Designing and Optimizing a Hybrid Renewable Power System Using HOMER Software.

A report presented in partial fulfillment of the requirements for the degree of Bachelor of science in Electrical and Electronics Engineering(EEE)

Submitted By

Md.Ruhul Amin Molla
ID No:163-33-3588

Sheikh Estiaque Ahamad

ID No:163-33-3655

Supervised By

Most. Mahzuba Islam
Senior Lecturer
Department of Electrical and Electronic Engineering
Faculty of Engineering

Department of Electrical & Electronics Engineering

Daffodil International University

December 2019

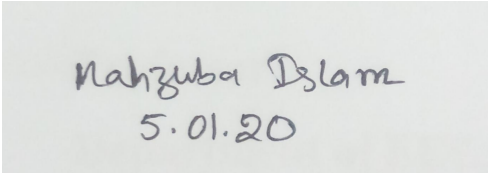
PREFACE

The Thesis Title

Designing and Optimizing a Hybrid Renewable Power System Using Homer Software.

Done Under my supervision, meets acceptable Presentation Standard and can be Submitted by **Md.Ruhul Amin Molla**(ID:163-33-3588) and **Sheikh Estiaque Ahamad** (ID:163-33-3655) has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronics Engineering(EEE) on December,2019.

APPROVAL OF THE SUPERVISOR



Most. Mahzuba Islam

Senior Lecturer

Department of Electrical and Electronic Engineering

Daffodil International University

BOARD OF EXAMINERS

Dr. Engr. **Chairman**

Professor

Department of EEE, DIU

Dr. Engr. --- **Internal Member**

Professor

Department of EEE, DIU

Dr. Engr. --- **Internal Member**

Professor

Department of EEE, DIU

Dedication

Our Parents

ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty Allah for this divine blessing makes us possible to complete this thesis successfully. We feel grateful to and wish our profound our indebtedness to supervisor **Most. Mahzuba Islam,** Senior Lecturer. Department of EEE Daffodil International University, Dhaka. Deep Knowledge & keen interest of your supervisor in the field of Electric power influenced us to carry out this thesis. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervisor, constructive criticism, valuable advice at all stage made it possible to complete this thesis. We would like to thank our entire course mate in Daffodil International University. Who took part in this discuss while compiling the course work. We would like to express our heartiest gratitude to the Assistant Head, Department of EEE, For this kind help to finish our thesis and also to other faculty member and the staff of EEE department of Daffodil International University.

ABSTRACT

As a developing country, Now focused on renewable energy. Especially wind energy because this energy source great potential opportunity in power sector. For decentralized or remote areas, where grid connection is almost not possible, renewable energy generation system coupled with diesel engines can be a reliable and optimized source of energy. Bangladesh has to deal with the increasing demand of electricity. The reduced costs of renewable energy technology and improved efficiency and reliability. The techno-economic analysis of the optimal off-grid system modelling is using HOMER software. There are energy resources are considered. Mainly wind energy beside solar energy and diesel fuel in this study a cost effective small grid power system modelling of wind-solar-diesel hybrid power system in a coastal area of "St Martin's Island". The main focused of this proposed optimized design is to supply the maximum load demand using renewable energy sources with the minimum cost of energy (COE). Global warming is an alarming issue in today's world. So we see reduce the burning of fuel and also reduced the emission of carbon-dioxide. Here HOMER is used to examine the most cost effective configurations among a set of systems for electricity requirement of 754 KWh/day primary load with 168 KW peak load. The COE is $0.29/KWh.

Table of Contents **Page No.**

Chapter 3: Situation of Bangladesh Power Sector

Chapter 4: System Modelling

Chapter 5: Optimization Result of the Mini-Grid Hybrid Power system

Chapter 6: Discussion And Conclusion

LIST OF FIGURE

Figure on. and list Page No.

LIST OF TABLE

LIST OF ABBREVIATION

DG	Diesel Generator
PV	Photovoltaic
WT	Wind Turbine
COE	Cost of Electricity
NPC	Net Present Cost
UNFCC	United Nations Framework Convention on Climate Change
CDM	Clean Development Mechanism
SREDA	Sustainable & Renewable Energy Development Authority
JICA	Japan International Cooperation Agency
SHSs	Scale of solar home systems
TNPC	Total net present cost
O&M	Operations and Maintenance

CHAPTER 1

INTRODUCTION

1.1 Background of study

Bangladesh is a small biggest populated country. Around 170 million people are living in this country. To fulfill the huge amount of people, need huge amount of energy. Energy is one of the most significant essential fixings required to ease destitution and to achieve socio - monetary advancement of a nation. Petroleum product, daylight, air, water source and atomic power plant are the wellsprings of vitality all through the world. Significant vitality source is as yet non-renewable energy source however the hold is declining. Petroleum derivative is being utilized however it produces ozone depleting substances for an Earth-wide temperature boost which is a risk to environmental change and economical improvement. In this circumstance reasonable and secure vitality are the significant concern around the world. Under these conditions there is a change in progress in the vitality area. In our Bangladesh

• Only 59.6% of its 170 million individuals approach power. In country zones, where over 70% of the populace lives, just 42% approach power electricity.

- A minor 6% of the whole populace approaches flammable gas, essentially in urban regions.
- Power supply isn't dependable and top interest can't be met.
- Significant measure of vitality is utilized wastefully.
- Most people in the rural areas depend on kerosene lamps for light.
- 90% of all Bangladeshis cook with biomass, for example, rice straw, dried leaves, jute sticks, cow compost, or wood.

It can be happening due to fall in petroleum product get to, decrease of worldwide outflows relating to moderating environmental change alongside vitality security. Under the changed point of view sustainable power source uncommonly sun oriented board innovation is turning out to be well known effectively noteworthiness in commitment for you to worldwide environmental change alongside carbon exchanging prospect. Joined countries Framework Convention on Climate Change (UNFCC) has stepped up to the plate for Clean Development Mechanism (CDM). To fulfill the extending need for control inside enterprises, transportation and family unit utilize many created nations are really utilizing sun oriented vitality while inexhaustible sources. This it isn't simply meeting the greater region of vitality request however likewise giving critical financial advantage and trying to

"©Daffodil International University"

keep up clean condition. Aside from individual inexhaustible sources at times it is going to never be dependable for consistent power. Lattice associated mixture framework will be progressively possible to convey continuous power. Wind and sun based incorporate the two sustainable sources relating to half and half framework. At the point when a model might be not in activity, different other can contribute. Sustainable power source assets are boundless and yes it will never be finished up. So we need most extreme utilizing those gigantic measures of one's.

Smaller than normal network crossover framework is increasingly mainstream approach to utilize precisely what of sustainable power source. There are a few small scale matrix frameworks in Bangladesh at this point exists. Our examination is basically for smaller than expected framework half and half sun wind energy system [1].

1.2 Introduction of Renewable Hybrid Grid System

1.2.1 Small Grid System

A small grid system, additionally here and there named as a smaller scale network or singled out matrix, is an off-network system that necessities small scale power generation. A smaller scale system is frequently a little scale control lattice which could work freely or cooperatively utilizing other little power matrices. The act of utilizing smaller scale matrices is named conveyed, scattered, decentralized, segment or implanted vitality age.

Small scale matrices are regularly upheld by generators just as inexhaustible breeze and sun oriented board innovation assets and can be utilized to give reinforcement power or supplement the standard power matrix during times of overwhelming interest. A smaller scale lattice strategy that coordinates nearby breeze or sun based assets offers repetition for fundamental administrations and make the rule network less defenseless for you to limited debacle.

Structures pre-stacked with electric age capacities through sun oriented power frameworks and possibility generators could likewise produce vitality and benefits during vacation. By participating notwithstanding keen system organizations, overabundance vitality can be offered time for nearby miniaturized scale networks to make income other than giving versatility and potential to neighborhood electrical lattices.

“©Daffodil International University”

1.2.2 Small Hybrid Grid System

Small grids essentially contain one source. Nearby planetary group is fundamentally utilized as smaller than expected network for the most part. Be that as it may, when at least two sustainable sources are as one, called half breeds small system. This is the most effective path for any inexhaustible hotspots for country charge. Half breed small network system can be sun oriented PV and wind, Solar PV and wind, Solar PV and wind and biomass and wind, sunlight based PV and wind and biomass and furthermore Generator as reinforcement source .

1.3 Types of Hybrid Small-Grid System

There are many types small hybrid system for different purposes.

- Campus Environment/Institutional small grid hybrid system.
- Remote "Off-lattice" Micro-grid hybrid system.
- Army installation Small-grid hybrid system.
- Commercial and Industrial (C&I) Micro-grid hybrid system.
- Community/Utility Micro-grid hybrid system.
- Micro-grid projects hybrid system.
- Necessity and Drivers of small-grid hybrid system.
- small-grid-enabling Technologies hybrid system.

Our investigation is essentially for Remote region 'Off-grid' hybrid system. Our work fundamentally dependent on the area of remote roral arranged in the Cox's Bazar locale at "St. Martin's island".

1.4 Remote “Off-Grid” Micro-Grid Remote hybrid system

These small- grid never get associated with the small grid rather work inside the island mode consistently. Instances of this style of Micro-framework incorporates the off the beaten path zone control system with Alaska or on islands that typically incorporate diesels - or wind age similarly as Nome, Alaska - which may be interconnected and give capacity to the nearby geology. BC Hydro is working endlessly at an undertaking in Bella Coola, British Columbia where an off-matrix small grid is it being created with concerning lessening diesel fuel by methods for coordinating sun based photovoltaic (PV), spread breeze, and additionally run-of-the riv hydro-control. As indicated by Pike Exploration this class speaks to the best number of current organizations off micro grid in any case, zone control frameworks speak to spending amicable normal limit.

“©Daffodil International University”

1.5 Statement of Problem

For small grid hybrid system to limit the expense is the most significant point. For just smaller than usual networks framework some of the time it's hard to help or satisfy all the interest for any rustic power needs. For sun powered scaled down framework Sometimes climate condition very little appropriate for one source subordinate off-matrix framework. At times battery can't be charge well when the light is excessively low or when stormy day .solve the issue Hybrid little off-lattice framework is the most ideal way. For crossover system contains sun powered, wind and furthermore generator as reinforcement system.

There is also some problem that should be minimized. The most important problem is high cost. So our study also shows the cost analysis of the hybrid system mini off grid. For any renewable sources cost is the most important thing.

1.6 Objectives

- To think about present renewable conditions for Bangladesh.
- To design an effective hybrid small off-grid system.
- To think about the HOMER.
- To calculate or optimize the cost form the system.

1.6.1 About HOMER

HOMER Energy LLC is a Boulder, Colorado based organization consolidated in 2009 to market the HOMER® Hybrid Optimization of Multiple Energy Resources (HOMER) model, which was created by the National Renewable Energy Lab, a division of the U.S. Division of Energy. HOMER Energy's essential center is the proceeding with advancement, appropriation, and backing of HOMER.

This HOMER Energy standards are working with financial notwithstanding building streamlining of Micro-lattice planned for more than 2 decades. HOMER Energy's workforce remembers the financial specialist for expansion to build who initially planned the HOMER programming however at NREL, along having proficient administrators, investigators alongside business experts with reasonable information in innovative endeavors, electric power frameworks, and inexhaustible quality. Our aggregate vision is for the most part to engage individuals worldwide with instruments, administrations, and data as an approach to quicken the selection associated with inexhaustible and conveyed quality sources.

"©Daffodil International University"

1.6.2 Simulation

Simulation HOMER reenacts your activity of a framework by essentially making vitality balance figuring's for all of the 8,760 hours in a very year. For every hour, HOMER looks at the power and warm burden inside hour to the vitality that this framework can supply in this hour. For frameworks which incorporate batteries or fuel-controlled age gadgets, HOMER additionally chooses for every single hour how to function the generators and regardless of whether to charge or take out the batteries.

1.6.3 Optimization

In the wake of re-enacting every one of the conceivable framework arrangements, HOMER shows a catalog of possible system, arranged by just life cycle cost. We can without much of a stretch acquire the least cost framework presents itself the rundown, or you can examine the rundown relating to other achievable system.

1.7 Outline of the Study

Our study basically shows the cost optimization for hybrid smaller off grid system. Planning an appropriate half and half smaller than expected off-network framework is likewise a piece of this investigation. Cost streamlining is fundamentally the most significant part for any undertakings. Everything relies upon it. Now and again venture achievement relies upon the expense. So our examination contains a full half and half framework model by utilizing HOMER programming and furthermore the cost investigation for this system.

Keywords: Hybrid System, HOMER, Renewable Energy Sources, LCOE, Net Present cost, Renewable Fraction, Capacity shortage .

"©Daffodil International University"

CHAPTER 2

LITERATURE REVIEWS

2.1 Introduction

This paper presented comparative analysis between off grid and a grid connected Hybrid grid system. Grid connect hybrid system is more efficient and economic compared to the traditional Hybrid system. In the same load. As its outcome present expense of the proposed model is not exactly off matrix model. Albeit off framework model needs extra-huge battery bank [2]. It isn't attainable to utilize just diesel as a wellspring of vitality age these days. Cross breed vitality framework can be doable and enhanced arrangement in such manner (PV- Diesel- Wind- Battery Hybrid) [3]. The most extreme breeze control relies on enormously on the breeze speed. Again the speed is extraordinarily relying on the decide site area [4]. Result found by ABC calculation have been contrasted and results gotten by programming apparatus HOMER and PSO.

The proposed calculation demonstrated better outcomes when contrasted with HOMER and PSO [5]. Variable size of PV cluster, no. of Wind turbine, AC-DC Converter. They require least affable development, little supply and considering all condition factor [6]. The successful exertion keeping up the power supply dependability of sustainable power sources identified with the mix of numerous power plants in various vitality sources, to be specific is mixture control framework [7]. The ascent of vitality requests is expanding the reliance on sustainable power sources. It will likewise diminish the weight on the national lattice. Decreases the outflow of gases and sensible COE [8]. Specialized design and business investigation instance of a half and half small network framework for a remote non-zap town are considered [9]. Inexhaustible assets hydro-control, sun powered PV, wind, bio-diesel generator the paper distinguishes the ideal off-matrix alternative and contrasts this and ordinary framework augmentation. A half breed blend of sustainable power source at off network area can be practical and feasible, techno-monetarily reasonable and naturally solid [10]. Various sorts of improvement methods utilized in PV-Wind based cross breed vitality framework. The crossover streamlining procedures are discovered best than single enhancement techniques [11]. PV, Wind turbine, Diesel generator with battery and inverter

“©Daffodil International University”

framework is likewise an awesome elective arrangement having minimal greater expense of power and net present expense. COE is higher than the cost System power yet condition assurance [12]. Sustainable power source is better vitalitysource for cost decrease [13]. The Main spotlight on network and remain solitary mode activity of miniaturized scale lattice. The model built up some assortment of burden those all associated with the matrix through bidirectional converters to keep up the solid and stable framework under consistent burdens considered [14]. This paper study regular and non-ordinary vitality asset for off network framework. Power age because of the great day by day normal sun oriented radiation which changes however diesel cost is practically same.

The diesel age just circumstance would diminish the working hours [15]. Bangladesh has incredible chance of wind vitality at Various Location. This vitality source will be the most practical wellspring of electrical power sooner rather than later. Bangladesh is searching for sustainable power sources to join the all out power request in nation. Enormous measure of wind vitality in beach front line of 574km in Bangladesh. By 2020, potential to deliver control over 10% of the absolute power request from sustainable power sources [16].

