COST PROBABILITY AND COMPARISON OF ON GRID AND OFF GRID PV POWER PLANT IN MYMENSINGH

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

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CERTIFICATION

This is to certify that this thesis paper that is entitled "**COST PROBABILITY AND COMPARISON OF ON GRID AND OFF GRID PV POWER PLANT IN MYMENSINGH**" is done by the following student under my direct supervision and this paper work has been carried out by him in the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held in December 2021.

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APPROVAL

The thesis entitled **"COST PROBABILITY AND COMPARISON OF ON GRID AND OFF GRID PV POWER PLANT IN MYMENSINGH."** submitted by, **Md. Oahedullah Khan Adnan (ID: 162-33-3298**) Session: Summer 2016,Batch 21th has been accepted as satisfactory in partial fulfilment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering on December 15th, 2021.**

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ABSTRACT

Bangladesh is a developing country. the biggest problem that interrupts the developing of Bangladesh is the shortage of electricity. This mostly occurs in the rural areas of the country. Electricity has not yet reached in many nook and corners of our country. Load shading is very much responsible for making public life a misery. Load shedding creates many problems to farmers in their irrigation work, fish feeding or farming which hinders the way of economic development of this country. Lack of electricity is one of the the serious problem at Gauripur area in Mymensingh. About 100k people lives in Gauripur. The Government cannot provide enough electricity to the consumers as per their demand. So for solving the problem in Gorakhpur I want to design a 15 MW PV power house in this paper where I will use Homer software to show the power dissipation deficit for Gouripur area. I want to represent a comparative economic analysis between off grid and on grid connection of electricity generated from the solar plant. All the technical ,economic comparison and design- simulation will be done using Homer pro software by which our government would be able to deliver that demanded electricity at a lower cost ,to the consumers. I have made a comparative analysis between on grid and off grid and found out that the net cost for on grid is much lower than off grid. Reducing the price and providing sufficient amount of electricity to the people of Gauripur is the main purpose of this thesis and my results shows that the on grid system is more acceptable then any other grid system.

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List of Abbreviations

PV = Photovoltaic

MW= Mega Watt

Kwh= Kilo watt hour

HOMER = Hybrid Optimization Model for Multiple Energy Resources

HRES = Hybrid Renewable Energy Systems

REN = Renewable Energy Policy Network

CPD = Centre for Policy Dialogue GDP = Gross domestic product.

USD = U.S. Dollar

CSP = Concentrated Solar Power

STC = Standard Test Conditions

IDCOL = Infrastructure Development Company Limited

SHS = Satellite smart home

LED = Light Emitting Diode

MTOE = Million Tonnes of Oil Equivalent

BPDB = Bangladesh Power Development Board

BWDB = Bangladesh Water Development Board

LGED = The Local Government Engineering Department

PJ = Power joules

TWH = Trillion watt-hour

SAPS = Stand-alone power systems

GHI = Global Horizontal Irradiance

DNI = Direct Normal Irradiance

LHV = lower heating value

HVAC = Heating, Ventilation, and Air Conditioning.

MKBM = Modified Kinetic Battery Model

COE = Cost of electricity

NPC = Net present cost

USDA = United States Department of Agriculture

CHAPTER 01
INTRODUCTION

1.1 Problem statement

As we know, Bangladesh is developing country with loads of energy demand as a result of immense population. Specially in electrical sector, as so much the restricted resources, People here are full of power crisis that is taken into account collectively of the important blockage to the economic development. It's an understatement of fate that we have a tendency to don't have correct resource and man power to induce the massive energy power generating system. Therefore we've got to travel through the renewable energy choice. As a result of it's thought-about to be the correct alternative for providing clean energy. Consequently we have a tendency to be choosing solar energy plant generation. it absolutely was elect as a result of the price and also the appropriate setting and geographic benefits. This paper presenting a comparison between efficient off grid and on-grid PV power generation plant system. The place that's elect for this PV plant at Gouripur in Mymensingh district. Bangladesh is placed between 20°34' and 26°38' north latitudes and 88°01' and 92° 41' east longitudes with nearly two hundred million people living In our country ,so we have a tendency to face acute power crisis downside. With growing population energy demand is increasing day by day, victimization renewable energy sources and plant beside typical power station and distribution system could be a common and quick answer currently days and Bangladesh won't keep behind. Gouripur, Mymensingh 24°45'36", 90°34'13" have four.446 kwh/m2/day daily total of world horizontal irradiation (© 2019 stargis) consistent with world Solar Atlas.so that means that annually we have a tendency to have gotten 1623kWh/m2 each year. that the lack of land availableness could be a main challenge for exploring alternative energy. Additionally there has a vital indisputable fact that is that the installation space. for a star plant the high initial value is additionally a vital downside.in this plant we'd like to use numerous sort of rare instrumentality and materials that is said with this plant. Therefore within the starting we'd like a that includes quantity of cash to established a star plant. This power station can facilitate us to scale backCO_2 emission and help the environment. One of the most significant sources of CO_2 pollution is electricity production.To reduce greenhouse emission emissions, bigger attention should be paid to the widespread use of renewable energy sources [1.2].

Below current and projected policies, energy-related dioxide emissions can rise by 6 June 1944 from thirty three Gt in 2015 to thirty five Gt in 2050 [1.3]. Similar renewables will scale back carbon emissions considerably, however fossil fuels, like fossil fuel, generally give the renewable energy capability for economical energy production [1.6]. Once considering a largescale preparation of renewables, it's desirable that these systems scale back the necessity for ancient power plants. Renewable energy systems ar mature technologies that might give gradual replacement of ancient fuel technologies [1.8, 1.9], however the viability of such a substitution is restricted because of value and dependability issues. Combining varied renewable sources (hybrid systems) and energy storage systems could also be a way to handle these feasibleness problems. (Hybrid Renewable Energy Systems) ar characterised as systems that embody a minimum of one ancient and one renewable energy supply, or multiple renewables and presumably energy storage [1.10, 1.11]. because of the hourly dynamic regional weather and irradiation conditions, associate HRES supported over one renewable supply will support native energy demands additional with efficiency than one renewable energy installation [1.12]. the foremost basic HRES may mix electrical phenomenon and grid systems, leading to high dependability because of the presence of a system which will give required electricity once the system is unable to fulfill demand (lack of radiation, failure within the system, etc]. Energy storage combined with electrical phenomenon put in power may be intercalary to the HRES, accumulating the surplus of electricity in batteries. [1.13]. This paper provides associate in-depth feasibleness study of implementing associate HRES on Gouripur, supported a full year of energy demand calculations, real-world prices associated HOMER code for an economic and technical feasibleness study.

1.2 Objective

According to the REN21 renewables 2014 international standing survey, renewable energy accounted for 19% of world energy consumption in 2012, up from 16.7% in 2010 [1.24]. In Bangladesh, the agricultural population includes a lower electrification rate and an erratic provide of electricity [1.25]. Since most rural square measureas are situated off from the national grid, the govt. was unable to offer grid electricity to them [1.26]. Rural households square measure presently electrified by "Palli Biddut," however the inconsistent and restricted supplimation delay the expansion of society, health, education, and economical economic activities [1.27]. solely renewable energy sources, like solar, that square measure copious in rural areas, will be used as a complete device to spice up matters [1.28]

[1.29] [1.30]. the final word goal of this analysis is to check of on-grid and off-grid renewable energy systems in Bangladesh's rural areas. Gouripur, Mymensingh is a town with an everyday current demand of fifteen MW per day. within the close to future, a lot of residential places, industries and completely different sectors of demand are going to be accrued. To counter this huge quantity, a solar energy plant to scale back this fifteen MW and also the future demand. By engineered this on-grid and off-grid station, would offer power to the buyer unendingly. this suggests that plant able to cut back a great deal of pressure from national grid. this may produce employment and opportunities for the native individuals.Bangladesh's weather is ideal for solar energy plant. The radiation of Gouripur perpetually not blink to four kW/m2/day all year. throughout Gregorian calendar month, march, April and should the numbers go even higher. The radiation may be peaked at 5.860 kW/m2/day around throughout monthly with 4.65 kW/m2/day annually. The fuel and resources that Bangladesh's government imports for manufacturing power square measure pricey and harmful for setting. this sort of station can show the authorities by victimisation renewable energy we will cut back the strain on our power offer whereas saving cash. standard station instrumentality price a great deal and their fuel worth is unstable and can increase depend upon international scenario. therefore specializing in renewable power supply is that the smart and value effective alternative and conjointly scrutiny off grid with on grid pv system. For such things, correct use of Renewable Energy Sources in Gouripur could also be a possible and cost-efficient various to increasing power grids. [1.27–1.29].

