWER GENERATION FROM DIFFERENT ENERGY:

Cost of power age ought to incorporate both inner and outside expense. The inside expense incorporates all the expense of building a plant, fuel cost, working and upkeep cost. The outside expenses are the ones that are identified with wellbeing, condition and security. It thinks about outflow, scattering and extreme effect including the danger of mishaps and radiological effects. In atomic vitality cost of waste administration lastly the expense of decommissioning of the plant is likewise viewed as which isn't consider if there should be an occurrence of most different types of vitality age. Table 4 speaks to the power age cost from various vitality sources.Fig.11 represents the average US nuclear production cost . Nuclear power generation worldwide has seen significant increase in efficiency.

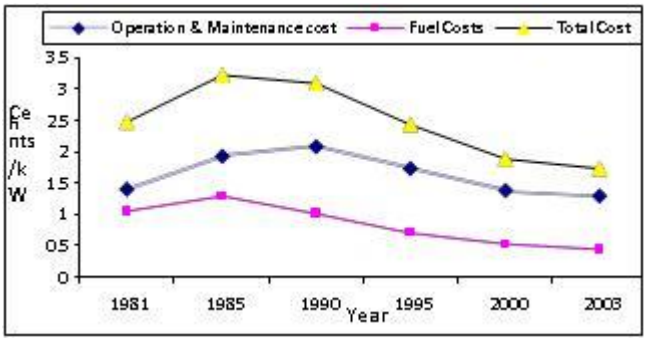


Fig. 11. Average US power (nuclear) production cost (cents/ kWh)

From fig. 11 fuel cost, task and support cost have declined amid years since mid-1980s. Somewhere in the range of 1981 and 2003, in general generation cost per kWh declined by 30% and fuel cost by almost 60%. In the wake of including the outside cost the EU cost of power from coal would twofold and that from gas would increment 30%.

Fig. 12 speaks to the effect of fuel costs on power age costs. This fig. demonstrates that a multiplying of fuel costs would result in the power cost for atomic ascending about 9%, for coal rising 31% and for gas 66%. So atomic is less delicate in variance to fuel cost.

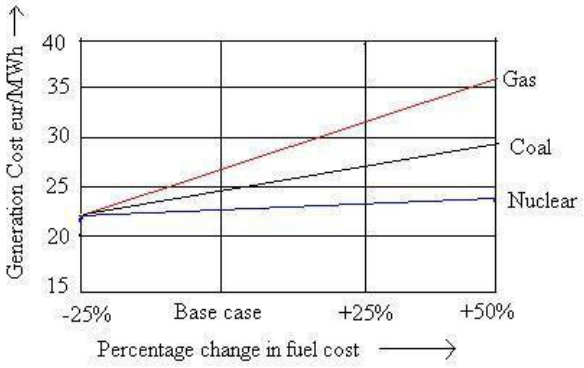


Fig. 12. The impact of fuel costs on electricity generation costs, Finland, early 2000

Table 5 represents a comparison between nuclear, gas and coal based power plant in respect of capital cost, fuel cost, fuel requirement, electricity generation cost, life time of power plant and CO2 emission.

6.6 PRESENT STATUS OF NUCLEAR POWER PLANT IN BANGLADESH

Atomic power in Bangladesh might be named as an account of botched chances. Not long after the principal atomic power station was worked in UK, at that point government began practicality thinks about for conceivable atomic power in Bangladesh in 1961. A site along the Padma River, estimating 262 sections of land of land in Rooppur and another 12 sections of land

of land, a couple of miles away for private state were procured. Albeit commonly govt. toke activities to execute the task yet it was desert because of absence of reserve.

The Law on Nuclear Safety and Radiation Control was instituted in 1993. Bangladesh has been a functioning accomplice in the Regional Cooperation Agreement (RCA) program. Bangladesh has faultless accreditation for non-multiplication, which are showed in marking of NPT (Nuclear Nonproliferation Treaty), Comprehensive Test Ban Treaty (CTBT), Safeguards Agreement, Protocol Additional to the Safeguards Agreement and Bilateral Agreements on quiet employments of nuclear vitality with various nations.