2.2 Mini-Grid of Hybrid power system

The Hybrid power are combination between various advancements to create control. It contributes various kinds of vitality sources, some PV sources, Wind sources, Diesel sources and Battery framework for reinforcement, converter. PV, Wind, Diesel Generator, Battery and Converter framework is powerful elective arrangement than having minimal greater expense of power. This framework enhancement investigation of cost and Environment impact.

2.3 Summary

Day by day increase of electricity demand. That need to do scan of elective asset for produce in electricity. Likewise, Hybrid power arrangement of smaller than normal matrix is vehicle for power produced. Hybrid control framework rely upon customary and non-ordinary vitality sources. Mini-grid half and half power system investigation between an off lattice and on lattice system. Off grid hybrid power system structure for remote area since framework associated isn't possible. Day by day, Renewable vitality based power plant will have increased. Bangladesh has extraordinary chance of Solar Radiation, Wind Energy and Biogas etc. She has 724 km long coastline along the delightful sound of Bengal. This zone we can get huge measure of wind vitality. Close planetary system, Wind Turbine system, Diesel Generator system and Battery System matrix step by step increased. Renewable based power contributing in Grid system. That being decline ordinary based power delivered.

“©Daffodil International University”

CHAPTER 3

SITUATION OF BANGLADESH POWER SECTOR

3.1 Situation of Bangladesh Power Sector

Bangladesh is a small Developing country - economically and socially in March, 2018. Bangladesh has achieved all the three conditions which were needed to be a developing country. Bangladesh is most thickly populated countries in light of its 170 Million individuals in a land mass of 147570 km. In 1971, only 3% of Bangladesh populace approached power. Today has increment of number of populace for this expands request of power.

Power Generation in the Country by 2017-15,351MW

Electricity Generation in the Country by 2018-20,000MW

Power is the significant wellspring of intensity for the vast majority of the nation's monetary exercises. Bangladesh's all out introduced power age limit (counting hostage control) was 20,000 megawatts (MW) as of 2018[17]. As 2015, 92% urban populace and 67% rustic populace have the entrance to the power for their wellspring of light. A normal of 77.9% of the populace have the entrance to power in Bangladesh [18]. Bangladesh will require an expected 34,000 MW of intensity by 2030 to continue its monetary development of more than 7 percent [19]. Bangladesh has intended to create 5% of absolute power generator By 2015& 10% by 2020 from Renewable vitality Sources like air, squander and sun powered vitality. When all is said in done, fast industrialization and urbanization has pushed the expansion sought after for vitality by 10% every year. What further worsens Bangladesh's vitality issues is the reality the nation's capacity age plants are dated and may should be closed down as soon as possible. There was unmistakably no institutional system with respect to sustainable power source before '08; in this manner the inexhaustible essentialness strategy was received from the administration. As indicated by the specific approach an organization, Sustainable and Renewable Energy Development Authority (SREDA), was being built up as a middle point for the advancement and furthermore improvement of manageable essentialness, examination of inexhaustible imperativeness, vitality proficiency and essentialness protection. Foundation of SREDA stays under procedure. Power division is consistently to encourage the

“©Daffodil International University”

advancement with respect to sustainable power source until SREDA will be shaped. The last year or tow, numerous achievement created stories inside the Power Sector in Bangladesh. However, the street that is arranged ahead is dabbed together with countless difficulties that be a result of the holes that are available between what's arranged versus what the vitality division has been equipped for convey. There is without a doubt that the interest in regards to power is expanding quickly with all the improvement of living normal, increment of agrarian creation, progress of enterprises alongside by and large advancement of the US.

3.2 Present Structure of power sector

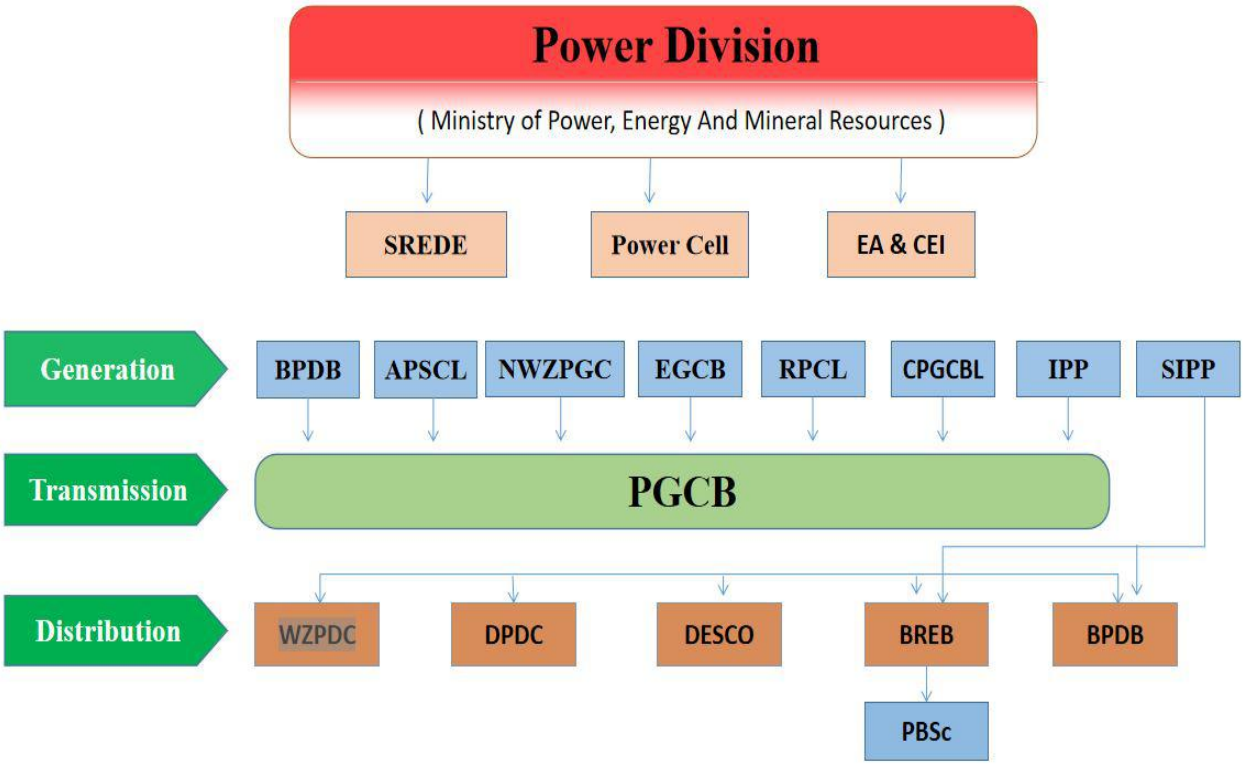


Figure 3.1: Structure of Power Sector.

- **Top Institution**

  Power Division, Ministry of Power, Energy Mineral Resources(MPEMR)

- **Generation**

  Bangladesh Power Development Board (BPDB)

  Ashuganj Power Station Company Ltd. (APSCL)

  Electricity Generation Company of Bangladesh

"©Daffodil International University"

(EGCB)

North West Power Generation Company Ltd. (NWPGCL) .

Independent Power Producers (IPPs).

- **Transmission**

  Power Grid Company of Bangladesh (PGCB).

- **Distribution**

  Bangladesh Power Development Board (BPDB)

  Dhaka Power Distribution Company (DPDC)

  Dhaka Electric Supply Company Ltd. (DESCO)

  West Zone Power Distribution Company

  (WZPDC)

  Rural Electrification Board (REB) through Rural Co-operatives.

3.3 Energy Sector

In 2019, Bangladesh has installed capacity in 21,419MW. Portion of government financing 56% and Share of Private financing 46%. Electricity inclusion 95% [20]. Bangladesh has gigantic the plausibility of intensity part in delivered electricity. Energy division relies upon a nation of improvement. Bangladesh government has proposed 100% power reach in people. Now, power reach in 95% of people. This division has contributed in private segment and government sector. Private segment are immense measure of power delivered blend regular and non-customary vitality.

3.3.1 Natural Gas

As in 2015, 79 petroleum gas wells are available in the 23 operational gas fields which produce more than 2700 a huge number of cubic feet of gas every day (MMCFD). It is well shy of more than 2500 MMCFD that is requested, a number which is developing by around 7 % every year. Truth be told, more than seventy-five percent of the country's business vitality request is being met by gaseous petrol. This compelling area caters for around 40% of the power plant feed-stock, 17% of enterprises, 15% hostage control, 11% for residential and family utilization, another 11% for manures, 5% in compacted petroleum gas (CNG) exercises and 1% for business and rural employments.

In Bangladesh, Natural gas is utilized as essential vitality in a large portion of the current power plants. Presently 88% of all out power is delivered from gas-based power plants. Adjacent to, gas a

limited quantity of power is delivered utilizing diesel, heater oil and coal.

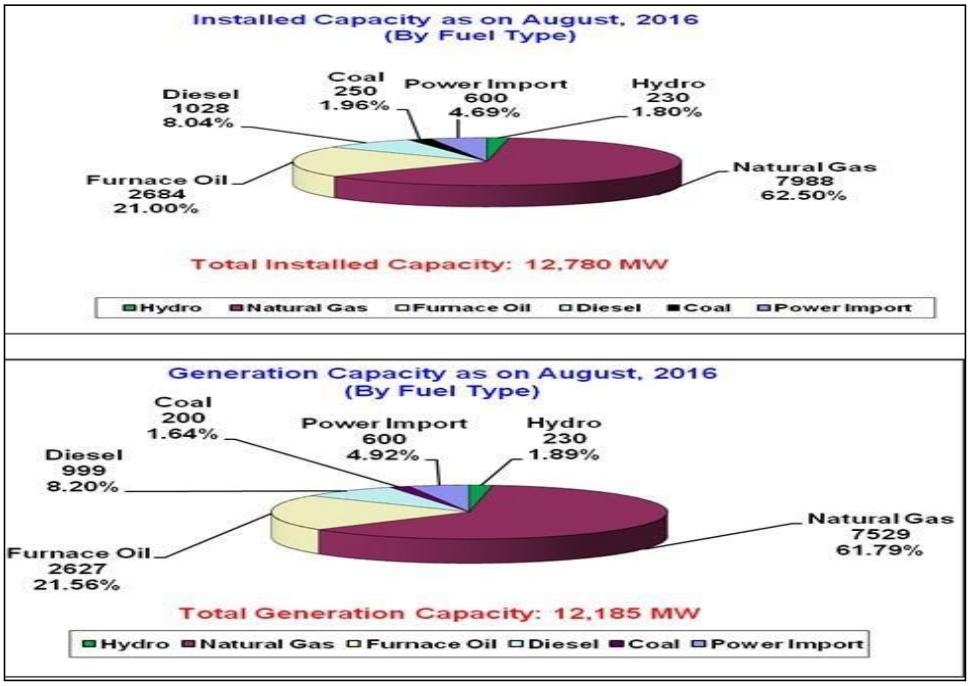
3.3.2 Coal

Natural gas is the main source of produce of energy. But it's going to run out day by day.So locate the elective way. There are arrangements of potential sustainable power source assets like the sun based, wind, tidal and so forth, however the activities are exceptionally moderate. Coal saves and their possibilities couldn't guarantee the country as there are demonstrated coal stores of around 4,750 Mt (identical to 975 GM3 of gas, which is around multiple times more noteworthy than the present gas hold in Bangladesh). Bangladesh has coal terminated power station in Matarbari, Cox's Bazar, Chittagong. It is Proposed 12,00MW coal Fired Power Station. Presently Proposed Coal terminated based power station in Rampal Power station. Its vitality Produce to 1320MW [21].

3.3.3 Oil

Oil is the Second means to vitality created. Bangladesh has limited quantity of oil Reserve. Bangladesh has found oil in two old gas fields in the nation's northeastern district with an extractable hold worth $5.5 billion, the director of state-claimed Petro Bangla said [22].

Figure 3.2: Energy Generation by Fuel (%).



"©Daffodil International University"

3.4 Master Plant of Power Sector in Bangladesh

The government is formulating the Power System Master Plan (PSMP) - 2016 with the year 2041 as a primary concern where the interest of intensity will have shot up to over 57,000MW. Out of that imagined sum, around 35 % would be created from gas just as from coal and the staying 30% from territorial network, sustainable and atomic vitality, as chalked out in the PSMP. The gathering of the directing council to finalist the PSMP-2016 was sorted out by the Power Division on Saturday at Bidyut Bhaban.

Japan International Cooperation Agency (JICA) which is helping the Power Division to define the PSMP displayed the arrangement before the partner. In the PSMP, JICA broadly centers around vitality balance, control parity and duty techniques following Bangladesh's desire to turn into a high-pay nation.

JICA likewise put its accentuation on future need of intensity, fuel, transmission of created control and proficient use, creating capable HR, method of sustainable power source generation and financing by 2041 for the segment [23]. Under this arrangement, the coal (indigenous or imported), control exchange from India, the constrained gas, atomic power will be utilized for the base burden control plant, and LNG will be utilized to supplement the gas deficiency. Constrained gas, fluid fuel and LNG will be utilized for the pinnacle load control plant. The legislature has likewise taken productivity improvement program for decrease of the developing force request.

She said an objective has been set to raise the power age from sustainable power source to 5 percent by 2021 and to 10 percent from sustainable power source out of the general power age according to the Renewable Energy Policy. "To realist this objective, an arrangement has been taken to create somewhere in the range of 3,100 MW of intensity by 2021 dependent on sustainable power source. "The framework misfortune in influence dispersion has now been decreased to 10.96 percent which was 15.67 percent before.

She said an objective has been set to raise the power age from sustainable power source to 5 percent by 2021 and to 10 percent from sustainable power source out of the general power age according to the Renewable Energy Policy. "To realist this objective, an arrangement has been taken to produce approximately 3,100 MW of intensity by 2021 dependent on sustainable power source. "The framework misfortune in influence appropriation has now been diminished to 10.96 percent which was 15.67 percent previously".

“©Daffodil International University”

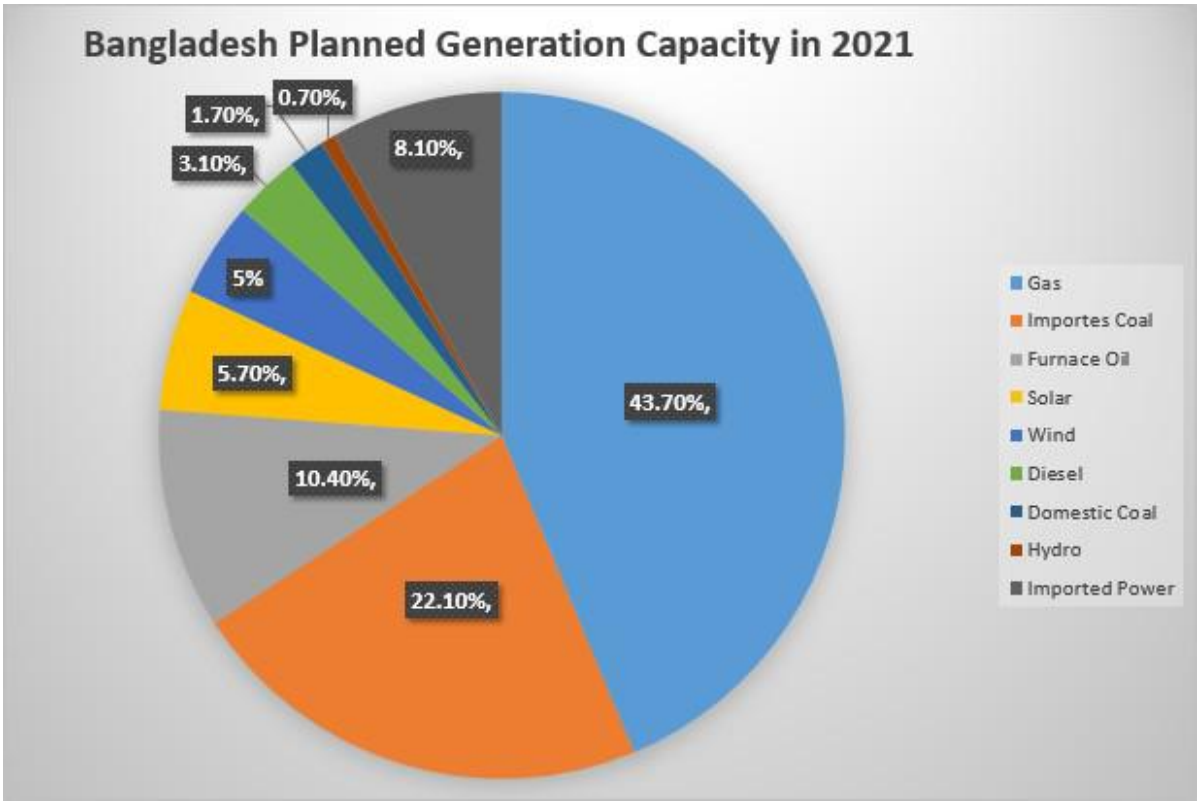


Figure 3.3: Bangladesh Planned Generation Capacity in 2021.