1.3 Literature review

Along with grid-scale electrification, off-grid and distributed generation systems supported renewable energy square measure receiving worldwide attention. Bangladesh, with a area of 147,610 km2 and a population of roughly 166 million folks, is one amongst the world's most densely inhabited countries (1115.62/km2 in 2018). over seventieth of Bangladesh's population lives in rural areas and that they would like energy for his or her domestic use like preparation, crop process, lighting, agricultural industries, welfare and business activities and concerning fifty one of the population lacks access to electricity [1.31]. In Bangladesh is that the one amongst the foremost vital bottlenecks to economic development severe demand-supply gap in electricity. they need no selection however to possess planned restriction of electricity offer throughout the height amount since the capability of power offer facilities is merely concerning 4,000 MW compared to the height electricity demand of half-dozen,100 MW [1.32]. in keeping with a report by the Centre for Policy

Dialogue, Bangladesh is losing a minimum of 3.5% of its GDP thanks to power shortages (CPD) [1.33]. Bangladesh's power generation is heavily obsessed on fossil fuels. per the Bangla Desh Power Development Board, gas provides sixty four p.c of the electricity, coal provides 2.0 percent, diesel/furnace oil provides twenty seven p.c, hydro provides two, and therefore the remaining more or less five-hitter is foreign [1.34]. With dwindling gas provides Bangladesh's power sector is in danger, and diversification of primary sources has become essential. Researchers have drawn attention to the poor state of grid-connected rural electrification systems, that area unit marked by intermittent or no electricity flow for several hours per day [1.35]. Off-grid microgrids can facilitate rural folks in Bangla Desh gain access to electricity. the world microgrid market is projected to hit thirty eight.99 billion USD by 2022, with a compound annual rate of twelve.45 p.c [1.36] [1.37]. Researchers have recommended a range of hybrid device configurations counting on the resources out there at the involved locations [1.38]. Salehin et al. projected a PV-Diesel-Battery system for Bangladesh's northern region [1.39]. Nandi et al. counsel a PV-Wind-Battery system for Bangladesh's unsmooth regions [1.40]. Deepak et al. counsel a small grid system with a primary load of three kWh/day and used HOMER to simulate and analyze it [1.41]. S. Moury et al. (2009) [1.42] known rising energy demand as a roadblock to progress in developing countries like Bangla Desh. additionally, a inadequacy causes load shedding problems. HOMER simulations were accustomed investigate the viability of a renewable on-grid system in an exceedingly Bangladeshi home. Muyiwa S. Adaramola et al. (2014) [1.43] investigated the practicability of hybrid energy systems in Nigeria's rural and semiurban locations. the employment of PV/ Generator/ Battery hybrid systems was shown to be cheaper than diesel systems. Emissions of greenhouse gases were conjointly reduced. the price and interest rates of PV were investigated, and a comparison of the monthly tariffs of grid and hybrid systems was created. In geographical region, microgrid systems have become additional common with the development of a five MW star microgrid, Annobon Island in Equatorial Guinea currently has access to electricity twenty four hours every day [1.44]. The analysis of literature shows that the microgrid infrastructure centered on renewable energy has the flexibility to affect additional rural areas worldwide. The aim of the analysis is to use HOMER code to simulate and optimize the performance of PV off grid-on grid hybrid models.

CHAPTER 2
Renewable Energy of Bangladesh

2.1 Renewable Energy

Renewable energy, conjointly referred to as "clean energy," is extracted from natural resources, like daylight, wind, rain, tides, waves, and geothermic heat, that ar replenished on a personality's timescale. though renewable energy is often thought of as a latest technology, it's long been used for heating, transportation, and lighting. Renewables have become a a lot of vital power supply, accounting for over eighth of U.S. generation currently that we've got a lot of innovative and less-expensive ways that to harness and sustain wind and alternative energy. Renewable energy is increasing in the least sizes, from top star panels on homes that may sell electricity back to the grid to huge offshore wind farms. For heating and lighting, some rural communities believe entirely on renewable energy [2.1]. The demand for energy to power our homes, industries, and communities is increasing because the world's population grows. to take care of a property level of energy and shield our world from global climate change, innovation and enlargement of renewable energy sources is essential [2.2]. Renewable technologies accounted for nearly 11 November of worldwide primary energy in 2019 [2.3]. As of 2011, a couple of million households were served by tiny star PV systems, and lots of a lot of were served by micro-hydro systems designed as mini-grids. Over forty four million households place confidence in biogas generated in small-scale digesters for lighting and/or change of state, and over 166 million households use a brand new generation of a lot of economical biomass cookstoves [2.4]. At the national level, renewable energy already accounts for over 2 hundredth of worldwide energy provide in a minimum of thirty countries. National renewable energy markets ar expected to expand chop-chop within the returning decade and on the far side, and over one hundred twenty countries have set long renewable energy goals, as well as a 2 hundredth goal for all electricity made European Economic Community by 2020. Some countries have set even higher long policy goals, like 100% renewable energy. Outside of Europe, an outsized coalition of twenty or a lot of countries have set renewable energy targets starting from 100% to five hundredth within the 2020–2030time frame [2.5].

The number of renewable energy sources is anticipated to expand within the future because the demand for electricity will increase. this can lower the price of renewable energy, that is nice for each the climate and our wallets. Currently, the foremost common renewable energy sources are: alternative energy, Wind energy, Hydro energy, recurrent event energy, heat, Biomass energy, Ocean wave energy [2.2].

Renewable energy facts:

► By 2020, solar PV will account for 5% of global demand, and by 2030, it could be up to 9% **[2.2].**

► By 2050, renewable energies will be able to meet 95% of our energy demands **[2.2**].

► Africa could run on 100% renewable energy by 2050, according to Price Waterhouse Cooper **[2.2].**

► Solar PV panels have dropped by 99% in price over the last four decades **[2.2].**

►According to a report conducted in the United States, renewable energy generates three times the number of jobs as fossil fuels **[2.2].**

►Renewable energy investment has exceeded fossil fuel investment. The global demand for renewable energy is now worth more than $250 billion **[2.2].**

2.2 Available Energy Sources in BD

Renewable energies are the resources that ar reproduced endlessly by natural manners, is reused thanks to their environment-friendly and property properties [2.6]. Bangladesh's major energy choices ar gas, liquefied gasses, coal, biomass & biofuel, hydropower, wind energy and alternative energy. However, within the financial year 2015–16 gas and coal offer within the yr 2015–16 was furnished a complete of 2725 million cubelike feet of gas and a complete of 9253,7 million cubelike feet of condensation [2.7]. Energy usage of the gas type fuel, 63%, serious fuel, 18%, high speed diesel, 7%, foreign power, 5% Biomass, 2%, and three clean energy, seen in figure a pair of.1, 9,200 kilometer of substations, 332,000 kilometer of distribution system and 100% increase in power for 2016 [2.8].