Considering the changed conditions in national and global dimension the administration of Bangladesh communicated its solid pledge to actualize the Rooppur atomic power venture (RNPP). The legislature of Bangladesh received the National Nuclear Action Plan (BNPAP) for meeting the previously mentioned purposes for early usage of the atomic power venture in the nation in 2000. A Cabinet Committee, led by the Head of the Government, has the duty to take choice on the undertaking. It takes all approach choices dependent on the data and examinations made accessible to it. This has likewise encouraged setting up appropriate linkages between the large scale and miniaturized scale level arranging. The fundamental obstructions for executing atomic power plant in Bangladesh are: sufficient assets for the higher capital cost, political responsibility and the transfer of waste. Uplifting news is that International Atomic Energy Agency (IAEA) offered endorsement to Bangladesh to set up atomic power plant for extensive scale control age in June, 2007. Bangladesh was in the highest priority on the rundown of eight creating nations which were affirmed to set up atomic power plant up to 2050.

As of late, new security concern, institutionalization, codes and aides are made to set up Nuclear power plant effectively. The greatest size of any power plant to be incorporated into a framework ought to be about 10% of its pinnacle request. An atomic power plant in a perfect world requires around 6 years for execution. Bookkeeping this and the development of interest in the in the meantime, a 600-1000 MW atomic power plant can be securely incorporated into national network by 2015-2020. The establishment cost per MW of regular power plant US$ 1 million. Though the establishment cost per MW of Nuclear power plant is US$ 1.5 million. In the wake of getting authorization from IAEA Russia, France, South Korea and China likewise need to give budgetary help.

The radioactive squanders that produces from atomic power plant ought to be placed in fixed holders and kept in a bunker like solid underground stockpiling to guarantee against spillage. Atomic waste does in reality set aside a long opportunity to rot. A great part of the staying waste can be come back to the fuel cycle and reprocessed. BAEC will prescribe to the designer to orchestrate fuel for the whole time of activity for the power reactor and reclaim the consumed fuel, so Bangladesh does not have the issue of the fundamental waste transfer.

Chapter 7

Recommendation

This examination prescribed to utilize proposed key execution pointers for PGCB. Since there is no methodical parameters. Henceforth by utilizing proposed parameters it has been demonstrated that execution assessment and arranging can be all the more effortlessly portrayed. Additionally, it is required for PGCB to hold information for figuring adapting proportion, transmission line support cost list, substation upkeep cost record and terrible obligation files. Additionally, it is prescribed to define a matrix code for PGCB. And furthermore there are still such a significant number of territories in which detail think about is required.

There is a noteworthy miss coordinate between information gathered from various sources. For example, the information gathered in regards to the limit of lattice substation from network circle and arranging office found a distinction of around 1000 MVA. A large portion of the great utilities save the information for study and examination. CEA of Canada hold their information for 25 long years. So this is likewise critical to discover the ways how the Bangladeshi utilities can record the dependable information. Specialized and monetary issues are interrelated, so it is important to put more accentuation on building financial aspects related examination.

From the examination it is seen that still PGCB has such a significant number of regions to grow, particularly records of sales days and working cost files, as these are high contrasted and other service organizations all through the world, well beyond standard. Research should be possible on the best way to lessen these pointers. Research ought to be gone about music, flash and unbalance. More investigation is required to decrease the misfortunes, increment the unwavering quality and security of the framework.