Until Now, gas based power age is a lot higher contrasted with different fills like hydro, Coal, Gas supply is the significant requirement for gas based power age ventures.

3.5 Renewable Energy

Renewable Energy likes Solar, Wind, Tidal, Hydroelectric Hydroelectric vitality, geothermal power, Biomass. This kind of vitality to create electric vitality and decrease to Environment Effect. Along these lines, it is better alternative produce to electricity.Bangladesh enormous capability of Renewable Energy.

3.5.1 Solar Energy

Bangladesh has big opportunity to produce electricity of solar energy. NGOs and Private Organizations actualizing sun oriented vitality program. There is a solid potential for sun oriented vitality inside the nation. An enormous - Scale of sunlight based home frameworks (SHSs) is execute. Sun based photovoltaic (PV) frameworks are being used all through the nation with over 2.9 million family level establishments having a limit of 122.2 MW (April 2014) [24].

"©Daffodil International University"

3.5.2 Wind Energy

There is a solid Potential for Wind Energy on the grounds that has 724km long coast line and numerous little islands in the Bay of Bengal. Bangladesh has two Wind Turbine Generation Power division. 1.9MW Wind Power in Feni and Kutubdia . The Power bends of wind turbines with two distinctive introduced limits from two unique makers have been utilized to ascertain vitality age. The assessed yearly vitality yields for Kutubdia and Kuakata are 133 MWh and 160 MWh for a 150 KW wind turbine; while the yields are around 200 MWh and 230 MWh separately from a 250 KW station at these spots [25].

3.5.3 Bio Energy

Biomass is natural material coming about because of living, or as of late found living beings. It regularly implies plants or plant-determined materials which may be explicitly called lignocellulose biomass. For vitality source, biomass can either twofold straightforwardly by means of burning to give heat, or in a roundabout way in the wake of redesigning it to different sorts of bio-fuel. Transformation of biomass to bio-fuel can be accomplished by various strategies which may be extensively arranged into: ice, substance, and biochemical methodologies. Wood remains the biggest biomass vitality source today; models incorporate backwoods deposits - like dead trees, branches notwithstanding tree stumps - , property clippings, wood chips and now and again civil strong waste. From the subsequent sense, biomass incorporates plant or creature matter which may be changed over into filaments or perhaps other mechanical synthetics, just as bio-energizes. Modern biomass is normally developed from various sorts of plants, including miscanthus, switch grass, hemp, hammer toe, poplar, willow, sorghum, sugarcane, bamboo bedding and sheets, and an assortment associated with tree species, running by eucalyptus to oil side (palm oil) [36]. Bangladesh has immense capability of account vitality. Bio vitality can deliver 37m3 of simply one ton of manure. Bangladesh make 400MW power to Rice husk.

3.6 Summary

Bangladesh vitality produce to different kinds of fuel, Renewable vitality source. Power increment reliance on sustainable power source. In light of regular vitality step by step getting lost. Now, has many working of mega projects. Such as, Ruppur Neuclear plant, Matarbari coal plant, Rampal coal plant and so on. This undertaking to gigantic measure of power delivered. Our interest of power satisfy in this project. So, Bangladesh are no most unfortunate nation. Presently Bangladesh is creating nation in this world.

“©Daffodil International University”

CHAPTER 4

SYSTEM MODELLIMG

4.1 HOMER Software

4.1.1 Methodology

It is an instrument for displaying and streamlining framework for sustainable and non-sustainable power source of both off lattice and a matrix associated control framework for assortment of utilization. HOMER is decrease the examination issue and structure of small scale framework, emerging because of number of plan choice. This product includes likewise all costs, for example, the underlying capital and support costs including contamination punishments. HOMER performs to guarantee the most ideal coordinating among supply and configuration so as to plan the enhancement framework. It reproduces the vitality balance figuring's for every one of the 8760 hours in a year. After reenactment, the entirety of the conceivable framework arrangements, shows HOMER that can be utilized to look at framework structure choice**.**

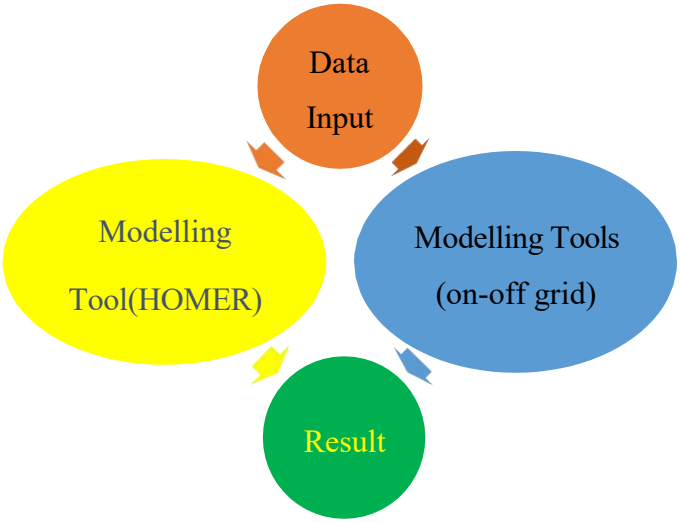


Figure 4.1:Optimization process of HOMER Software.

"©Daffodil International University"

4.1.2 Optimization Process

Attainably structured with respect to economy, dependability and biological estimates the subject of different operational and physical developments on the area. The general goal is for the most part to recognize a miniaturized scale network design that is low TNPC (all out net present expense). For that, diverse framework designs notwithstanding specialized limitations are reenacted. This Forms Various Combining of framework parts whereupon the specialist has control to choose. At long last, rundown of arrangement is sifted through notwithstanding analyzed.

4.2 System Configuration

In a very remote rural village the demand for electricity is just not high compared to urban areas. Power is requested relating to local utilize like Celling Supporter, Light, Fridge and TV. At evening time hours, the power utilization to the private unit tags along where just fundamental voter mechanical apparatuses are devouring electrical power.

The heap request decline during Morning hours when everyone leaves relating to schools, administration or Preparing nourishment. All through the early afternoon quite a while, the heap request amounts are least as practically the entirety of the relatives are outside the house.

Once more, during the night hours when all the relatives are available, the power utilization ascends as anybody turns on different Weight apparatuses. The normal vitality use of electrical apparatuses of the private unit is assumed (754 kWh/day). The Peak Load is 168KW.

For this theory we have taken of st. martin's island is Tourist Spots. Here most extreme individuals are Service man. So most extreme individuals work throughout the day. So this locale is Electricity Consume a Small Amount.

This district 500 Households,150 Hotelroom,10 Shop,a school,a Mosque and a shared trait wellbeing focus has been considered. This heap depends on 3 vitality efficient lamps(15W each) , for summer we considered 2 fans(40W each) and Winter we considered 1 fan(40W), 1 Fridge(200W), 1 Computer (200W) and 1 TV (40W) for every family. Yearly Peak load 168KW and Primary burden to 754KWh/day.

“©Daffodil International University”

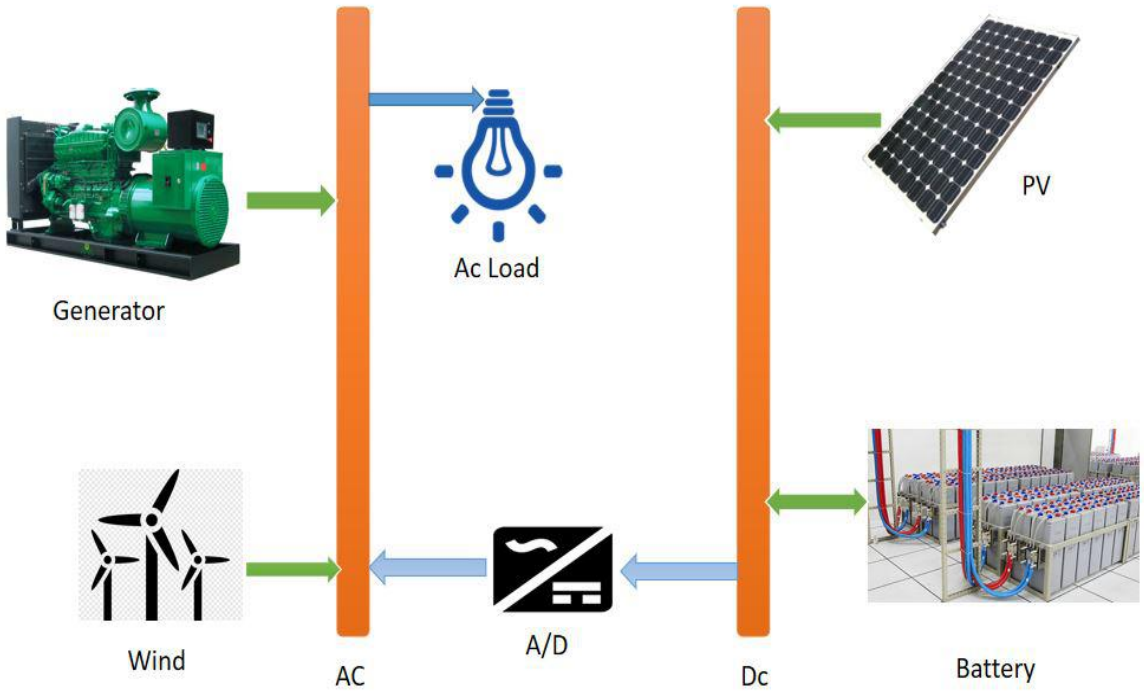


Figure 4.2: System configuration.

4.3 Hybrid Energy System

Standard energy systems for Nowadays position. Hybrid energy system depend on renewable energy source. This framework are most impact in vitality area as a result of it is associated in matrix associated and off network associated. This system is off lattice associated framework. Lattice associated system has advantage additional vitality given in network. So system is successful our vitality area. Among the sustainable power sources, sun oriented and wind vitality have been used with diesel motor in this study. Energy request is DC Load. Most extreme source associated in DC transport and Load is DC. The half and half age framework comprises of an electrical burden, sustainable power sources and other framework segments, for example, PV, wind turbines, battery. Diesel Generator and converter. Fig.4.3 shows the crossover vitality system.

"©Daffodil International University"

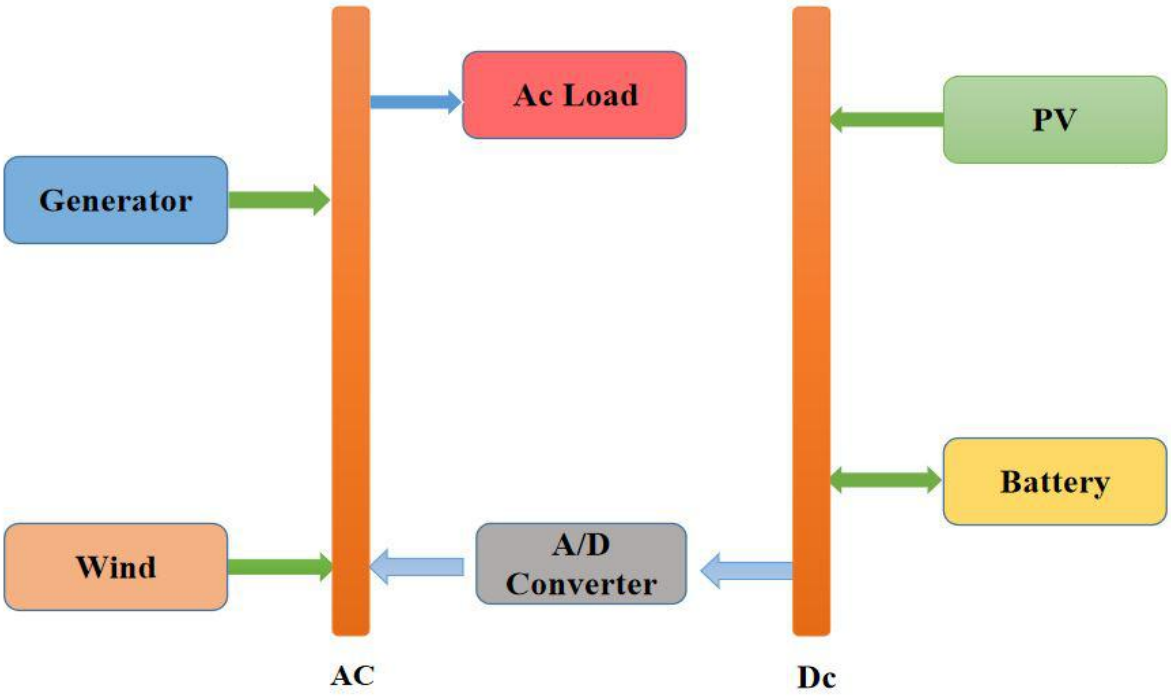


Figure 4.3: Hybrid Energy System.

4.4 Economic Input Analysis

A Mini-Grid system are very important part system fixed capital cost and system fixed Operation and Maintenance cost. This expense is input give in HOMER Software. A Small-Grid arrangement of fixed capital expense are Land, Infrastrucer and related structure, Distribution hardware and materials cost and so forth. What's more, system fixed activity and maintenance cost are pay. Considered 36 area for this half and half matrix control system. A little framework are produce power. This power conveyance thinks about region in 500 families ,150 Hotel room, 10 Shops, a School, a Mosque and a Health Community Center. Electricity dissemination included material are wire, poles, circuit breaker, energy meter, multipole breaker and work salary. So, all out system fixed capital expense are $150,000 considered in this Location and framework fixed O&M cost is $12000 for pa

“©Daffodil International University”

4.6 Hybrid Power System Components

The Hybrid generation system blend PV boards, Wind turbines, Diesel generator, Batteries and Converters.

4.5.1 Solar Photovoltaic

The cost of PV module including in Capital cost and Replacement cost, O&M cost have to be provided to the software for the simulation and Modeling purpose. This PV module life time has 25 years. Here 1 kw to 190 kw PV modules are Considered .[31]

Table 4.1: Solar Panel Specification.