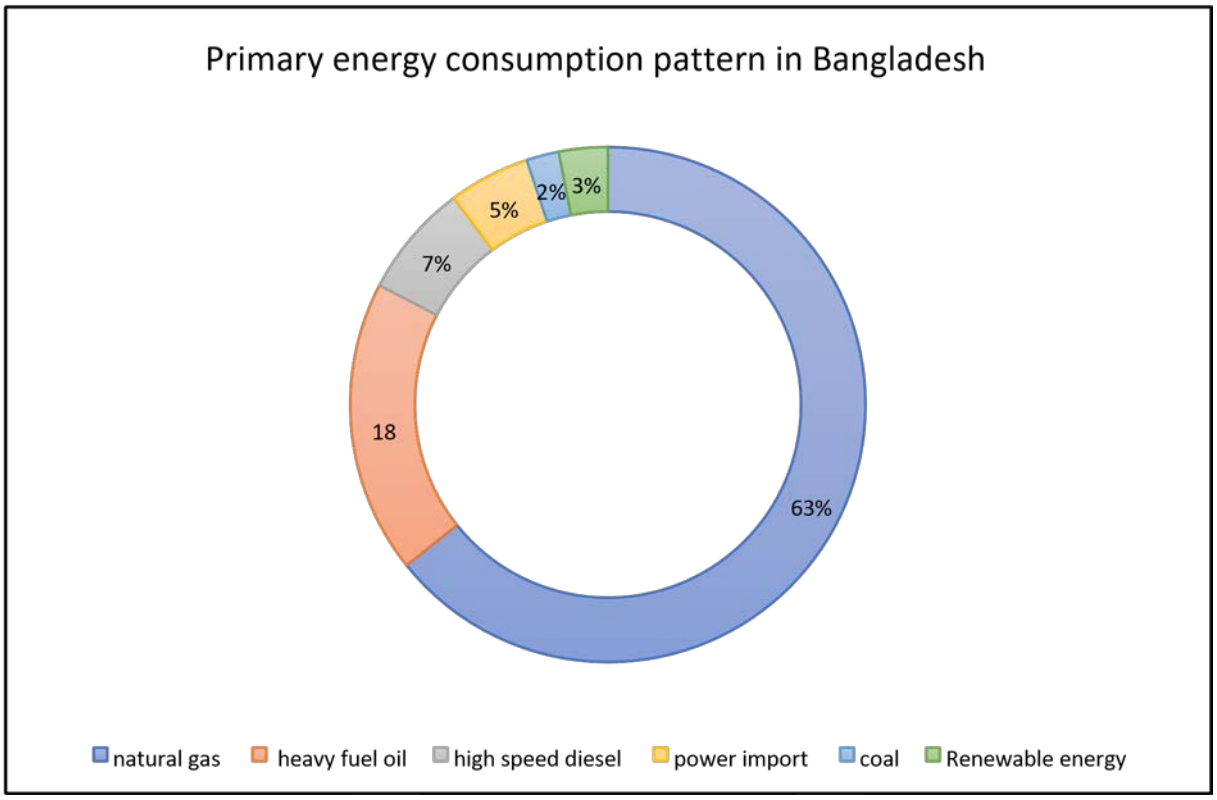

Fig 2.1: *primary energy consumption in Bangladesh* [2.8]

The core demand of human life is energy, and therefore the dynamic electricity generated worldwide is 20 trillion kWh [2.8]. Actively Bangladeshi energy use gas is forty first, plant food (7%), trade & Tea-Estate (17%), Captive power (17%), CNG (5%), industrial (01%), & Domestic gas (12%) and growth of two,5 million customers Figure 2.2. whereas sector wise residential, industry, company, agriculture and energy field customers another 50.07%, 34.47%, 9.09%, 4.58%, and 1.79%, as seen in Figure a 2.3 [2.9].

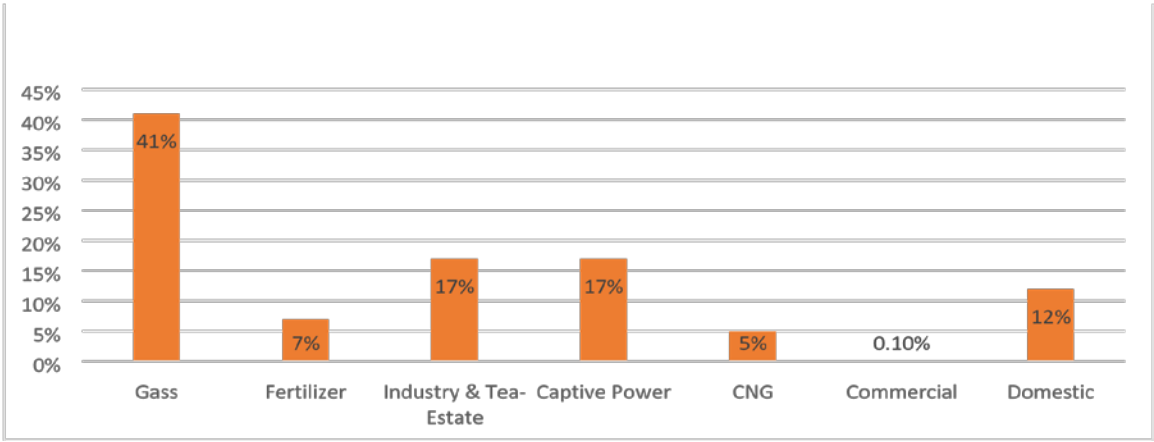

Fig 2.2: *Bangladeshi gas being consumed by the power*

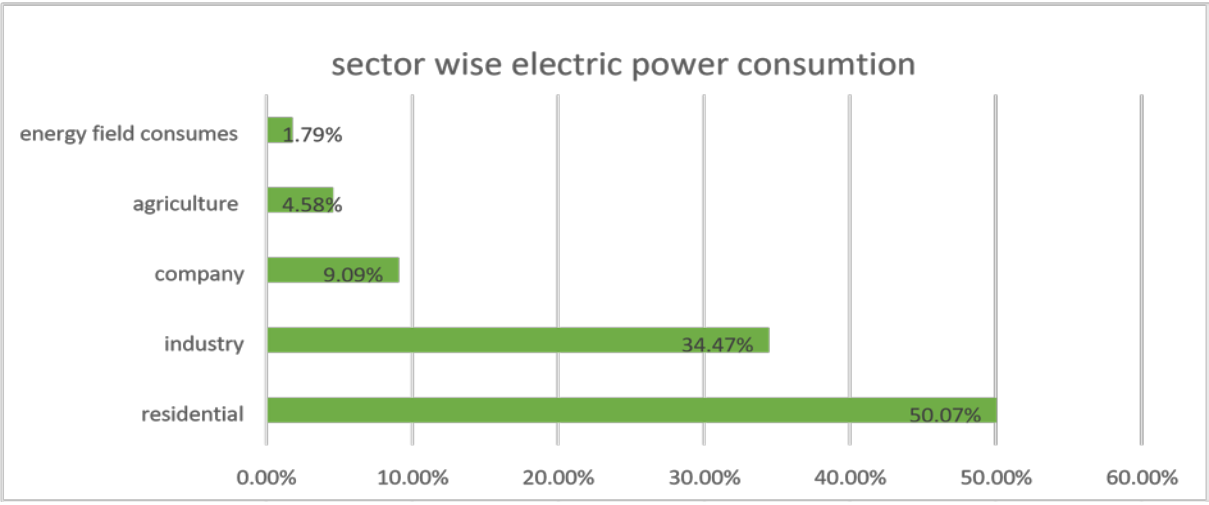

Fig 2.3: *Bangladeshi Sector wise electric power consumed*

2.3 Available Renewable Energy Sources

Renewable energies square measure the resources that square measure reproduced ceaselessly by natural manners, will be reused thanks to their environment-friendly and property properties, that play a essential role in meeting Bangladesh's energy demand [2.10,2.11,2.6]. The renewable energies accessible in Bangladesh embody star, biomass, wind, hydropower and heat and square measure the renewable energy chance in Bangladesh to eliminate the energy issue, however we tend to stay still so much lag behind within the use of those energies [2.6,2.9]. Figure 2.4 shows things of Bangladesh's inexperienced energy use. Total three-dimensional of the national electricity consumption includes a share of hour together with hydro, star and wind energy, 39.5% and 0.5%. the foremost speedily increasing clean energy sectors in People's Republic of Bangladesh square measure solar energy [2.12]. Table one but shows clean energy choices accessible in People's Republic of Bangladesh and their use of technology [2.11]. Fig.2.4 The contribution of various instigated renewable sources in People's Republic of Bangladesh [2.13]