Chapter 8

Conclusion

Thinking about the potential outcomes of fusing electrical micro grids, new models for age and conveyance of power ought to be in the motivation of intensity arranging cell of the Government of Bangladesh. It is normal that by joining electrical micro grid by methods for sustainable vitality, T&D misfortune and in general expense of power creation will be limited fundamentally. Additionally, the discharge of CO2 will be irrelevant with another heap the board strategy as well as solid and amazing force will be guaranteed inside the most limited conceivable time. Establishment of huge power plant dependent on sustainable power source assets is great. Be that as it may, the extent of usage isn't accessible wherever in Bangladesh. Besides, it additionally needs the clearing framework, which is still expensive despite the fact that misfortune has been limited. Then again, the introduced number of SHSs in the nation is enormous (in excess of 3 million) however its offer to the aggregate age isn't that critical. In addition, it isn't adding to the national matrix in any capacity. In this way appropriate estimating of the power sources are critical and also the clearing framework. New model with legitimate arrangement ought to be proposed as an option in contrast to the mass scale age and supplement the conventional power framework. A great part of the innovation utilized for geothermal power age as of now exists. or on the other hand can be adjusted from different sources. The productivity of a geothermal framework is just 20%, yet that is regular among power age offices. The ecological effects of geothermal Energy offices are not exactly the other current vitality sources. Gas discharges from geothermal plants are little to focus in contrast with coal and oil plants, and spills and quakes are improbable. The issue of encroaching into untamed life natural surroundings still remains, yet Acts for the protection of natural life ought to be cautiously considered. At last, geothermal vitality is extremely useful from a financial point of view, since geothermal vitality is shabby, and is additionally a base load generator. The greatest drawback, however, is that geothermal power plants are not as shoddy as coal or even atomic power plants. In light of these realities, this gathering chose that expanding the focal point of vitality generation to geothermal vitality far from different types of vitality that are either more expensive or progressively risky would be a judicious vitality system for the US government.

Chapter 9

Reference

[1] N. Islam, T. M. Redi, A. Mostarin, Nur-E-Tamrin Chowdhury, Md. S. R. Zishan, A study of

Bangladesh's Energy Situation and Probable Future in the Energy Sector, *Journal of Multidisciplinary Engineering Science and Technology (JMEST), 3*(3), 2016, 4355-4360.

[2] Energy, *SlideShare* [internet], Accessed: 02 February, 2018, Available from: http://de.slideshare.net/MdHasanAli/energy-15459083.

[3] Ahmad Fahad Tayab and Toshib Nusrat, Biomass- The Perfect Alternative for Energy Situation in Bangladesh, *Proceedings of the International Conference on Mechanical Engineering and Renewable Energy 2015(ICMERE2015)*, Chittagong University of Engineering & Technology, Chittagong, Bangladesh, 2015.

[4] Rahman, Saha, Khan, Habiba & Chowdhury, Present Situation of Renewable Energy in Bangladesh, *Global Journal of Researches in Engineering Electrical and Electronics Engineering, 13*(5), 2013, 1-7.

[5] Ullah, Hoque, Hasib, Current Status of Renewable Energy Sector in Bangladesh and a Proposed Grid Connected Hybrid Renewable Energy System, *International Journal of Advanced Renewable Energy Research, 1*(11), 2012, 618-627.

[6] Low Carbon Development, 100% Renewable Energy and Poverty Reduction in Bangladesh Study Tour, April 2016, Bangladesh, *World Future Council* [internet], Accessed: 24 March, 2018, Available from: https://www.worldfuturecouncil.org/inc/uploads/2016/04/Bangladesh-RE-strategy_Presentation.pdf.

[7] MdAbul Hasnat, Muhammad Naimul Hasan and Md. Nurul Islam, An Exploration of Solar - Diesel Hybrid Irrigation System in Bangladesh, *Proceedings of the International Conference on Mechanical Engineering and Renewable Energy 2015 (ICMERE2015)*, Chittagong University of Engineering & Technology, Chittagong, Bangladesh, 2015.

[8] Md Ishtiak Ahmed Turzo, Shahedul Islam and Rubel Chandra Das, Prospects of Solar Power and Its Applications in Bangladesh, *Proceedings of the International Conference on Mechanical Engineering and Renewable Energy 2015(ICMERE2015)*, Chittagong University of Engineering & Technology, Chittagong, Bangladesh, 2015.