Parameter	Unit	Value
Capital cost	1 KW	$ 350
Replacement cost	1 KW	$ 310
O&M cost	1KW/yr	$ 5
Tracking System	No tracking system	0.05
Life time	Years	25

4.5.2 Diesel Generators

Diesel generator cost depends on its Size. Here has been 100 kw used in diesel generator. Because of our system peak is 224 kw. For this system a slope and the intercept are 0.25 L/hr/KW and 0.08 L/hr/KW respectively. [32]

"©Daffodil International University"

Table 4.2: Diesel generator Specification.

Parameter	Unit	Value
Capital cost	100 KW	$ 15,000
Replacement cost	100 KW	$ 15,000
Operational Life time	Hours	15000
Minimum load ratio	Percent	30
Fuel curve intercent	100/h/kw rated	2.8
Fuel curve slope	100/h/kw output	0.253
Fuel price	US $	0.67

Diesel fuel price =O.67 [Where $1= 85tk] [28]

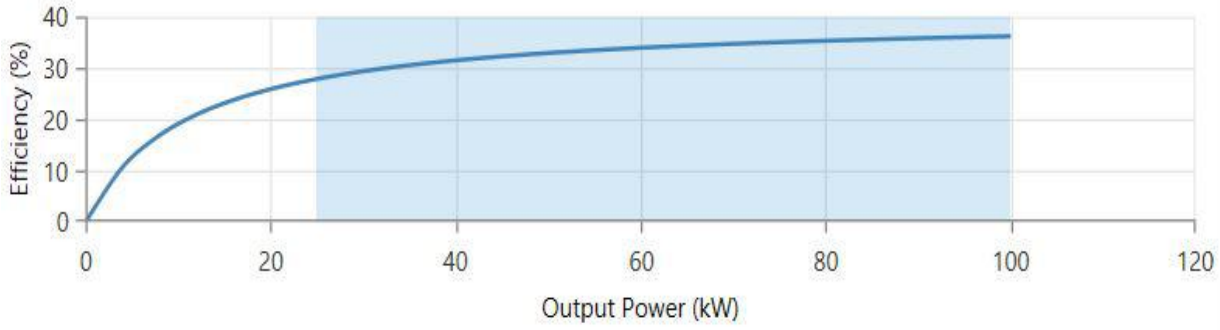


Figure 4.4: Efficiency curve of 100KW diesel generator.

4.5.3 Wind Turbine

Wind Turbine cost depends on Wind Height and model For the Hybrid system Generic 3KW Wind Turbine can be Considered. Conventional 3KW breeze turbine beginning breeze speed is 3m/s in this investigation. Appraised DC voltage 24/48V. Evaluated wind Speed 12.5m/s. Demonstrated Table 5.1.3 has specialized parameters and cost presumption[33].

"©Daffodil International University"

Table 4.3: Wind Turbine Specification

Parameter	Unit	Value
Rated Power	KW	3
Starting Wind Speed	m/s	3
Rated Wind Speed	m/s	12.5
Security wind Speed	m/s	40
Capital cost	3 KW	$ 2,865
Replacement cost	3 KW	$ 2,500
O&M cost	$/ year	$ 50
Life time	Years	20

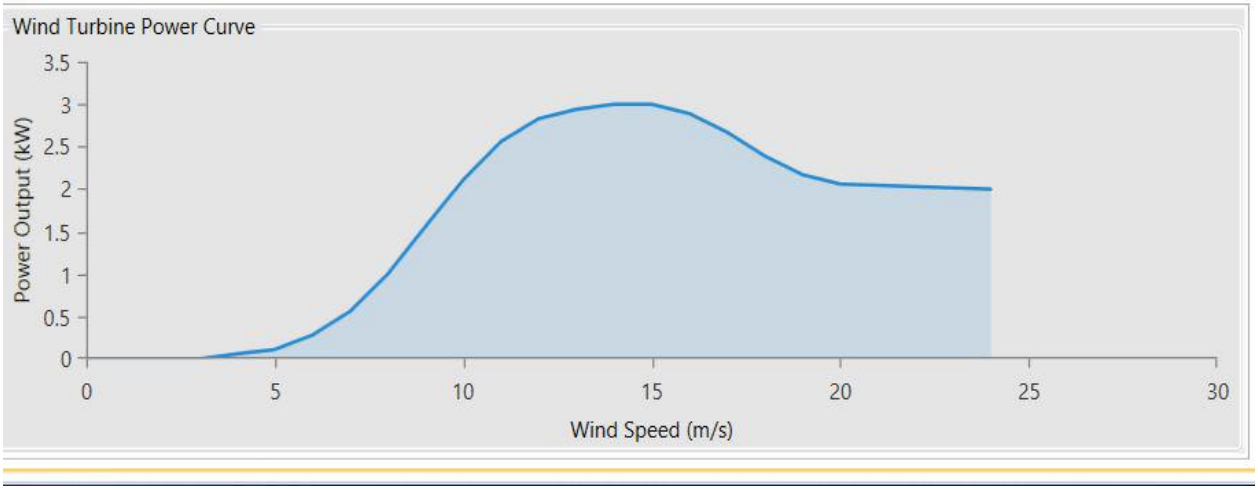


Figure 4.5: Power curve of Generic 3KW Wind Turbine.

4.5.4 Battery

The Hybrid system are considered in The Globatt ACE NX120-7 stockpiling batteries. This Battery Available in Bangladesh. Batteries System associated in Hybrid power system for reinforcement system. Considered batteries are ostensible voltage 12V and ostensible Capacity 83.4Ah. [33]

"©Daffodil International University"

Figure 4.6: Specification Globatt ACE NX120-7 Battery.

Table 4.4: Specification of Globatt ACE NX120-7 of Battery.

Parameter	Unit	Value
Nominal Voltage	Volt	12
Nominal Capacity	KWh	1
Maximum Charge Current	A	16.7
Round Trip Efficiency	Percent	80
Capital cost	1 KWh	$ 160
Replacement cost	1 KWh	$ 160
O&M cost	1 KWh/yr	$ 10
Maximum capacity	Ah	83.4

4.5.5 Power Converter

Here in this system connected in AC Load. As the electricity generated from the PV or Battery turbine is DC. DC current into AC current used it Inverter. When AC current into DC current used it Rectifier Converter.Considered Converter Range 1KW to 69.7KW. Shown Table 5.5 the technical and Economical parameters of the Converter [35].

"©Daffodil International University"

Table 4.5: Specification of Converter

Parameter	Unit	Value
Capital cost	1 KW	$ 180
Replacement cost	1 KW	$ 180
Life time	Years	15
Efficiency	Percent	95
Rectifier capacity	Percent	100
Rectifier Efficiency	Percent	95
O & M	1 KW	$ 5

4.6 Summary

In this Chapter is about specification of hybrid grid power system. Hybrid power grid system to do build up prerequisite different sorts of equipment. Now, that hardware subtleties costs is discourse. My ideal worth use to do looking through different site. Here satisfactory worth is use. Sun oriented panel,Wind turbine, Diesel Generator, Battery and Converter are particular in talk about.

“©Daffodil International University”

CHAPTER 5

RESULT AND DISCUSSION

5.1 Study of St. Martin's island Area

St. Martin's is a little island Located south of the port city of Coax's Bazar, Chittagong , Bangladesh. It is the main island in Bangladesh which has coral reef.

Island lying 10 km south of the southern tip of Teknaf landmass in the Cox's Bazar District (20°36'N; 92°20'E). There is a little connecting island that is isolated at elevated tide, called Chera Dwip. The island makes up the Saint Martin's Union Parishad. It has 9 towns/territories and 4,000 people groups live in this St. Martin island. From 1989 to 2004, non-private Bangladeshis and outsiders were the main individuals allowed on the island, However, this has changed and now private Bangladesh are permitted.

St. Martin's Island has become a place of interest, and 5 transportation liners run every day excursions to the island. It's conceivable to stroll around the island in a day since it gauges just 8 km2 (3 sq. mile), contracting to about 5 km2 (2 sq. mi) during high tide. The island exists simply because of its coral base, so expulsion of that coral dangers disintegration of the sea shore. Along these lines, St. Martin's has lost generally 25% of its coral reef in the previous seven years. [26].

"©Daffodil International University"

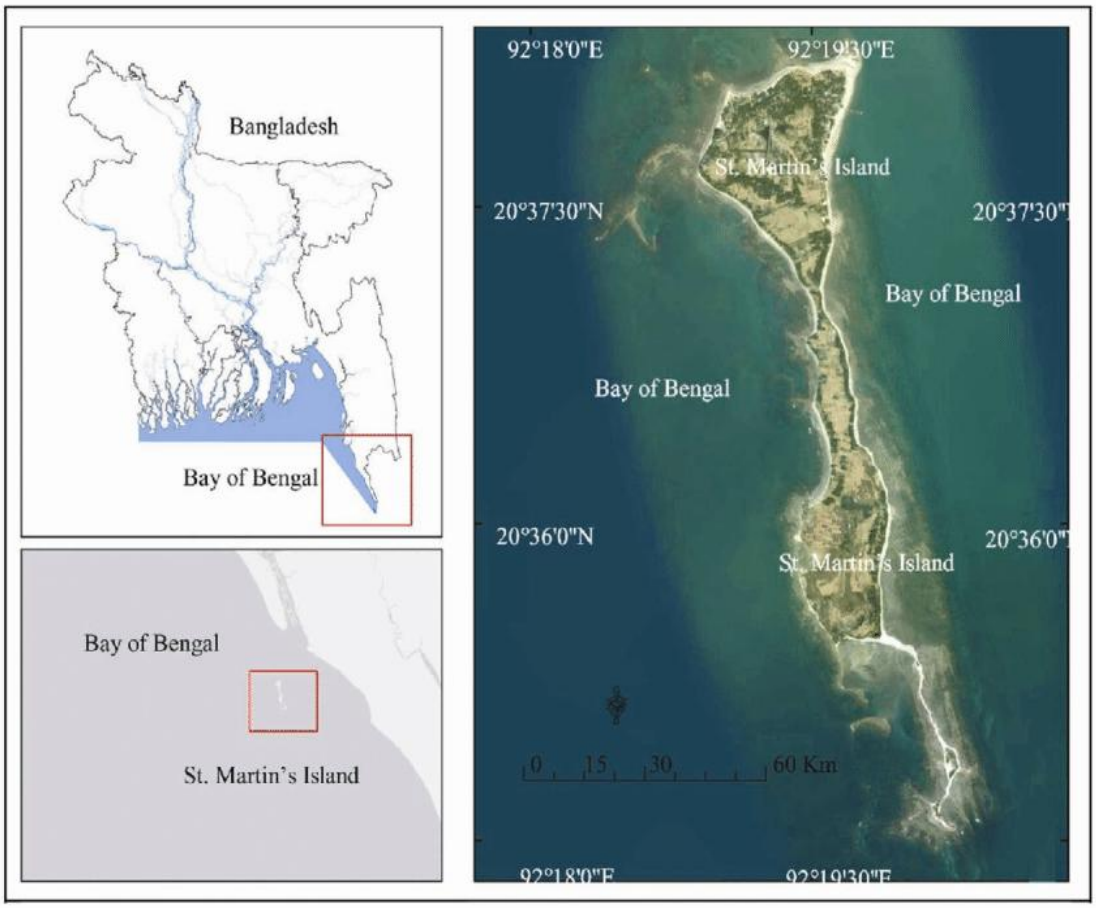


Figure 5.1: St. Martin's Island.

5.2 Load Assessment Profile

5.2.1 Summer Season Load Profile (March–October)

At maximum energy utilization is summer regular since that time use is two celling fan, two light, one computer , one ice chest and one TV. Utilizing by here most extreme vitality utilization of Celling Fan . The mid year top heap of the framework with 500 family unit, lodging 150, a school, a mosque, Community health centre focus considered and every day vitality request around 754 kWh/day.

Here,

Electricity Demand for Each Family

Three Light =15W

Two Celling Fan = 40W

One Television=40W

Fridge = 200W

"©Daffodil International University"

On =1 , off=0

Time Duration	Light(15W)	Fan(40W)	TV(20W)	PC(200W)	Fridge(200W)	KW
0-1	0	1	0	0	1	38
1-2	0	1	0	0	1	38
2-3	0	1	0	0	1	38
3-4	0	1	0	0	1	39
4-5	1	1	0	0	1	45.3
5-6	0	1	0	0	1	40
6-7	0	1	1	0	1	20
7-8	0	1	1	0	1	20
8-9	0	1	0	0	1	40
9-10	0	1	1	0	1	46
10-11	0	1	1	1	1	38.85
11-12	0	1	0	1	1	20.8
12-13	0	1	0	1	1	20.8
13-14	1	1	0	0	1	40.61
14-15	0	1	1	0	1	46.4
15-16	0	1	1	1	1	46.8
16-17	0	1	1	1	1	26.73
17-18	0	1	1	0	1	20
18-19	1	1	0	0	1	39.06
19-20	1	1	1	0	1	44.9
20-21	1	1	1	0	1	45.06
21-22	1	1	1	0	1	40.5
22-23	1	1	1	0	1	40
23-24	0	1	1	0	1	38
	6 hr	24hr	13 hr	5 hr	24 hr	872.81

Table 5.1: Summer Load (March-October).

"©Daffodil International University"

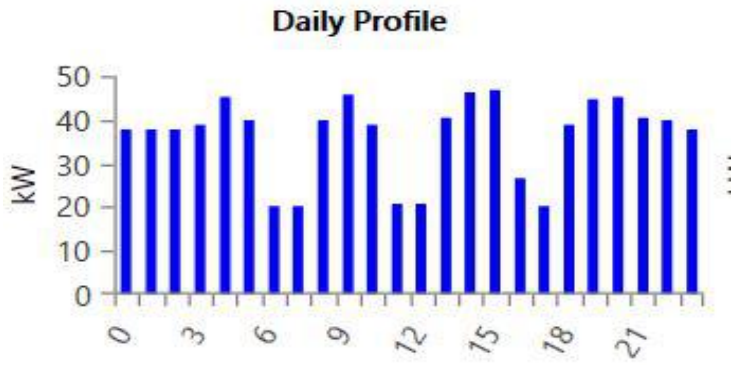


Figure 5.2: Summer Load Profile.

5.2.2 Winter Load Profile (November-February)

The winter power energy take half of the summer energy consumption due to use of one ceiling fan. The winter load has took half of the summer load due to absence of one ceiling fan not in operation. The winter peak load for consider of the system with 500 household,150 hotel room, 1 school, a health center, a Mosque considered and daily energy consumption as 754kWh/day.

Table 5.2: The winter load (November-February).