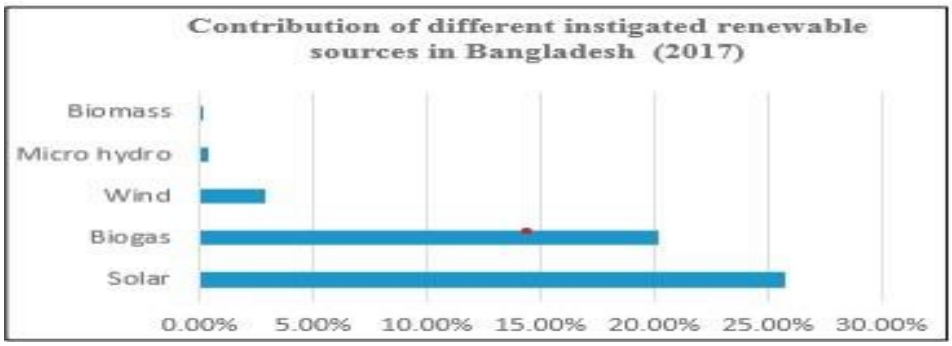

Fig.2.4: *The contribution of different instigated renewable sources in Bangladesh* ***[2.13]***

Table 1. Progress in the Renewable Energy Sector **[2.13]**

Methods	MW
Installation of Solar Home System (3.5 million)	150.00
Installation of Rooftop Photovoltaic (PV) at Government/Semi- Government offices	3.00
Installation of PVs on commercial buildings and shopping center	1.00
Installation of PVs by the consumer during new Electricity connections	11.00
Installation of Wind-based power plants	2.00
Installation of Biomass-based power plants	1.00
Installation of Biogas- based power plants	5.00
Solar Irrigation	1.00
Hydro Electric power generation	230.00
Total	404.00

2.4 Solar energy

Solar energy is that the world's leading property and renewable energy supply. Solar home, star PV (Figure two.5) and alternative energy concentrations (CSP) ar worldwide promising technologies for the assembly of radiation electricity. cell (PV module) panel ar wont to collect energy from the sun. PV modules and panels ar sometimes classified in terms of their overall DC output (watts) underneath the quality check Conditions (STC). the quality check Criteria shall be such by the operational (cell) module (25o C), the star radiance incident level a thousand W/m2 and therefore the spectral distribution of the atmosphere one.5. this output is generally eighty five to ninetieth of the STC rating [2.14]. thanks to its geographical location, Bangladesh uses radiation hugely [2.6]. Bangladesh's restricted share of the marketplace for electricity part stuffed with electrical generation (PV) and Bangladesh's geographical read from 241 0' 0″ N latitude and 901 0' 0″ E line of longitude [2.12, 22]. however the general solar power generation in Bangladesh is five hundred MW, and therefore the clean energy share is thirty-nine.5% [2.9]. By activity renewable energy for quite thirteen million rural individuals, the Bangladesh government-owned infrastructure construction company (IDCOL) is currently implementing three million satellite sensible

home (SHS). the standard sunray in Bangladesh is 4-6.5 kWh/m2 that may turn out more or less 1018x10*18 J energy, a daily average [2.15,2.6]. The future 2021 mega project power, initiated by the electricity minister. international Post quotes Bangladesh because the most chop-chop increasing country within the world with over fifty,000 SHS deployed and Bangladesh [2.16]. The distribution of SHSs by the installer is calculable and indicates that it's the biggest in Dhaka district and therefore the lowest in Sylhet district, as illustrated in figure a pair of.6 below. [2.11]

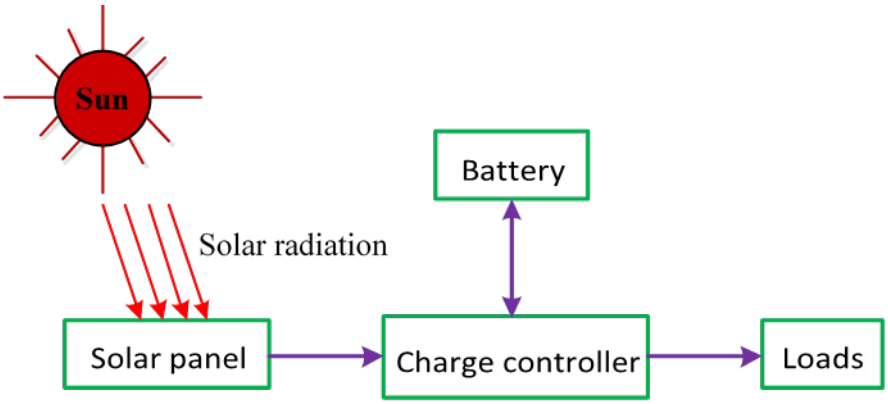

Fig. 2.5: A schematic illustration of solar energy utilization **[2.11]**

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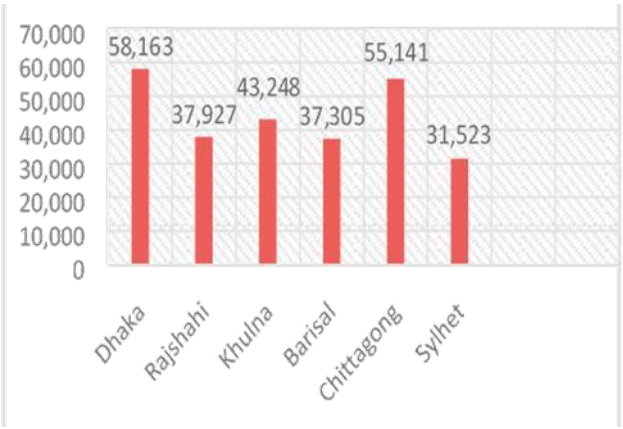

Fig. 2.6: Future Prospect of Solar Energy in Bangladesh

This technology may generate regarding one hundred MW of electricity by suggests that of average customary annual direct insolation within the country [2.17]. The network-connected electrical device or the thought of mini-grid can add a brand new layer to the solar power market [2.18]. Bangla Desh includes a potential for grid connected star PV as conferred in Table two [2.18]

Table 2: Solar energy potential in Bangladesh

Technology	Potential power (MW)
CSP	100
Grid connected solar PV	50,174
SHS	234

Bangladesh power development board and power division has also installed combined cycle plants, solar irrigation pumps, LED street light, and hot box cooker **[2.18].**

2.5 Hydro power

Hydroelectric power, additionally referred to as hydropower, is electricity generated by turbines that rework the P.E. of falling or quickly flowing water into energy [2.19]. electricity power plants use a rotary engine to come up with energy. The water from the dam flows through associate intake gate, and also the pressure created by the water flowing from the reservoir to the penstock spins the rotary engine blades, that flip a metal shaft in an electrical generator to come up with electricity. As a result, once the dam is completed, electricity will be provided at no cost. what is more, since water evaporates from seas and reservoirs and falls as rain within the mountains, the dam will be unbroken furnished with water as long because the reservoir is massive enough to satisfy the electricity demand [2.20]. electricity power was the foremost ordinarily used supply of renewable energy within the early 21st century [2.19]. Hydropower generates concerning 2 hundredth of the world's total electricity [2.21]. Asian country has lower electricity output sources than the remainder of the planet [2.22], and overall electricity production at the tip of 2014 was 879.0 MTOE, a 2.0 p.c increase over the previous 2 years and below the ten-year average of three.3 percent. In 2014, the world consumption of electricity was 406.83 percent, with China leading the approach (27.4 p.c of worldwide share) [2.23]. In distinction, Bangladesh's electricity generation capability was 230MW in 2014, with little world sharing. Asian country is additionally trying to extend hydropower generation through a spread of ways. With a capability of 230MW, the Kaptai station was Bangladesh's 1st hydropower plant.To increase hydropower output during this region, the Asian country Power Development Board (BPDB) intends to create a replacement a hundred MW station. In Bandarban, Bangladesh's 1st smallscale micro-hydropower project, with a capability of ten kilowatt, was designed to satisfy the energy

needs of a hundred and forty households and a temple. In Barkal Upazila, Rangamati, the govt. designed a fifty power unit micro-hydropower plant [2.21]. In Asian nation, some potential hydropower harvest home sites are investigated. In city district, the property Rural Energy Project surveyed locations for micro-hydro plants, with a complete capability of a hundred thirty five.5 MW. The Sangu and Matamuhuri watercourse basins, that have hydro potential capacities of 87MW and 80MW, severally, area unit thought of appropriate for affordable power generation. The Sangu and Matamuhuri comes area unit projected to provide three hundred GW and two hundred GW of energy per annum, severally. The Brahmaputra River Basin features a tremendous capability for large-scale power generation of one,400 MW [2.24]. In 1981, the Bangladesh Power Development Board (BPDB) and also the Bangladesh water program Board (BWDB) conducted a nationwide survey to spot potential hydropower plant sites. Table three shows the nineteen potential electricity power generation sites discovered throughout this analysis [2.25] [2.26].