[9] Energy Crisis and Potential in Bangladesh, Research *gate* [internet], Accessed: 15 April, 2018,

Available from:

https://www.researchgate.net/publication/233359955Energy_Crisis_and_Potential_in_Bangladesh.

[10] Pratik Roy, Rupanker Das and Shahriyar Hossain Topu, Possibilities of Tidal Power in Bangladesh, *International Conference on Mechanical Engineering 2015 (ICME2015)*, Dhaka, Bangladesh, 2015.

[11] Bangladesh and coal, *SourceWatch* [internet], Accessed: 25 March, 2018, Available from: http://www.sourcewatch.org/index.php/Bangladesh_and_coal.

[12] Mawa power station, SourceWatch [internet], Accessed: 31 March, 2018, Available from: http://www.sourcewatch.org/index.php/Mawa_power_station.

[13] Barapukuria Coal Power Plant, *SourceWatch* [internet], Accessed: 26 March, 2018, Available from: http://www.sourcewatch.org/index.php/Barapukuria_Coal_Power_Plant.

[14] Chittagong power station (Orion), *SourceWatch* [internet], Accessed: 27 March, 2018, Available from: http://www.sourcewatch.org/index.php/Chittagong_power_station_(Orion).

[15] Khulna power station (Orion), *SourceWatch* [internet], Accessed: 28 March, 2018, Available from: http://www.sourcewatch.org/index.php/Khulna_power_stati on_(Orion).

[16] Energy & Mineral Resources, www.powerdevision.gov.bd [2] PETROBANGLA, Bangladesh Oil, Gas & Mineral Corporation Ministry Power MPEMR, Ministry of Power, Energy & Mineral Resources, www.powerdevision.gov.bd [2] PETROBANGLA, Bangladesh Oil, Gas & Mineral Corporation.

[17] MPEMR, Ministry of Power, Energy & Mineral Resources, www.powerdevision.gov.bd

[18] PETROBANGL Bangladesh Oil, Gas & Mineral Corporation, www.petrobangla.org.bd.

[19] CES, Centre for Energy Studies, Bangladesh University of Engineering & Technology.

[20] WNA, World Nuclear Association, www.world-nuclear.org.

[21] CNPP, Country Nuclear Power Profile, Bangladesh Resources.

[22] Nuclear power, www.icjt.org.

[23] **“**Nuclear power for Bangladesh**”**, The Daily Star, July28, 2006, Dr. A. Hossain, Ex. Chairman, BAEC.

[24] EPJ, Energy & Power Journal, November 16, 2004.

[25] The New Nation, 28 Jun. 2007.

[26] The Daily Ittafaq, Mar 24, April04, May 08, 10, 2008.

[27] World Energy 2000, www.google.com/world energy2000.htm

[28] https://media.dhakatribune.com/uploads/2017/12/06_News-1st-Edition.jpg

[29] http://www.xinhuanet.com//english/2017-09/13/c_136607232

[30] https://www.sciencedirect.com/science/article/pii/S0360128506000347

[31] https://en.wikipedia.org/wiki/Electricity_sector_in_Bangladesh#Renewable_energy

[32] Faisal Mahmud (20 August 2011). "Experts for microgrids to ease power woes". The Independent. Archived from the original on 24 April 2012. Retrieved 31 March 2008.

[33] M. Rahman, **“**Geothermal potential resources in Thakurgaon district, northern Bangladesh,**”** Bangladesh Journal of Geology, 25:13-30, 2006

[34] Nasrul: Lack in electricity management caused blackout – Dhaka Tribune". dhakatribune.com. Retrieved 21 September 2015.

[35] Md. A. Akbar, **“**An assessment of the geothermal potential of Bangladesh**”**, United Nations University, Geothermal Training Programme, Orkustofnun, Grensasvegur 9, IS-108 Reykjavik, Iceland, Reports 2011, Number 5.