Duration	Light(15W)	Fan(40W)	TV(20W)	PC(200W)	Fridge(200W)	(Watt*80)/1000
0-1	1	0	0	0	1	10
1-2	1	0	0	0	1	10
2-3	1	0	0	0	1	10
3-4	1	0	0	0	1	10
4-5	1	0	0	0	1	10
5-6	1	0	0	0	1	20
6-7	1	0	0	0	1	18
7-8	1	0	0	0	1	19
8-9	1	0	0	0	1	20
9-10	0	0	1	0	1	26
10-11	0	1	1	1	1	26.61
11-12	0	0	1	1	1	26.56

"©Daffodil International University"

12-13	0	0	0	1	1	20.4
13-14	0	1	1	1	1	20.4
14-15	0	1	0	1	1	20.285
15-16	0	0	1	1	1	20.54
16-17	0	0	1	1	1	20.4
17-18	0	0	0	0	1	30.56
18-19	1	0	1	0	1	36.56
19-20	1	0	1	0	1	36.56
20-21	1	0	1	0	1	32.4
21-22	1	1	1	0	1	25.3
22-23	0	1	1	0	1	21.2
23-24	0	1	1	0	1	20
	13hr	6hr	12hr	7hr	24hr	510.775KW

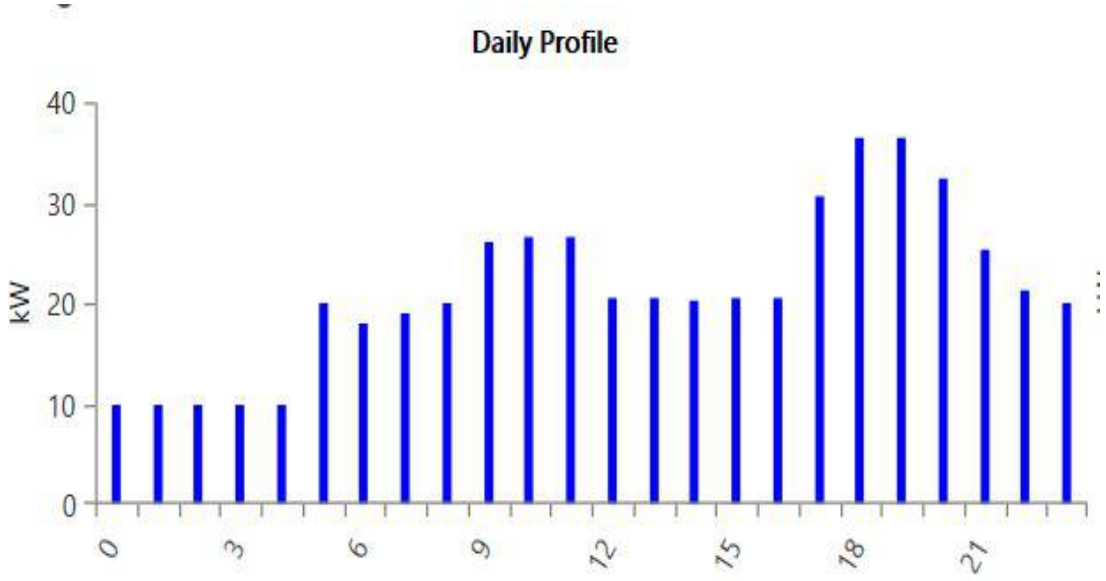


Figure 5.3: Winter Load profile.

"©Daffodil International University"

5.3 Many Types of Off-Grid System Optimization Result for AC Load

1.PV+ wind+ Generator + Battery .

2. Wind +Battery.

3.PV +Wind Turbine + Battery.

4.PV +Wind + Battery+ Converter (Proposed System) .

For (754 ,1000,1500) kWh/Day.

Shown here 4 energy generator system. This system simulated by using HOMER software. HOMER programming by discover out different optimization result. We will pick the Correct outcome from inside.

5.4 Photo voltaic (PV)

PV or photovoltic is a term that covers the conversion of light into electricity using semiconducting materials that exhibit the photo-voltaic effect, a phenomenon studied in physics, photo chemistry, and electrochemistry [29].

A type photo-voltaic system utilizes sun based boards, each including various sunlight based solar cells, which produce electrical power. PV establishments might be ground-mounted, housetop mounted or divider mounted. The mount might be fixed, or utilize a sun based tracker to pursue the sun over the sky. [28]

Photo-voltaic has explicit favorable circumstances similarly as one vitality source. its activity creates no contamination without ozone harming substance outflows after introduced, it shows straightforward versatility concurring of intensity needs alongside silicon has enormous accessibility inside Earth's outside. PV system contain the significant hindrance that the power yield is subject to daylight, so around 10-25% is lost if the following system is absolutely not utilized, since the cell are not straightforwardly confronting the sun consistently. Residue, mists, and different interests in the climate additionally decrease the power yield. Another primary issue will be the centralization of the generation inside hours relating to significant insolation, which don't for the most part coordinate the pinnacles generally utilized in human action menstrual cycles. Except if flow cultural propensities for utilization and electrical systems commonly suit this situation, power still ought to be made up by different other power sources, normally hydrocarbon. [29]

The figure 6.4 shows a solar panel arrangement,

“©Daffodil International University”

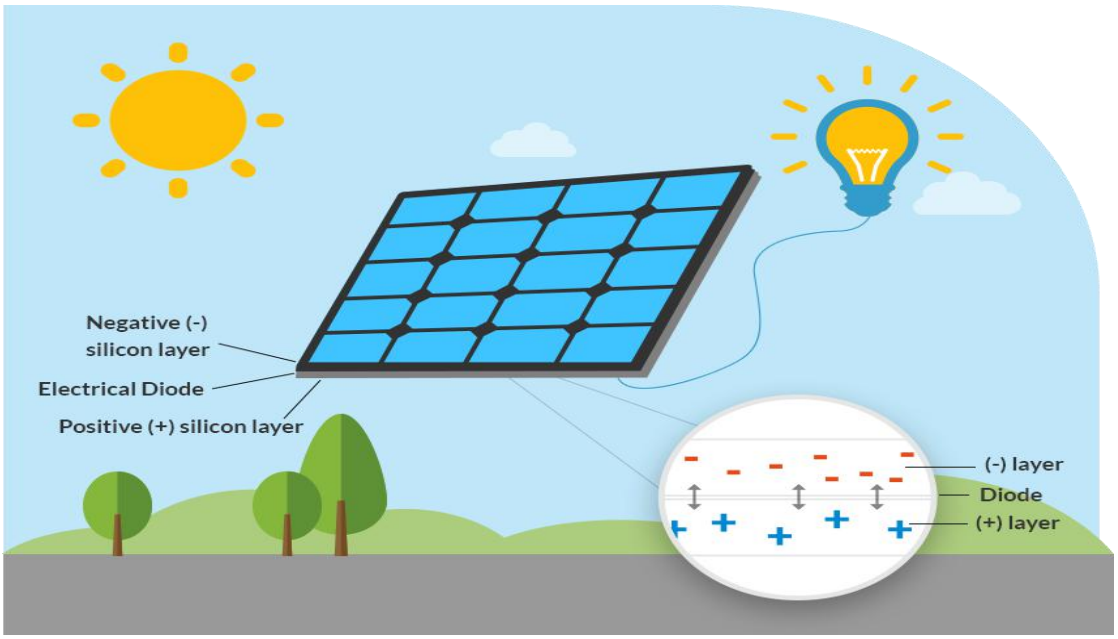


Figure 5.4: Solar panel Arrangement system.

5.5 Diesel Generator (GD)

A diesel generator is the combination of a diesel engine with an electric generator (AC) to generate electrical Power. This is a particular instance of motor generator. A diesel pressure start motor regularly is intended to run on fuel oil, yet a few kinds are adjusted for other fluid fills or gaseous petrol. Diesel generator sets are utilized in places without association with a power network, or as crisis control supply if the lattice comes up short, just as for progressively complex applications, for example, top trimming, system backing and fare to the power grid [30]

The below figure 6.5 shows a common diesel generator model.

Figure 5.5: Diesel Generator.

.

"©Daffodil International University"

5.6 (PV+ Diesel Generator+ Wind+Battery+Battery) Energy Generation System for 754KWh/Day

5.6.1 System Components Assessment

The power system components are photovoltaic Modules, Diesel Generator, Battery and Power Converter. The cost, number of units to be utilized, working hours, and so on should be indicated in HOMER programming for every one of this equipment. These data subtleties associated with past area.

In this system, the principle segment is sustainable power source part its PV Panel. Further elective vitality segment which Diesel Generator(DG). DG produce to AC current however Load is AC and wind turbine produce AC Power yet PV produce DC, So use Inverter will change DC to AC Current. Here, use is Large measure of PV Panel component,PV Panel segment have the other part included, for example, a battery(Globatt ACE NX120-7) [33].

The PV board to created is DC and PV associated DC transport so, this current isn't changed over on the grounds that heap is DC. Batteries System has for reinforcement system. Indicated figure 6.6 (PV+ Diesel Generator +Wind +Battery +Converter) power generator system

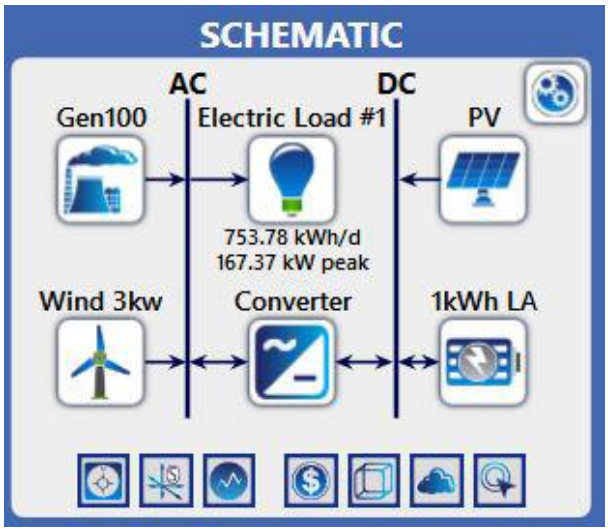


Figure 5.6: (PV+ Diesel Generator+Wind+Battery) energy generation system.

5.6.2 Photovoltaic array Model

Solar-Panel(PV) Installation cost is $.35/W. This reason, considered 24KW solar energy system. The 24KW solar energy system's installation and Replacement cost are taken as $8400 and $7200.

"©Daffodil International University"

There are various sizes are considered, for example, 1KW to 25KW. This PV exhibit lifetime is 25 Years and 25 years yield come here. This PV exhibit is no following system [31].

5.6.3 Solar Resource Data

Bangladesh is much good for the purpose of electricity generation from the solar irradiance, measure of incoming solar radiation. This has been Location consider is St. Martin's. St. Martin's Island Latitude and Longitude are 20°36' North and 92°20' East. St. Martin month to month arrived at the midpoint of worldwide radiation information has been taken from NASA (National Aeronautics and Space Administration). This Location to Annual Average radiation is 4.80KWh/m2/day and normal clearness list is 0.526.[26]

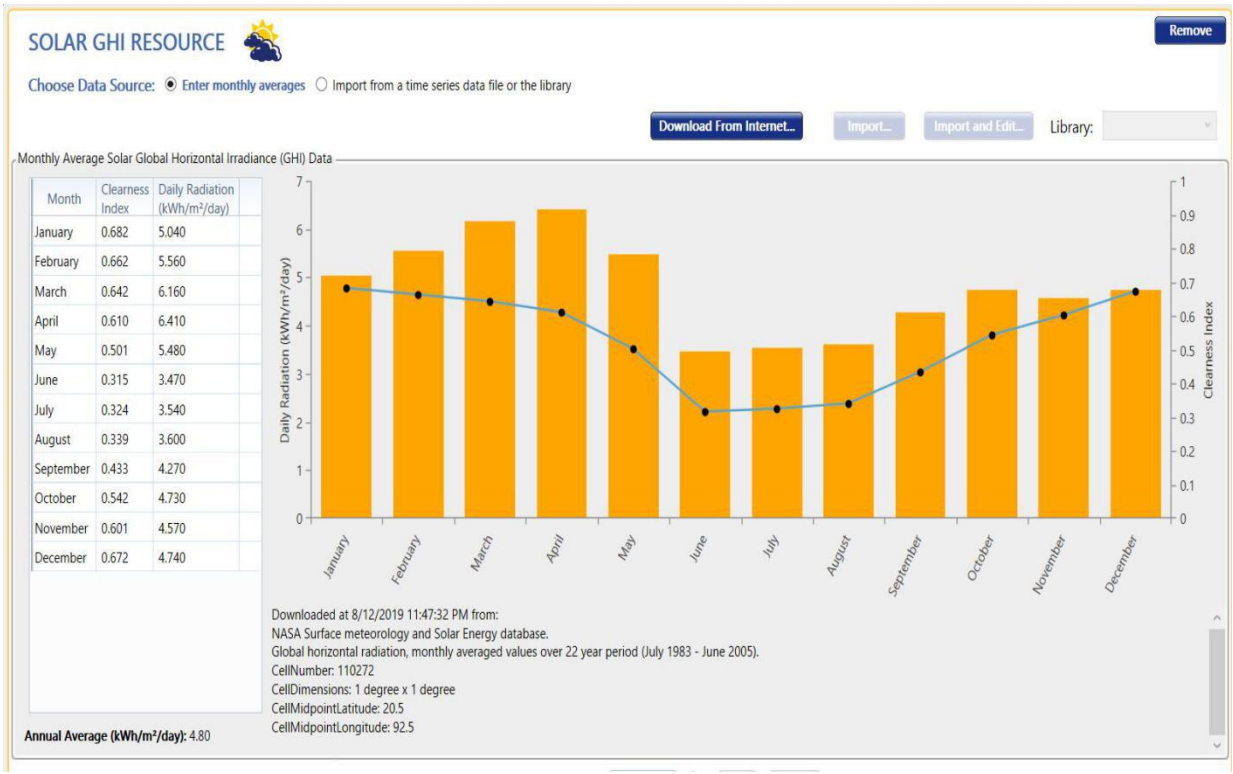


Figure 5.7: Annual Solar Global Horizontal Radiation.

5.6.4 Diesel Generator Model

Diesel generator or DG connected in AC bus. For this remote electrification commonly used in Diesel Generator. Since it is low cost, easy to introduce and electric working system. There are different scope of diesel generator, pick in suitable model for this Location. This case use is 100KW diesel generator and cost is taken $15,000. The least burden proportion 25%. The lifetime rating is taken 15000hr. The diesel cost per liter $ 0.67.[32,28]

"©Daffodil International University"

5.6.5 Battery Model

Battery carry major cost in power energy system. For each situation diverse number of batteries are utilized. This battery model are accessible in Bangladesh. The battery model is Globatt ACE NX120-7 (12V. 84 Ah). This Battery administration are Long life. A Warranty 2 years. The expense of one is ($160) with a replacement cost of ($160) while the support cost is normal at ($.29/year). The battery to be considered in this recreation is go from 1to 62 units .[34]

5.6.6 Power converter Model

The power converter is one kind of power electronics converter which used to convert AC to DC and DC to AC. The simulation range of power converter are 1KW to 67KW. We can use 5KW converter in this reason. A life time of a unit is considered to be (15 years). [35]

5.6.7 Simulation Results

The project lifetime is considered to be 25 years. The ideal blend of intensity system parts for our contextual investigation is a 170KW PV - Array, rahimafrooz (GLOBATT ACE NX120-7) battery , and 5kW rectifier. This system is considered at ($ 0.67/L) Where $1=85tk of diesel cost. The total net present cost, capital cost and the cost of electricity (COE) for such a hybrid system are $1.06M, and initial capital $284,405 and $0.29/kWh, respectively [34,28]
The figure 6.8 shows the simulation result of (Diesel Generator +Wind +PV+ Battery+ Converter) energy generation system.