Table 3: Prospective Sites for Micro Hydropower Development in Chittagong Hill Tracts [2.25, 2.26]

Location	Gross Sectional Area	Lowest Flood Level	Highest Level Flood	Power
Nunchari Tholi Khal, Khagrachori	11	0.06 (May)	3	5
Sealock Khal in Bandarban	25	0.15 (April)	4	30
Taracha Khal in Bandarban	35	0.1 (April)	6	20
Rowangchari Khal in Bandarban	30	0.1 (April)	5	10
Hnara Khal in Kamal Chari, Rangamati	20	0.15 (May)	4.20	10
Hnara Khal in, Hang Khrue Chara Mukh, Rangamati	25	0.12 (May)	4	30
Monjaipara Micro Hydropower Unit	15	0.50	1	10
Bamer Chara Irrigation Project		10		

After three years, in 1984, a team of Chinese experts discovered 12 possible hydropower sites in Bangladesh's hill tract areas. Mahamaya Chara, in Mirsharai, Chittagong, has the greatest

potential for developing a small-scale hydropower plant of those sites. At the foot of the dam, a mini-hydro plant are going to be engineered, which can be high-powered by reservoir water [2.25]. The government Engineering Department (LGED) has been making an attempt to satisfy the energy demand in hill tract areas by victimization hydro energy resources. As a result, LGED discovered many potential sites in Bangladesh's remote hill tract space. Lists potential sites additionally as their power generation potential in Table four [2.25, 2.26]. Micro-hydropower plants have the capability to be in-built Sitakunda, Richang, and Toibang, port [2.21]. The Teesta barrage, which incorporates nineteen potential power generation sites, is Bangladesh's largest irrigation project. Figure 2.7 depicts the proportion of electricity created in Bangla Desh from hydropower resources from 1971 to 2018. [2.21]

Table 4: Potential Small Hydropower Sites Identified by BPDB and BWDB [2.25, 2.26].

District	River/Stream	Potential of Electrical Energy (kW)
Chittagong	Faiz Lake	4
Chittagong	Choto Kumira	15
Chittagong	Hinguli Chara	12
Chittagong Hilltracts	Sealock	81
Chittagong	Lungichara	10
Chittagong	Budichara	10
Sylhet	Nikhan Charaa	26
Sylhet	MadhabChara	78
Sylhet	Banga Pani Gung	616
Jamalpur	Bhugi Kanga	60 kW for 10 month 48 kW for 2 months
Jamalpur	Marisi	35 kW for 10 months 20 kW for 2 months
Dinajpur	Badul	24
Dinajpur	Chawai	32
Dinajpur	Talma	24

Dinajpur	Pathraj	32
Dinajpur	Tangon	48
Dinajpur	Punar Haba	11
Rangpur	Bari Khola	32
Rangpur	Ful Kumar	48

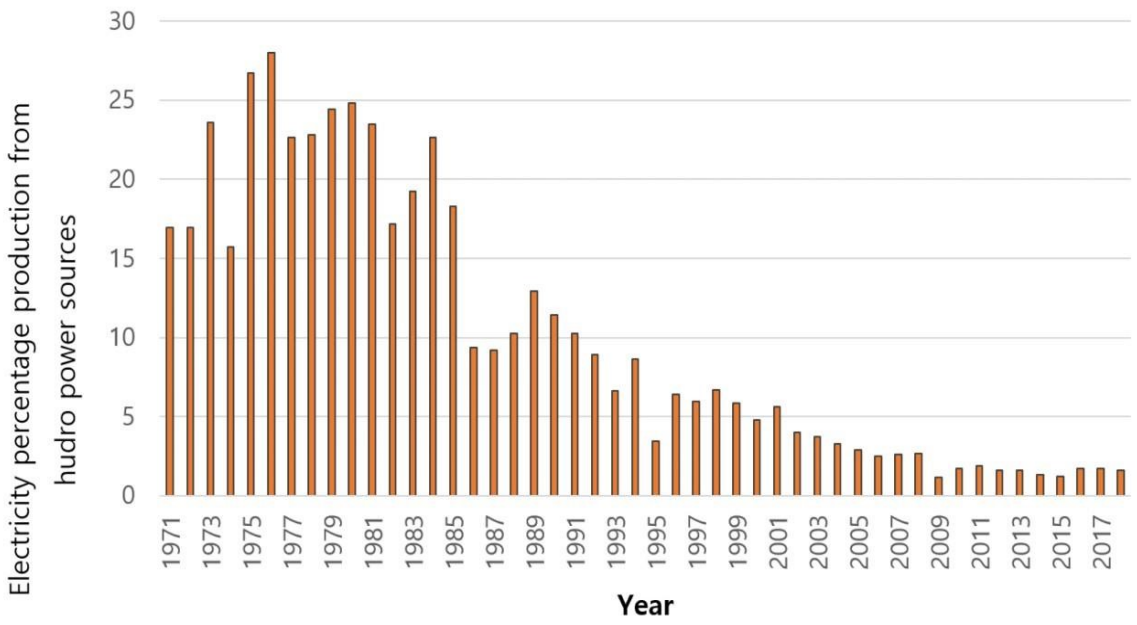

Fig 2.7: Electricity percentage production from hydropower sources in Bangladesh from 1971 to 2018

2.6 Wind power

An alternative energy plant may be a set of wind turbines in one location that square measure wont to generate electricity. Wind farms zero in scale from some dozen turbines to many hundred turbines detached over an oversized space. Onshore and offshore wind turbines also are viable choices. [12.27] Wind turbines remodel the wind's K.E. into energy. A generator may be a device that converts energy into current. [2.28] Wind turbines care for a basic principle: instead of victimisation electricity to make wind (as a lover does), they use wind to make electricity. The propeller-like blades of a rotary engine square measure turned by the wind around a rotor, that spins a generator, that generates electricity. Wind may be a kind of alternative energy that's generated by a series of 3 events:

1. Irregularities on the surface of the planet.

2. The earth's axis of rotation.

3. The sun heats the atmosphere unevenly. [2.29] and [2.30]

There square measure some options of turbine for generate energy. like automatic orientation, gear box, banishment, turning of the blades, generation, observance etc [2.30] At the top of 2018, wind generation had a four.8% share of world energy consumption, up from 3.5% in 2015. Wind was the second-largest renewable energy supply for power generation. With 591 GW of world energy, wind generation generated around five-hitter of world electricity in 2018. (568.4 GW is onshore). [2.31]

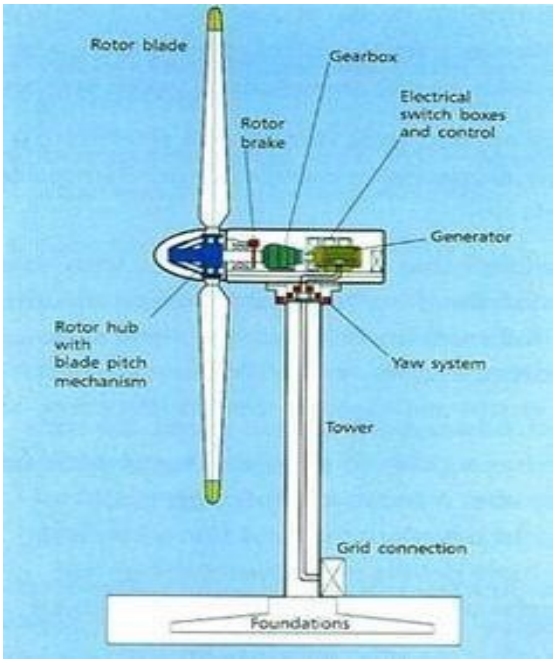

Fig 2.8: *diagram of wind energy power procedure. [2.32]*

2.7 Wind energy and power plant in Bangladesh

Bangladesh is subjected to very large quantities of precipitation and robust wind speeds (gusts) throughout hurricane season because of its sub-tropical setting and monsoon and hurricane seasons. the typical annual wind speeds in Asian country square measure poorly recorded, and there's a inadequacy of knowledge. Low wind speeds square measure predominant on Bangladeshi lands, in keeping with without delay on the market information. apart from onshore wind speeds, no (substantial) information on (far) offshore wind speeds is quickly on the market [2.36].