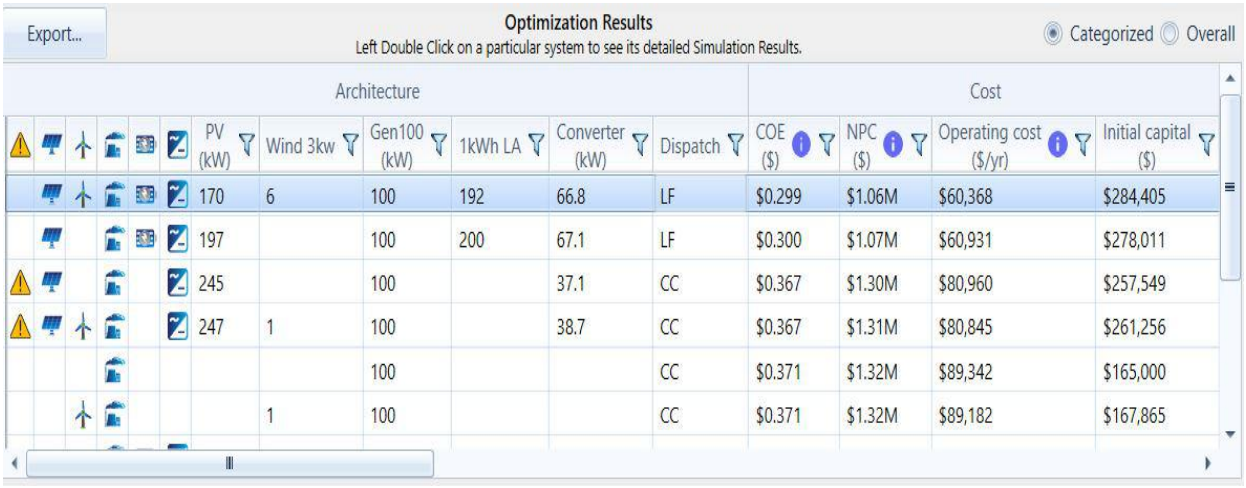
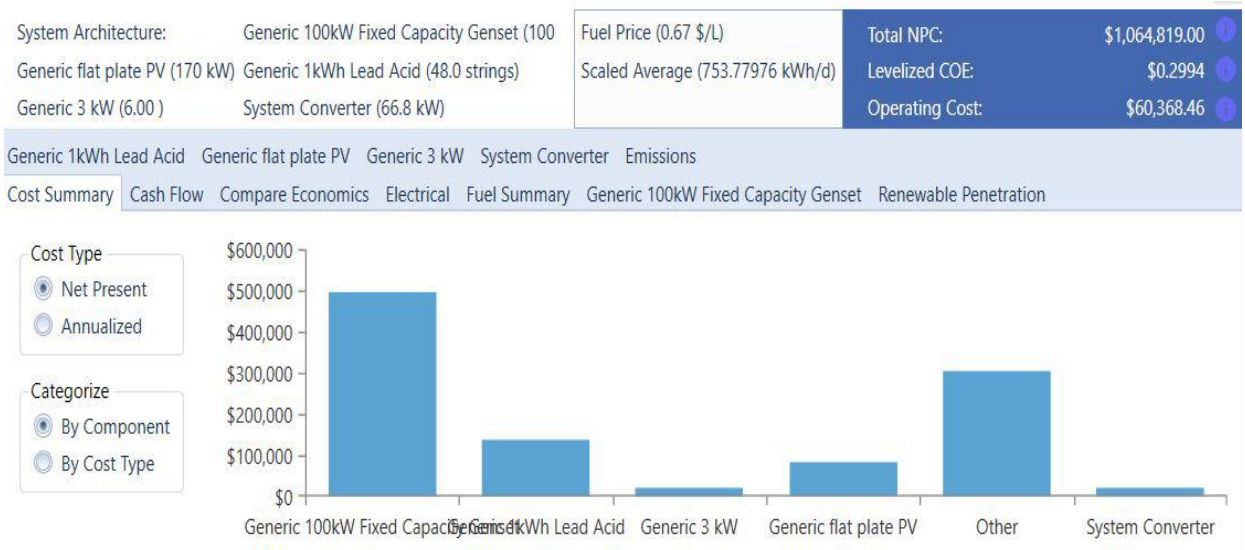


Figure 5.8: Simulation Results.

"©Daffodil International University"

5.6.8 Cost Summary for 754 kwh/Day

The total project cost summary shown in below figure. Anyway once PV installed, the maintenance and working expense become exceptionally modest then Diesel generator system. Fixed capital expense of this undertaking are $284,405. And the operating and maintenance cost (O&M) is evaluated to be $219,507. The replacement cost is $145,501 and Total expense/cost $1,064819. The system fixed capital expenses incorporate different common developments, work, coordination's compensation, required licenses, organization and government endorsements and different random expenses.



Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Generic 100kW Fixed Capacity Genset	$15,000.00	$46,467.17	$10,740.18	$424,941.71	-$275.49	$496,873.56
Generic 1kWh Lead Acid	$30,720.00	$89,148.15	$24,820.83	$0.00	-$5,603.50	$139,085.48
Generic 3 kW	$17,190.00	$4,782.11	$2,531.64	$0.00	-$2,695.03	$21,808.72
Generic flat plate PV	$59,466.86	$0.00	$21,964.54	$0.00	$0.00	$81,431.40
Other	$150,000.00	$0.00	$155,130.20	$0.00	$0.00	$305,130.20
System Converter	$12,027.77	$5,103.07	$4,319.14	$0.00	-$960.45	$20,489.53
System	$284,404.63	$145,500.49	$219,506.53	$424,941.71	-$9,534.47	$1,064,818.89

Figure 5.9: Cost Summary.

5.6.9 Cash Flows

The beneath figure, we can see that, the complete NPC is $1,064819. Furthermore, the levelized COE is $0.29/kwh/day. At last the operating cost OC is $60,369/year for scaled normal 754kwh/day.

"©Daffodil International University"

Figure 5.10: Cash Flows.

5.6.10 Monthly Average Electric Production

The beneath figure indicated the month to month circulation of the power delivered in kW by the (PV) and Generator. From April to September, the PV is for the most part utilized joined with Diesel generator(DG). Additionally, from April to May the pinnacle load is met by (PV) and (DG). Lack of sun powered radiation during winter month, We get the majority of the power from diesel generator.

"©Daffodil International University"

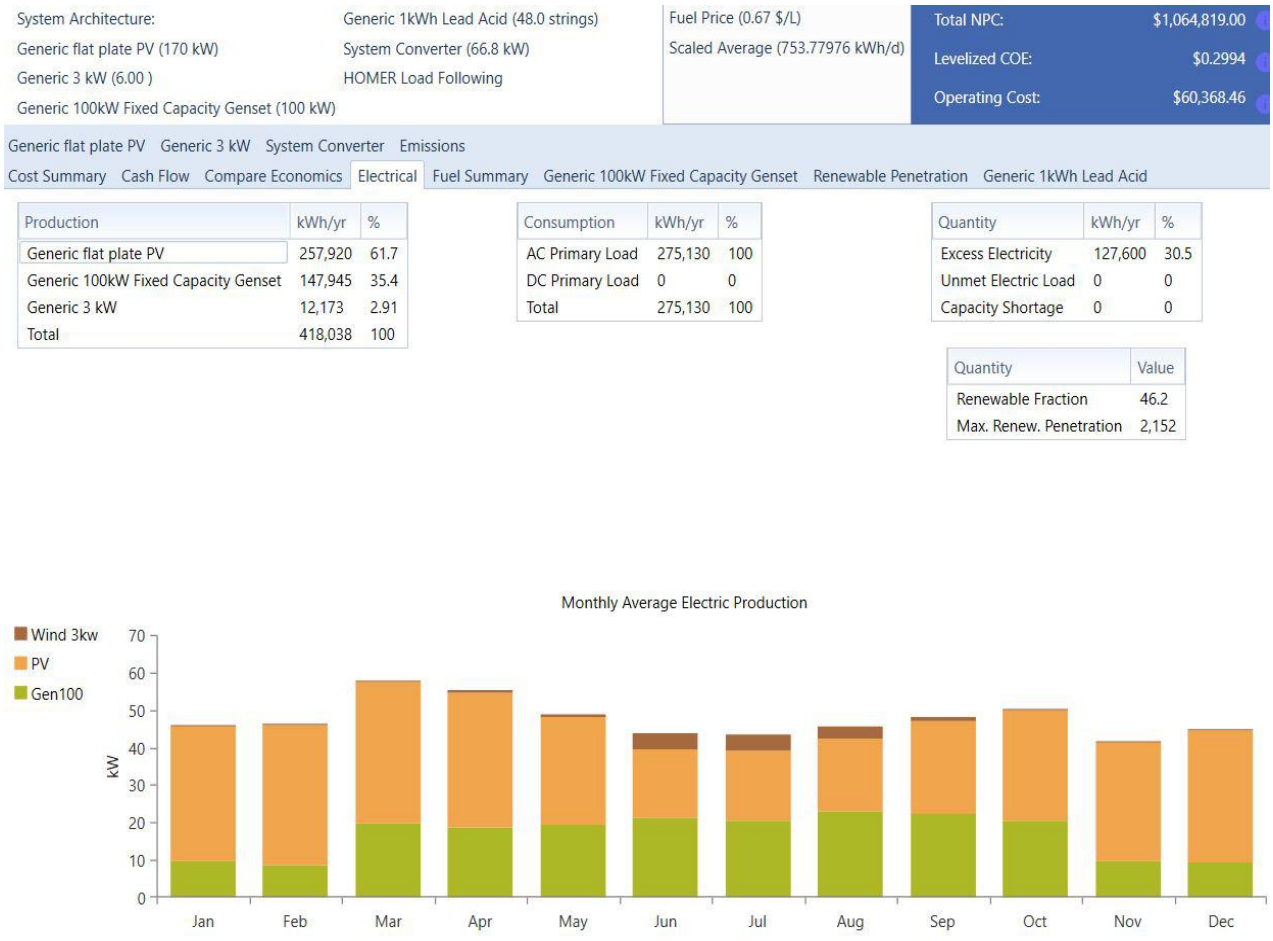


Figure 5.11: Every Monthly Average Electric Production.

The below table shows the electricity production of the system components.

Table 5.3: Electricity production of the system components

Production	**KWh/yr**	**%**
PV Array	257,920	61.7
Generator 1	147,945	35.4
Wind	12,173	2.91
Total	418,038	100

"©Daffodil International University"

5.7 Wind Turbine

A wind turbine is an one kind of device which converts the wind's kinetic energy into electrical power. Wind turbines are fabricated in a wide scope of vertical and even pivot types. The primary part of wind turbine are, blade, Nacelle, rotor, Tower, Hub etc. This case we utilize even pivot type wind turbine. The wind turbine working standard are when wind are available, the turbine cutting edges begin to turn and we get electrical power from dynamic vitality. The turbines are utilized for applications like battery charging for extra power for pontoons or bands so they can control traffic cautioning signals. Marginally bigger turbines can be utilized for making commitments into a household control supply however selling unused power here we are at the utility provider by utilizing the electrical lattice. Exhibits associated with enormous turbines, realized seeing that breeze ranches, are turning into an undeniably significant reason for irregular sustainable power source and are likewise utilized by numerous nations during a methodology to bring down their dependence on fossil warms up. The underneath fig. shows the structure of a breeze turbine.

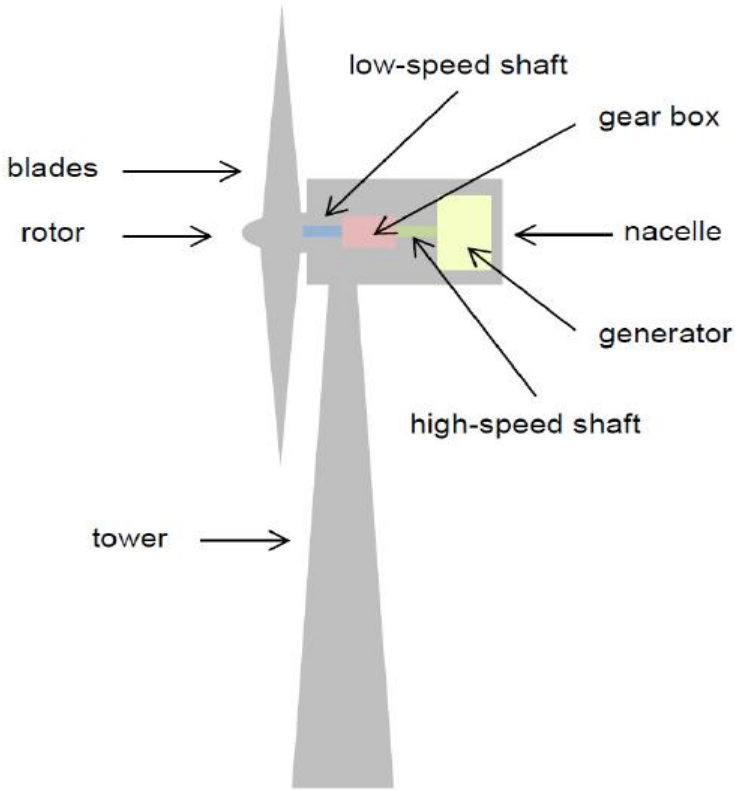


Figure 5.12: Structure of wind turbine.

"©Daffodil International University"

5.8 Battery Design

Battery is a kind of energy stored system. A scaled down lattice mixture control system are incorporated source PV, Wind Turbine and Diesel generator. Here, PV and Wind are Renewable vitality Produced. This vitality produce fluctuate are occasional and condition chance. So, that vitality are required stored. There are two sorts Battery plan. For example, Parallel and arrangement design. We utilized Batteries per String 4, Bus 48V 12V 84 Ah Battery.

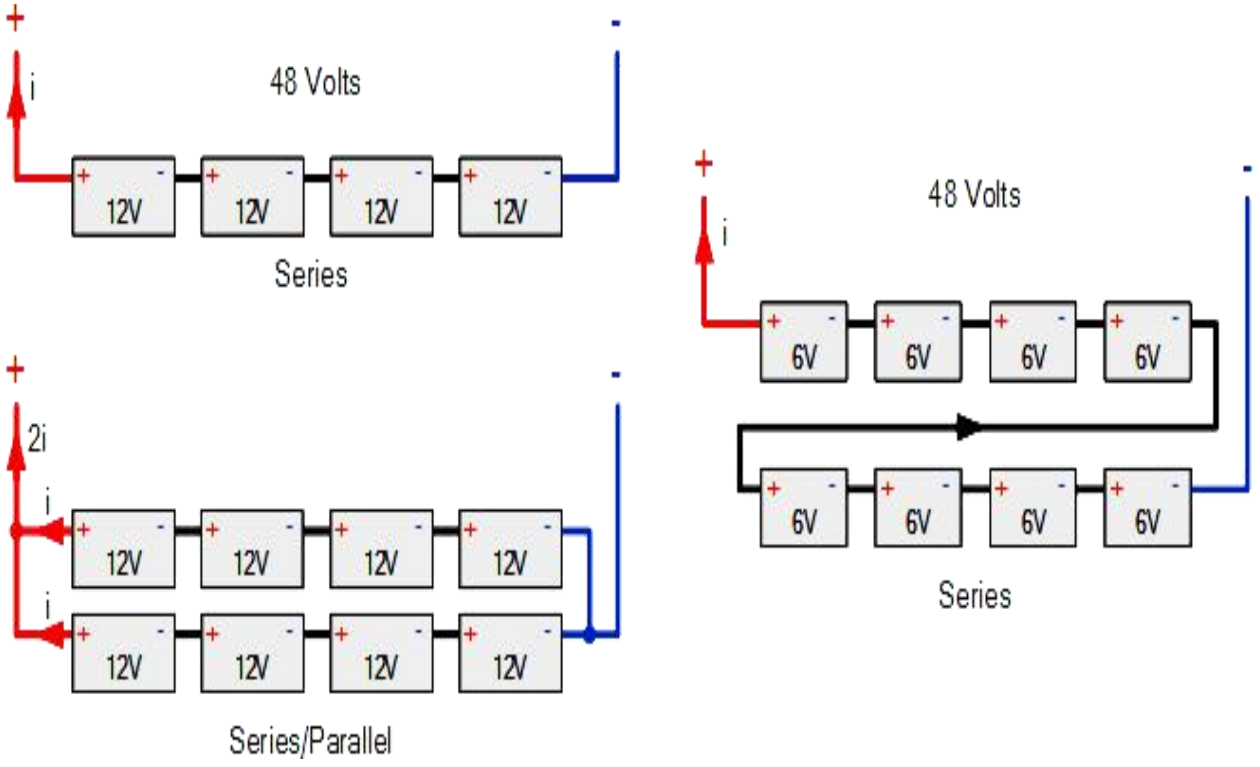


Figure 5.13: Battery Design.