Wind energy potentiality -The practicability of manufacturing electricity from Bangladesh's wind resources is investigated. The abstract thought is that there ar deficient wind resources. There aren't any long wind analysis studies centered on applicable heights and information on wind energy out there. [2.36]

value of wind energy and power station -Wind energy in Asian nation would be pricey thanks to the shortage of promising wind resources and also the planned high investments for grid link. Low average wind speeds combined with typically harsh stormy weather like typhoons and flooding would necessitate dedicated turbine styles, creating wind energy rather more pricey. [2.36]

2.8 Biomass energy

Natural biomass springs from live or dead animals like plants, trees, crops and their residues and is employed because the largest provide of renewable and clean resources to store and move. Biomass absorbs carbonic acid gas to come up with microorganisms required for its growth within the presence of alternative energy for chemical action. Biomass is additionally with chemicals carbonic acid gas-neutral once it consumes virtually similar or higher amounts of CO2 because it grows that it releases as a fuel once burning [2.37]. Figure 2.9 shows schematically the transfer of biomass energy provides and also the carbon cycle [2.38].

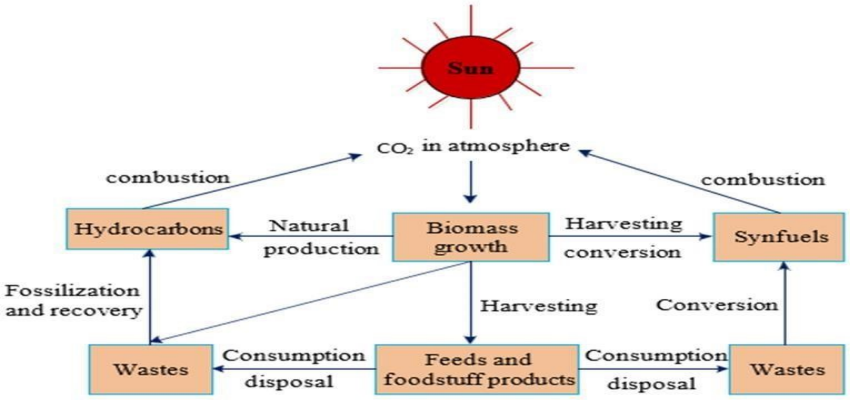

Fig. 2.9: Main features of the biomass energy technology with carbon cycle [2.38]

Bangladesh possesses a vast number of materials for biomass, including corn, crop rubbish, timber, jute stick, waste animals, urban waste, bagasse sugar cane and other sources associated with its rain-flooded ecology. In addition, almost 70% of people depend directly or indirectlyon biomass energies. Bangladesh possesses an enormous variety of materials for biomass, as well as corn, crop rubbish, timber, jute stick, waste animals, urban waste, pulp sugar cane and different sources related to its rain-flooded ecology.

additionally, nearly seventieth of individuals rely directly or indirectly on biomass energies. However, about 2,6 billion individuals worldwide area unit hooked in to biomass for cookery and heating biomass [2.37]. the standard share of biomass for year 2013 accounted for nearly hr of the general world intake of biomass, whereas the full electricity was extracted from biomass simply one.8% [2.39]. Agriculture could be a major economic operation in Bangladesh's with regarding sixty fourth of overall land use. The country thereby generates a large vary of waste from totally different crops such rice, sugar cane, vegetables, wheat, juice, peas, cocoa, maize, millet and cotton and groundnut full-grown within the country throughout the complete of the year. Rice, that covers regarding ninety six.35% of total food cereals, was the most important agricultural crop full-grown regarding thirty four.36 million tons in 2013–2014. the full output of crop plants was around sixty one.09 million metric tons in calendar 2012-2013. Moreover, the bulk of the family in Bangladesh has horse, buffalo, pig, sheep and eutherian as well as chicken and duck. the state had fifty 3,02 million Bos taurus and 293,235 million chickens within the year 2012-2013. however in Bangladesh, this animal waste and human excretion are going to be a serious chance for biomass. conducive to the biomass energy business, however, area unit vital forest junk as well as tree leaves, twigs, barks, roots and saw dusts. Bangladesh creates an oversized amount of town and industrial waste that's appeared to be the energy offer due to speedy urbanization. Agriculture sector and timber residues, animal excretory product and concrete waste, additionally as energy generation, will play an important role. Via totally different technology like biogas, chemical process, transformation etc., these biomass provides is created into fuel for the facility plant. Bangladesh's biomass production capability for business 2012-2013 was nearly 213,81 million tons adequate 1344,99 peter joules (PJ) [2.37]. The reserves had associate annual power capability of forty five,91 million a lot of coal equivalent, which, as shown in Table three, would generate around 373,71 trillion watt hour (TWh) of renewable and property electricity [2.40]. additionally to the current, biogas could be a gasses fuel made by biomass disintegrating, within the inert atmosphere, principally eutherian manure, animal waste and organic solid waste (CH4). Biogas is provided by anaerobic digestion, for illumination, cookery and manufacturing electricity, and therefore the remainder is used as fertiliser and fish fodder as seen in Figure two.10 Bangladesh has associate vast capability to provide biogas from its current residues and waste resources [2.37]. a quest has shown that in two012-2013 regarding 2,91 billion money supply of biogas is generated from usable animal dung equals one,455 billion litres of diesel [2.40].

Table 5 Total biomass potential in Bangladesh in 2012–2013 [2.40]

Biomass sources	Biomass generation (million tons)	Energy content (PJ)	Electricity Generation (TWH)	Coal equivalent (Million tons)	Gas equivalent (BCM)
Agricultural residues	94.10	582.33	161.80	19.88	14.72
Forest residues	17.44	210.64	58.53	7.19	5.33
Livestock	88.89	456.41	126.81	15.58	11.54
MSW	13.38	95.61	26.57	3.26	2.42
Total	213.81	1344.99	373.71	45.91	34.01

In table 5 the potential for biomass from 2012 to 2013 has shown to understand the electricity generation.

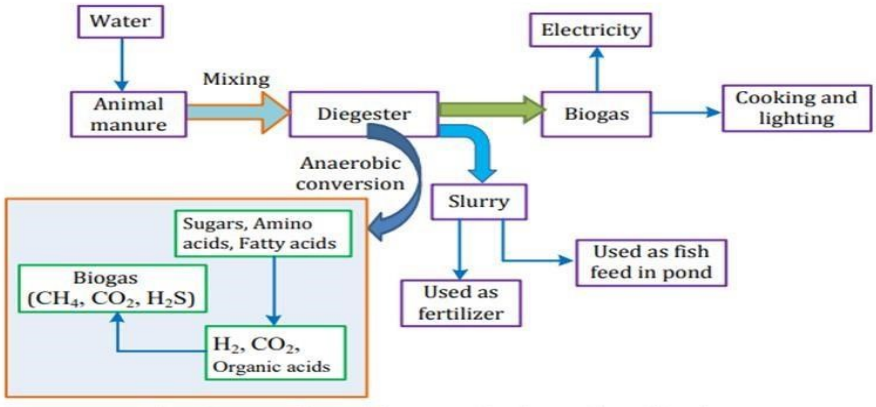

Fig. 2.10: An outline of biogas production and it's utilization

Biogas plants are getting common among farmers in Bangla Desh. Infrastructure Construction Company restricted (IDCOL) and several other governmental agencies, designed virtually seven,9612 domestic biogas plants throughout the country till Oct 2014. IDCOL has funded 2 250-kW and four hundred kW-capacity rice husk chemical action plants and eight power generation plants for the biogas market. In distinction, the biogas plants in China and Republic of India area unit concerning

45,000,000 and five million. Organic fuel may be a worldwide rising energy supply within the transport trade [2.37]. The generation and use of biofuels within the world amounted to around 116.6 billion liters in 2013[2.39]. Bangladesh is embryonically manufacturing biofuels with ten plants of transformation to come up with organic oil from waste pipes and different biomasses. however thanks to lack of adequate care and technological skills the plants don't work properly [2.37]. whereas there aren't any energy crops offered commercially for the biofuel production, for the assembly of biodiesel it's potential to cultivate pennata and Jatropha carcasses effectively [2.46,2.47,2.48,2.49]. Biomass block may be a light-weight solid, loose biocarbon fuel with a better heat worth than biomass [2.37]. however solely 19881 plenty of rice husk block ar created annually [2.41].