"©Daffodil International University"

5.9 (Wind+Generator+ PV+Battery) Energy Generation System for 1000KWh/day

5.9.1 System Components Assessment

The energy system components are Wind turbine, generator, PV and Battery. The cost, number of units to be utilized, working hours, and so forth should be determined in HOMER programming for every one of this gear. This data subtleties engaged with past segment.in this system, the fundamental part is sustainable power source segment its Wind Turbine. The Wind turbine is to delivered Ac and associated with AC transport So this current isn't changed over Ac since load is AC. What's more, the Batteries System has for reinforcement system.The below figure shows the model of Wind Turbine +Generator +PV +Batteries Energy Generation System.

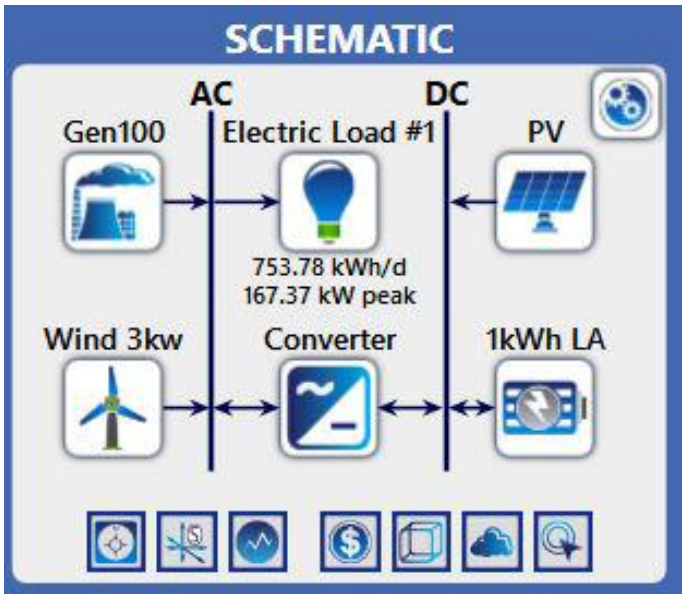


Figure 5.14: Wind+ Generator +PV + Battery Energy Generation System.

5.9.2 Wind Turbine Model

Accessibility of vitality from the breeze turbines depends enormously on wind varieties. Subsequently, wind turbine rating a lot of lower contrasted with the normal electrical burden. In this analysis, we thought about Generic 3KW model with hub height (25 m) is considered. It gives (DC) voltage as an output. The capital, replacement and maintenance cost of 30 kw

"©Daffodil International University"

are taken as ($9,688), ($5,785) and ($500/year).A lifetime of a turbine is taken to be (15 years).[33,26]

The underneath table shows wind speed information of St. Martin's .

Table 5.4: Wind speed data of St. Martin.

Month	Average (m/s)
January	3.830
February	3.970
March	4.170
April	4.290
May	4.550
June	7.330
July	7.430
August	6.600
September	4.740
October	3.820
November	3.790
December	3.630
Annual Average (m/s): 4.85	

From the above table we can see that various wind speed for 12 months and the average annual wind speed is 4.85 m/s. [37]

"©Daffodil International University"

5.9.3 Battery Model

The Battery carry major cost in power grid system. For each situation distinctive number of batteries are utilized. This battery model are accessible in Bangladesh. The battery model is GLOBATT ACE NX120-7 Battery (12V, 84 Ah). This Battery administration are Long life. A Warranty 2 years. The expense of one is ($150) with a substitution cost of ($150) while the upkeep cost is normal at ($10/year). The battery to be considered in this reenactment is extend from 1to 62 units.[34]

5.9.4 Simulation Results for 1000kwh/day

The project's lifetime is considered to be 25 years. The ideal blend of intensity system segments for our contextual investigation is a 30KW breeze turbine, GLOBATT ACE NX120-7 Battery. For 1000kwh/day the all out net present cost 1.24M , starting capital expense and for such a framework are $165,000 , $3102,398 and cost of power (COE) $0.26/kWh. [33,34]

The below fig shows the simulation result of Wind Turbine and Batteries Energy Generation System.

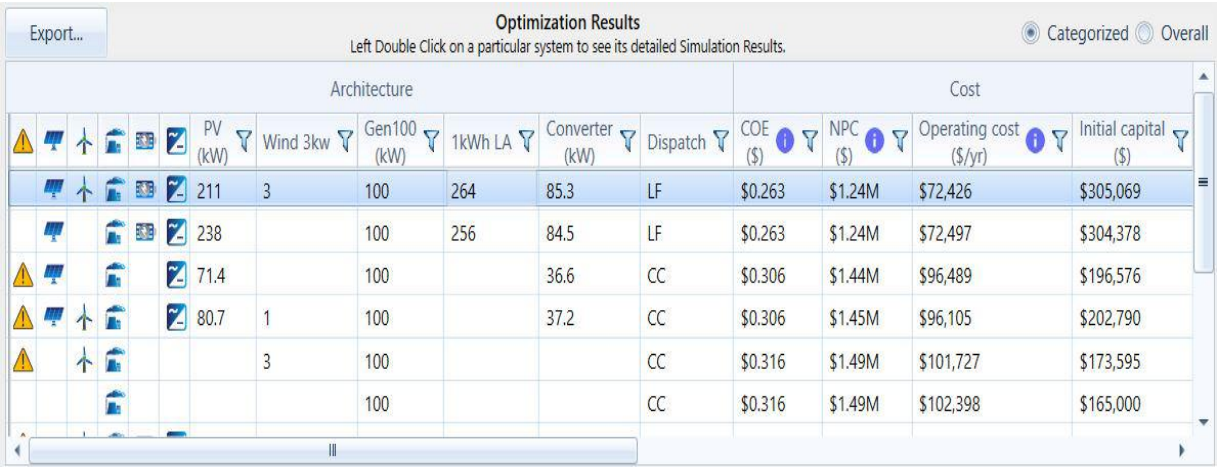


Figure 5.15: Simulation results.

"©Daffodil International University"

5.9.5 Cost Summary

The total project cost summary shown in infra figure. However once Wind Turbine installed, the maintenance and operating cost become very cheap. Fixed capital cost of this project are $39,363.And the operating and maintenance cost is estimated to be $9,439.The replacement cost is $19,122.The system fixed capital costs include various civil constructions, labor, logistics wages, required licenses, administration and government approvals and other miscellaneous costs.

Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Generic 100kW Fixed Capacity Genset	$15,000.00	$52,062.58	$11,433.10	$548,399.29	-$2,263.82	$624,631.15
Generic 1kWh Lead Acid	$42,240.00	$102,649.60	$34,128.64	$0.00	-$5,788.36	$173,229.88
Generic 3 kW	$8,595.00	$2,391.06	$1,400.48	$0.00	-$1,347.51	$11,039.02
Generic flat plate PV	$73,877.34	$0.00	$27,287.16	$0.00	$0.00	$101,164.50
Other	$150,000.00	$0.00	$155,130.20	$0.00	$0.00	$305,130.20
System Converter	$15,356.25	$6,515.25	$5,514.39	$0.00	-$1,226.24	$26,159.66
System	$305,068.59	$163,618.50	$234,893.97	$548,399.29	-$10,625.93	$1,241,354.42

Figure 5.16: Cost Summary.

5.9.6 Cash Flows

This fig. 6.18 shower the cash flows graph and The total NPC is $1,241,354 .The levelized COE is $0.263/KWh. And the operating cost is $72,425.80 /year.

"©Daffodil International University"

Figure 5.17 :Cash Flows chart.

5.9.7 Monthly Average Electric Production

The beneath figure indicated the month to month circulation of the power delivered in kW by the (PV) and Generator . From April to September, the PV is for the most part utilized joined with Diesel generator(DG). Additionally, from April to May the pinnacle load is met by (PV) and (DG).Lack of sun powered radiation during winter month, We get the majority of the power from diesel generators.

"©Daffodil International University"

Table 5.18 : Electricity production of the system components.

Table 5.5: electricity production of the system components.

Production	KWh/yr	%
PV	320,421	60.7
Generator	201,318	38.1
Wind Turbine	6,087	1.15
Total	= 527826	=100

5.9.8 Sensitivity and Optimization Results

This case comprise of affectability factors like (Generator, PV, Wind Turbine size, battery size) are considered in this investigation. The zone load at 1000 KWh/day, 168 kW top, this system may dominant part comprise of 211 kW Wind Turbine , 264 unit of batteries .And those case reproduces HOMER Software.

For this case improvement result are comprise of starting capital, all out net present cost (NPC), cost of vitality (COE), sustainable portion, diesel in litter and generator in hourly working in this framework. This arrangement of COE $.263/KWh. The all out Net present expense $1,241,354 . Overabundance power produce 141,959 KWh/year of 27.3 % .And

"©Daffodil International University"

neglected electric burden 0.0KWh/year of 0.0 % . Likewise limit lack 0.0KWh/year of 0.0 % . Further inexhaustible part esteem 1.0.

So the Sensitivity consequence of this case,the (PV, Generatir, Wind Turbine and Batteries) based system isn't appropriate Because we can not give 100% power vitality of consumers.it has no elective source and furthermore the capacity control from Battery can not back up the entire system.

5.10 (PV+ Wind + Generator+Battery)

Energy Consumption System for 1500 KWh/day

5.10.1 System Components Assessment

This system for 1500KWh/day. The energy system segments are PV Modules, Battery and Power Converter. The cost, number of units to be utilized, working hours, and so on . should be indicated in HOMER programming for every one of this gear. This data subtlety associated with past segment.

In this case, the principle segment is sustainable power source part its PV Panel and Wind Turbine Load is DC. Here, we utilize Large measure of PV Panel and medium measure of Wind Turbine, Generator there have the other part included, for example, a battery (GLOBATT ACE NX120-7)[34].

The PV board and Battery are created DC and PV (Photovoltic), Battery associated DC transport so, this current is changed over on the grounds that load is DC.

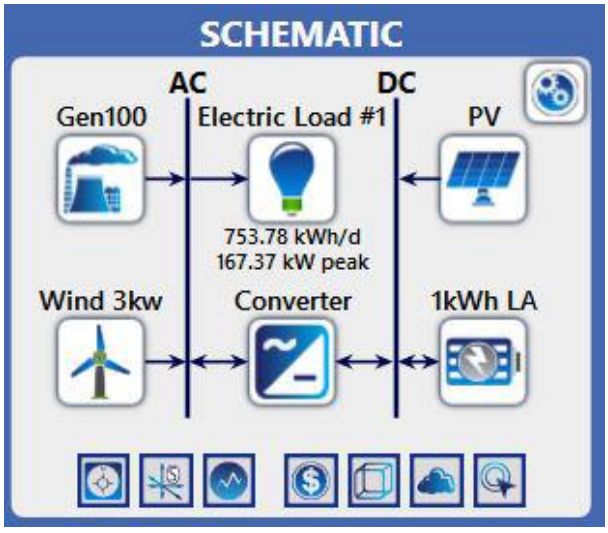


Figure 5.19: (PV+Generator+Wind Turbine+ Battery)Energy Consumption System.

"©Daffodil International University"

5.10.2 Battery Model

Batteries carry main important cost in power system. In every case different number of batteries are used. it battery model are available in Bangladesh. The battery model is rahimafrooz GLOBATT ACE NX120-7 (12V. 84Ah). This Battery service are Long life. An Warranty 2 years. The cost of one is ($150) with a replacement cost of ($160) while the maintenance cost is expected at ($.10/year). The battery to be considered in this simulation is range from 1to 304 units[34].

Table 5.7: GLOBATT ACE NX120-7 Battery Specification.

GLOBATT ACE NX120-7 Battery	
Normal Voltage (V)	12
Normal Capacity (kWh)	1
Maximum Capacity (Ah)	83.4
Capacity Ratio (1/hr)	0.403
Round-trip Efficiency (%)	80
Maximum charge Current (A)	16.7
Maximum Discharge Current (A)	24.4
Maximum Charge Rate (A/Ah)	1

"©Daffodil International University"

5.10.3 Simulation Results

This project's lifetime is consider to be 25 years . The ideal mix of intensity of power system components for our case study is a 368 kW PV-Array, 9 KW Wind Turbine, 304 unit 12v, 84Ah GLOBATT ACE NX120-7 Battery. The total net present cost $1,603,566, Initial Capital cost $389,601 and the cost of electricity (COE) for such a hybrid system $0.227/kWh. The figure6.6.7 shows the simulation result of (Wind Turbine+Generator+PV+ Battery) energy generation system.