2.9 Agricultural Remains capability and Energy Renewal

The capability of farming and residue remains extremely primarily based upon unavailability of land use and development filtrations. In 2014-2015, the aush, aman, boro output (husked) was over the previous year, with 2.328 million tons (MT), 1.4 large integer MT and twenty eight.8 MT. Even then, within the study free last year by the u. s. Department of Agriculture (USDA), overall production of rice might rise from the previous year to three.48 large integer tons by zero.60% [2.42]. Bangladesh's annual recoverable agricultural residue amounts to nearly forty two MT, sixty three of that stay as field residues, whereas thirty seventh stay on residues of growth [2.43]. The estimates in Table half dozen show that, close to one million 470,300 million heaps of wheat straw and seventeen,760 million heaps of saw-pulp will be transported on over eighteen 000 block machines and three,538,400 million heaps of rice husk and twenty two,900 million heaps of rice paw [2.44].

Table 6: Domestic activities energy consumption 2015 in Bangladesh: whole divisions (per household/year: average overall family circle) [2.44]

Sorts of Energy	Wholly use	Boiler		
		Cuisine	Steam rice	Others
Saw dust (kg)	8	8	0.02	0.02
Firewood (kg)	1186	1065	29	93
Tree leaves (kg)	502	471	30	0.9
Crop residue (kg)	708	539	164	2.7
Dung cake/stick (kg)	524	504	16	4.2

2.10 Forest Residue Potentiality and Energy Repossession

Forest contaminants embrace superfluous pole trees, mining remains, and rough or terrible dead timber. Forest residues are often used as timber, wood works, manufactory, hardboard, fencedwood, particle production and lots of different sawmilling operations. Asian nation has a mean wood production of 167.4 million blockish metres, 1.0 million bamboos and five.2 million heaps of fuel woods annually, [2.45] as illustrated in Table seven.

Table 7: Forest residue recycling product value [2.44]

Forest Residue production	Quantity	Price value
Wood	Bangladesh 167.4 million cubic feet	Tk.64.07 billion
Bamboos	1.0 million	Tk.23.07 billion
Wood fuel	5.2 million tons	Tk.46.50 billion.
Rubber	1552 tons	Tk.123.90 billion
Households tree plantation (12.5 million people)	2.06 million(family)	Tk.123.90 billion

The ability to be used as a renewable energy supply within the world has been seen by biomass. In Asian nation, 16.7% of land is roofed by forest land and seventieth is roofed by farmland. Today, Asian nation is making an attempt to expand the utilization of biomass energy by promoting environmentally property, potential economic considerations. this is often such a lot of researchers need to foster biofuel and biopower technologies. the govt. of Asian nation has place a selected effort into making a large-scale energy generation bio-power facility. [2.42]

2.11 On Grid Solar Power System

On grid alternative energy system or grid tie system is that the commonest system that is wide used. during this system there has no would like any battery. the alternative energy generation system directly connected to the general public electricity grid. There used either star electrical converter or small electrical converter. The electricity made by the system is routed to the grid from wherever it's wont to run the varied appliances.

The most important matter of the on grid solar plant is that if the solar pannel doesn't work properly due to bad weather condition or any other problem or if we consume more electricity than it generates than we can use the extra electricity from the grid connection.

Working Principle:

Let's have a look on how a grid solar system works by some simple following steps :-

Step 1: First of all the electricity produced by the solar panel in DC mode. Then the electricity sent to the inverter.

Step2: In this step the inverter converted the DC current to the AC current. because house hole is only equipped in AC current.

Step3: From the inverter the generated electricity directly go to the external grid. there has a worry that when the sun is not enough reflection than how our home get power from the solar plant. That's why we use the grid to get non-stop clean and green electricity not depend on weather. [2.50,2.51,2.52]

2.12 Off Grid Solar power system

A solar battery could be a series of solar (or electrical phenomenon) cells which will be utilized by photovoltaic effects to get electricity. These cells area unit organized on the surface of solar panels in a very grid-like pattern. An off grid power grid is additionally called Stand alone power systems (SAPS). It operates by generating energy from solar panels and victimisation it through a charger controller to charge a solar array. victimisation AN electrical converter, this energy is then reworked in order that it will fuel home or business appliances. this method isn't connected to the electricity grid and therefore includes storage of batteries. Off-grid solar systems area units are well engineered to supply ample power throughout the year and supply comfortable battery capability to satisfy the necessities of the house, even within the depths of winter wherever there's usually a lot of less daylight.The Main components of an Off-Grid System are:

Solar panels: The exact size and production capabilities of the first ingredient of the individual solar panel array will depend on the amount of sunlight available in the area, the accessible roof space, and the requirements for energy consumption.

Solar Battery: A solar panel is needed to permit the house to continue running once the sun goes down. As solar panels turn out excess energy, solar storage devices will charge throughout the day. rather than simply missing out on all that obtainable alternative energy, electric battery permits it to be maintained for later use. one battery, or maybe electric battery bank, is employed looking on energy wants.

solar Charge controller: so as to save lots of the battery, the solar charge controller or device is crucial. to forestall overcharging and damage, the controller regulates the voltage and current obtained by the solar panel.

solar electrical converter (AC) or solar charge controllers (DC): The alternative energy system includes a solar electrical converter, additionally said as a solar device or a PV electrical converter, to convert the DC (DC) gathered by the solar array array into the electricity (AC) for running most well-liked house appliances and natural philosophy. employing a complete device for associate off-grid facility.

Generator (Optional): As a backup to the device, it'd be price finding associate alternate supply of electricity. throughout the depths of winter, this can be needed once solar output is at its lowest. many house owners UN agency use off-grid systems mix them with a generator that may offer the electricity needs of the house. [2.53]

CHAPTER 3

HOMER SOFTWARE

3.1 About Homer

HOMER Energy's HOMER professional microgrid software system is that the world normal for microgrid designs and optimisation in power sectors, from village electricity and island utilities to gridconnected campuses and military locations. HOMER (Hybrid optimisation Model for Multiple Energy Resources) was developed at the National Renewable Energy Laboratory and is currently upgraded

and sold by HOMER Energy. It combines 3 powerful tools in one computer code program, permitting engineering and social science to figure along.

3.2 Simulation

HOMER may be a simulation program at its core. it'll decide to simulate a feasible system for all potential instrumentality combos. HOMER may mimic tons of or perhaps thousands of systems betting on however we tend to originated our scenario. HOMER simulates a hybrid microgrid's functioning over the course of a year, in time increments starting from one minute to 1 hour.