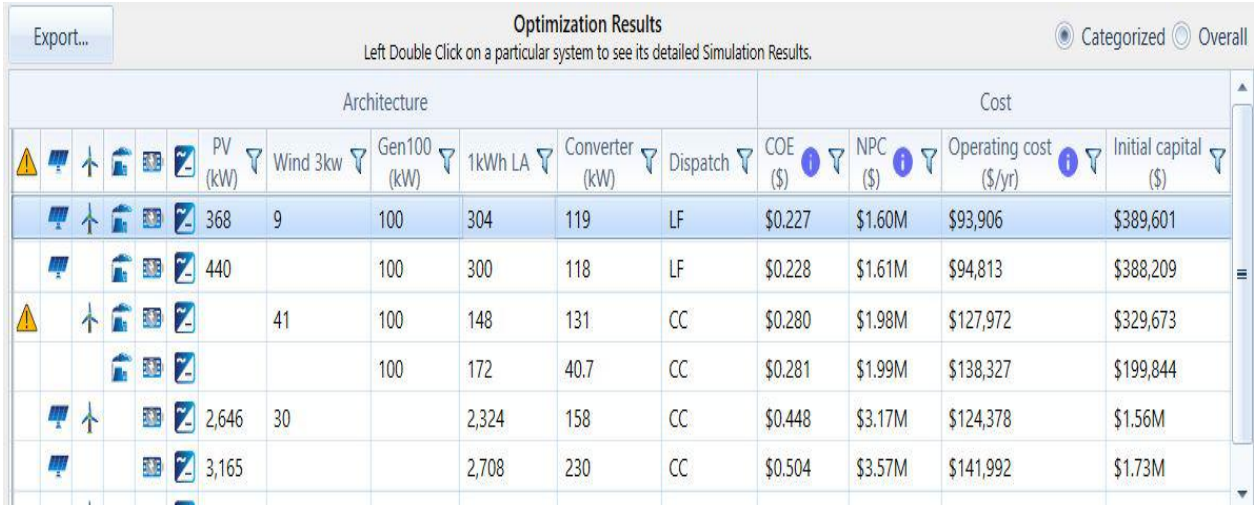
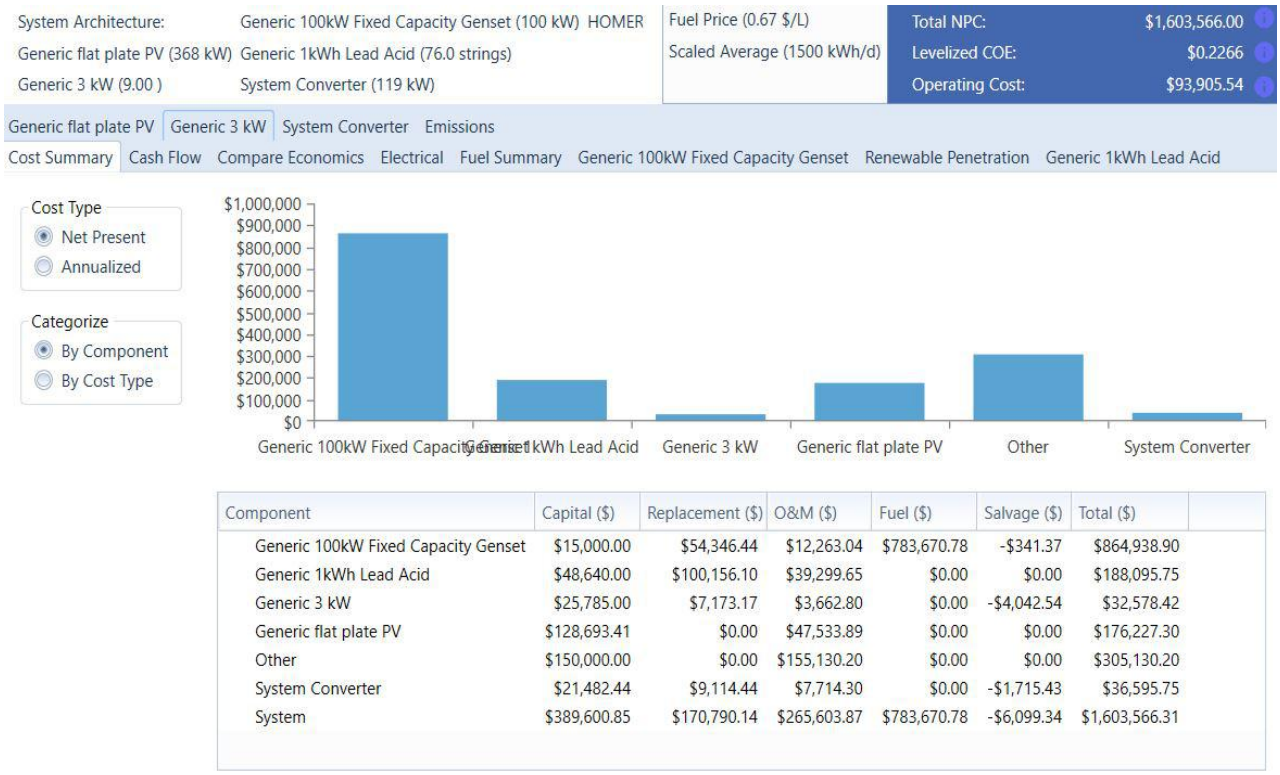


Figure 5.20: Simulation Results.

5.10.4 Cost Summary

The total project cost summary shown in infra figure . However once PV board, Generator, battery and Wind Turbine installed, the maintenance and working expense become extremely modest . Fixed capital expense of this undertaking are $389,600.86. Also, the working and maintenance cost is assessed to be $265,603. The replacement cost is $170,790. The framework fixed capital expenses incorporate different common developments, work, co-ordinations compensation, required licenses, organization and government endorsements and different various expenses.

"©Daffodil International University"



Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Generic 100kW Fixed Capacity Genset	$15,000.00	$54,346.44	$12,263.04	$783,670.78	-$341.37	$864,938.90
Generic 1kWh Lead Acid	$48,640.00	$100,156.10	$39,299.65	$0.00	$0.00	$188,095.75
Generic 3 kW	$25,785.00	$7,173.17	$3,662.80	$0.00	-$4,042.54	$32,578.42
Generic flat plate PV	$128,693.41	$0.00	$47,533.89	$0.00	$0.00	$176,227.30
Other	$150,000.00	$0.00	$155,130.20	$0.00	$0.00	$305,130.20
System Converter	$21,482.44	$9,114.44	$7,714.30	$0.00	-$1,715.43	$36,595.75
System	$389,600.85	$170,790.14	$265,603.87	$783,670.78	-$6,099.34	$1,603,566.31

Figure 5.21: Cost Summary.

5.10.5 Cash Flows

The fig. shows the cash flows graph. The total NPC is $1,603,566. The levelized COE is $0.196/kwh. And the operating cost is $2,027/year.

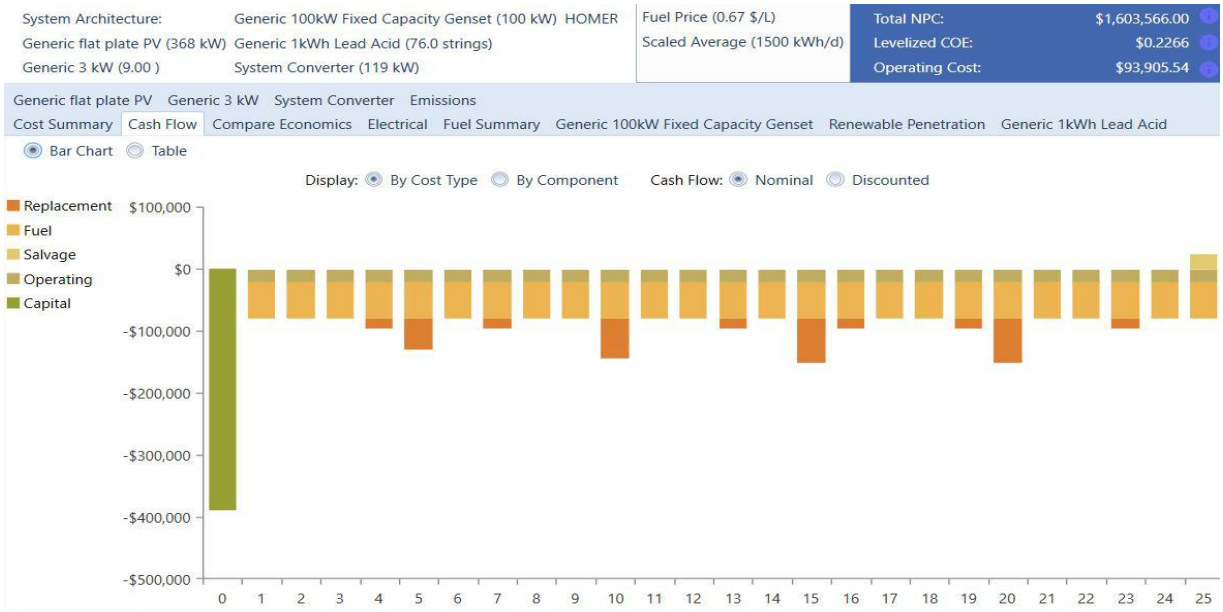


Figure 5.22: Cash Flow.

"©Daffodil International University"

5.10.6 Monthly Average Electric Production power

The beneath figure indicated the month to month circulation of the power delivered in kW by the (PV) and Generator. From April to September, the PV is for the most part utilized joined with Diesel generator(DG). Additionally, from April to May the pinnacle load is met by (PV) and (DG).Lack of sun powered radiation during winter month, We get the majority of the power from diesel generators.

Figure 5.23: Monthly Average Electric Production

Table 5.8: Electric Production of the system Components

Production	KWh/yr	%
PV Array	30,118	63.3
Wind Turbine	18,215	34.6
Generator	48,333	2.07
Total	=881,558	=100

"©Daffodil International University"

5.10.7 Emission

We can see below this figure the major emission comes from carbon dioxide.

Table 5.9: Emission .

Quantity	Value	Units
Carbon Dioxide	236,653	kg/year
Carbon Monoxide	1,610	kg/year
Unturned Hydrocarbons	65.1	kg/year
Particulate Matter	6.44	kg/year
Sulfur Dioxides	580	kg/year
Nitrogen Oxides	129	kg/year

"©Daffodil International University"

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Conclusion

Optimization of wind-solar-Diesel generator hybrid power system connected to DC load is presented in this study. The cost of diesel fuel is increasing day by day. On the other hand, the amount of non-renewable energy sources is decreasing day by day. It is not feasible to use only diesel as a source of energy generation nowadays. Hybrid energy generation system can be feasible and optimized solution in this regard. In HOMER shows that component sizes, cost summary, cash flow summary, electrical production and cost of PV-Wind-Diesel Generator hybrid system. In this study, a PV-diesel-wind-battery hybrid generation system was found most feasible and optimized. For our Proposal Model 8KW solar-PV modules, 9KW Wind Turbine (each of 3KW), 100 KW diesel generators,120 batteries (each of 83.4 Ah) and 1KW converter is found to be the best configuration in terms of Cost of Energy (COE), environmental conditions and Renewable Fraction (RF). The Cost of Energy (COE) $0.29/KWh for 754kwh/day and when the load increase in future 1000KWh/day then the pur unit cost or cost of energy (COE) $0.26 and in future increase more then 1000kwh/day then if total load 1500KWh/day then the cost decreases more then the cost of energy will COE $0.229. So for this system 1500KWh/day combination is the best grid system. The renewable fraction of this system is found 99%. This Project Lifetime 25years.

6.2 Future Plan

Bangladesh is the most populated small country in which people increase day by day. For this huge population will need more electricity. Our conventional energy decreases day by day in the whole world so we should need to go non-conventional energy. When people increase in St. Martin then more electricity need for increases people. when our total kw hour / day then the cost of electricity will decrease.

"©Daffodil International University"

Reference:

1. https://whatis.techtarget.com/definition/microgrid
2. Md. Nurnnabi, N.K. Roy, " Grid connected hybrid power system design using HOMER", Proceedings of 2015 3rd International Conference on Advances in Electrical Engineering 17-19 December, 2015, Dhaka, Bangladesh.
3. Nasif Mahmud, Asif Hasan, Md Shaminur Rahman," Modelling and cost analysis of hybrid energy system for St. martin Island using HOMER", 2013 2nd International Conference on Informatics, Electronics and Vision (ICIEV 2013) (2013).
4. Suman Chowdhury, Swapan Kumar Saha," Height analysis for site selection of wind potentiality in bangladesh", INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 3, ISSUE 1, JANUARY 2014.
5. Shakti Singh, Mukesh Singh,"Feasibility study of an Island micro-grid in rural area consisting of PV, Wind, Biomass and Battery energy storage system", Energy Conversion and Management Volume 128, 15 November 2016, Pages 178-190.
6. Kandula Murali Krishna," Optimization analysis of micro-grid using HOMER", India Conference (INDICON), 2011 Annual IEEE.
7. R. Nazir, H. D. Laksono," Renewable energy sources optimization: A micro-grid model design", 2013 International Conference on Alternative Energy in Developing Countries and Emerging Economies.
8. Sk. A. Shezan, M. Farzana," Techno-Economic Analysis of a Hybrid PV Wind-Diesel Energy System for Sustainable development at Coastal Areas in Bangladesh", 2016 4th International Conference on the Development in the in Renewable Energy Technology (ICDRET).
9. Subhes C. Bhattacharyya," mini-grid based electrification in Bangladesh: Technical configuration and business analysis", Renewable Energy Volume 75, March 2015, Pages 745-761.
10. Rohit Sen, Subhes C. Bhattacharyya," off- grid electricity generatio with renewable energy technologies in india: An application of HOMER" Renewable Energy Volume 62, February 2014, Pages 388-398.
11. Sunanda Sinha, S. S. Chandel," Review of recent trends in optimization techniques for solar photovoltaic–wind based hybrid energy systems", Renewable and Sustainable Energy Reviews, Elsevier, vol. 50(C), pages 755-769.
12. Vinod Srivastava, Vinod Kumar Giri," optimization of hybrid renewable resources using HOMER" INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH R. Srivastava and V.K.Giri, Vol.6, No.1, 2016.
13. Vikas Khare, Savita Nema," Status of solar wind renewable energy in india", Renewable and Sustainable Energy Reviews Volume 27, November 2013, Pages 1-10.
14. Muhammad Taheruzzaman," Design, Planning, and Modelling of Renewable Energy Integrated Microgrid for Rural Electrification in Bangladesh".
15. Alam Hossain mondal, Manfred Denich, " Hybrid system for decentralized power generation in Bangladesh", Energy for Sustainable Development Volume 14, Issue 1, March 2010, Pages 48-55.
16. A. Z. A. Saifullah, Md. Abdul Karim, Md. Raisul Karim," Wind Energy Potential in Bangladesh".

17. "Key Statistics". Bangladesh Power Development Board. Retrieved 3 November 2014.
18. "Source of Light in Bangladesh : 2015". Retrieved 8 June 2017.
19. "Govt plans to sign energy pact with Bangladesh". The Himalayan Times. 2018-04-16. Retrieved 2018-05-09.
20. https://en.wikipedia.org/wiki/Electricity_sector_in_Bangladesh.
21. https://www.sourcewatch.org/index.php/Matarbari_power_station.
22. http://mole.my/bangladesh-finds-oil-reserves-worth-5-5-billion/.
23. http://energynewsbd.com/details.php?id=622
24. https://energypedia.info/wiki/Bangladesh_Energy_Situation#Wind_Energy
25. http://www.sdnbd.org/wind.htm
26. http://en.banglapedia.org/index.php?title=St_Martin%27s_Island
27. http://www.bpc.gov.bd/contactus.php?id=39
28. https://en.wikipedia.org/wiki/Photovoltaics
29. https://en.wikipedia.org/wiki/Diesel_generator
30. https://www.alibaba.com/product-detail/Cheap-price-hot-selling-top-quality_60783235106.html?spm=a2700.7724857.normalList.18.22d669c5S9XXRJ&s=p
31. https://www.alibaba.com/product-detail/1kw-2kw-low-price-diesel-generator_60035448850.html?spm=a2700.7724857.normalList.6.28bf18400hL4xR&s=p
32. https://www.alibaba.com/product-detail/600w-1kw-2kw-3kw-5kw-10kw_1706128678.html?spm=a2700.7724857.normalList.46.125d49aemud7zN
33. https://www.-https://estore.rahimafrooz.com/globatt-ace-nx120-7-battery
34. https://www.amazon.com/Adjustable-Converter-110V-220V-Switching-Transformer/dp/B0777MH681?ref_=fsclp_pl_dp_3
35. https://en.wikipedia.org/wiki/Renewable_energy
36. Md.Robiul Islam,Md.Nazibur Rahman,"STUDY OF WIND POWER IN DIFFERENT PARTS OF BANGLADESH",page-1292,volume:03.
37. https://www.researchgate.net/profile/Hasibul_Jamil2/publication/317344280_Hybrid_Power_Optimization_in_StMartin_Island_With_Smart_Grid_Modeling/links/5934dbada6fdcc89e7f37ab9/Hybrid-Power-Optimization-in-StMartin-Island-With-Smart-Grid-Modeling.pdf
38. https://pdfs.semanticscholar.org/f7b1/1c6b2c8f72266d364cf2e994b80fd48687a6.pdf
39. https://www.researchgate.net/profile/M_Shamim_Kaiser/publication/285746376_Hybrid_options_analysis_for_power_systems_in_St_Martin%27s_Island/links/56ea32bc08ae3a5b48cce75a/Hybrid-options-analysis-for-power-systems-in-St-Martins-Island.pdf

"©Daffodil International University"