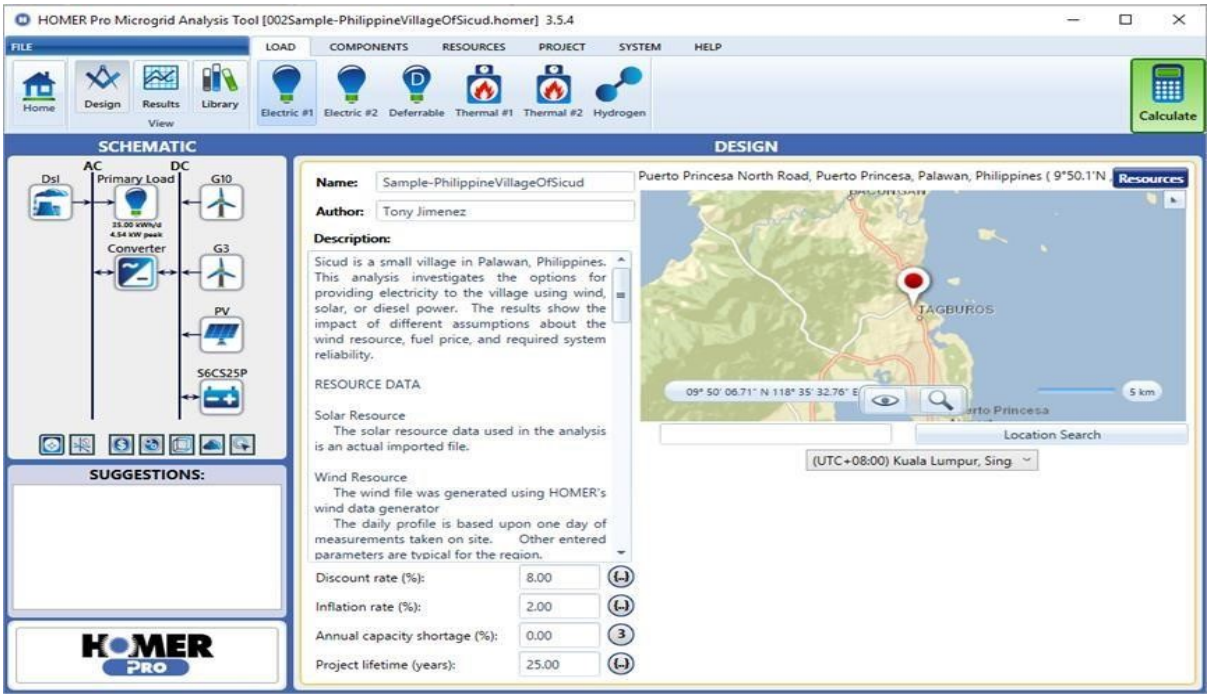

Fig- 3.1- Simulation part

3.3 Optimization

In a single run, HOMER examines all conceivable combos of system sorts and arranges them in step with the optimisation variable of alternative. HOMER professional includes a brand new optimisation methodology that creates choosing the bottom value decisions for microgrids and different distributed generation wattage systems abundant easier. The HOMER Optimizer could be a distinctive "derivative free" optimisation methodology created significantly for HOMER. HOMER has been a world workhorse for locating economically possible microgrid and distributed generation solutions for over twenty years, using a solid, well-tested “modified grid search” algorithmic program. The grid search approach contains a ton of benefits for people that have loads of expertise with microgrids, however it's tough for newcomers. it has been accustomed value

hundreds of thousands of systems in over a hundred ninety countries. the aim of HOMER is to get the foremost efficient instrumentality combination for faithfully meeting the electrical load. the quantity of various combos of apparatus is within the thousands or tens of thousands. every "case" that HOMER evaluates necessitates the program simulating associate electrical system over the course of a year. The changed grid search methodology necessitates the user specifying all out there search decisions, whereas HOMER Optimizer doesn't. All that's needed could be a website, information of the electrical load that has to be handled, and a few evaluation estimates for numerous elements (for example, dollars, Bangladeshi monetary unit per kilowatt for star electrical phenomenon panels). All elements in HOMER have default prices, though these area unit merely estimate. though a a lot of versatile algorithmic program, such as. though HOMER Optimizer seems to be a straightforward selection for improvement software system, applying several improvement techniques to electrical systems is usually not an appropriate work, because the uncommon techniques out there need simplicity that is false which shows incorrect results (a false optimum). The classic HOMER technique is powerful since it considers all conceivable instrumentality combos given by the user and doesn't become “stuck” during a false optimum. HOMER professional will permit the user to be terribly specific regarding wherever the improvement is required, and so let HOMER build the ultimate call. due to constraints, a user is also restricted within the quantity of star PV which will be used. in order that they are often terribly specific this, whereas lease HOMER search associate primarily infinite house of storage sizes.”

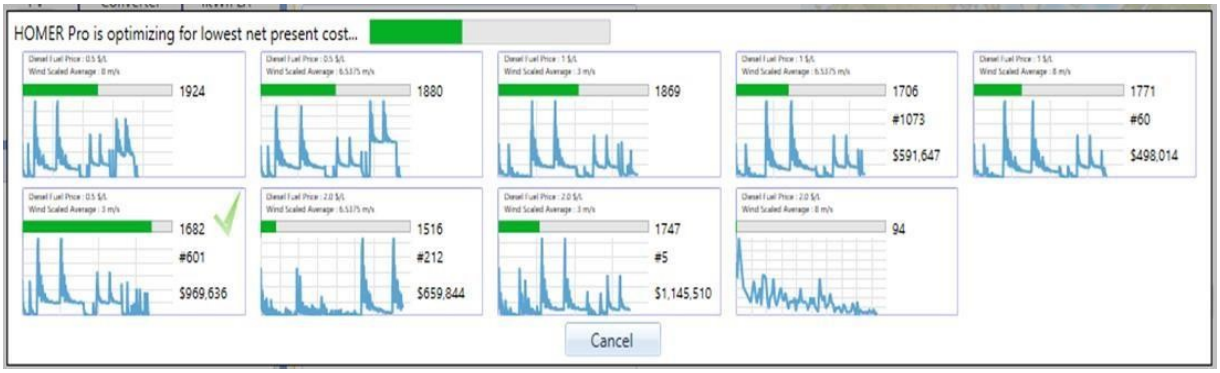

Fig- 3.2 - Optimization part

Both grid-connected and off-grid systems may be sculptured with the HOMER Optimizer. solar photovoltaics, wind turbines, diesel generators, inverters, and batteries area unit samples of solar electrical phenomenon systems. The user may be a lot of precise concerning what sizes ought to be thought of once the HOMER Optimizer has found an inventory of candidate systems, and so repeat the model to higher depict a sensible preliminary style. this is often HOMER's most vital update in its 24year history. HOMER was created at the National Renewable Energy Laboratory of the United States

Department of Energy and has been downloaded by over 140,000 people from all over the world.

3.4 Sensitivity Analysis

Because users cannot management all parts of a system and can't confirm the importance of one variable or selection while not conducting a whole bunch or thousands of simulations and scrutiny the outcomes, HOMER permits users to raise as several “What if?” queries as they require. during a single run, HOMER permits you to match thousands of choices. This helps the user to watch the results of parts on the far side their management, like wind speed and fuel prices, and comprehend however the best system changes as a results of these changes.

Modules: HOMER Pro can be customized with up to 9 individual modules to meet our specific modeling need

- solar
- Biomass
- Hydro
- Combined Heat & Power
- Advanced Load
- Advanced Grid
- Hydrogen
- Advanced Storage
- Multi-Year
- MATLAB Link

3.5 Solar Module

We can acquire daily radiation in (KWh/m2/day) from the star module. we've got 2 choices underneath the resource tab. the primary is star GHI, whereas the second is star DNI. the whole alternative energy incident on a surface is understood as world horizontal irradiance (GHI). Direct traditional Irradiance (DNI), Diffuse Horizontal Irradiance (DHI), and ground-reflected radiation frame the whole. star GHI is employed by HOMER to calculate flat-panel PV output [2].The amount of radiation received per unit space by a surface that's perpetually command perpendicular

(or normal) to the rays that are available in a line from the direction of the sun at its current position within the sky [3] is thought as DNI (Direct traditional Irradiation). By choosing the transfer om net icon within the Homer professional package, we will transfer these 2 varieties of knowledge. there'll be 2 options: (National Renewable Energy Lab) and (National Renewable Energy Laboratory) (NASA Surface meteorology and star Energy). we have a tendency to could acquire our daily sun radiation index by choosing one and clicking transfer. For the whole year, the index can show the clearness index, daily radiation, yearly average radiation, and scale yearly average price.

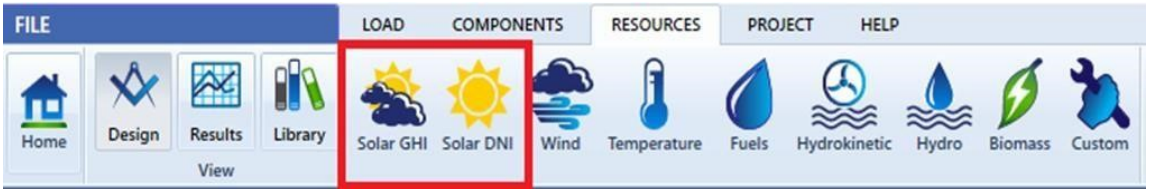

Fig- 3.3 - Solar module part

Solar resource

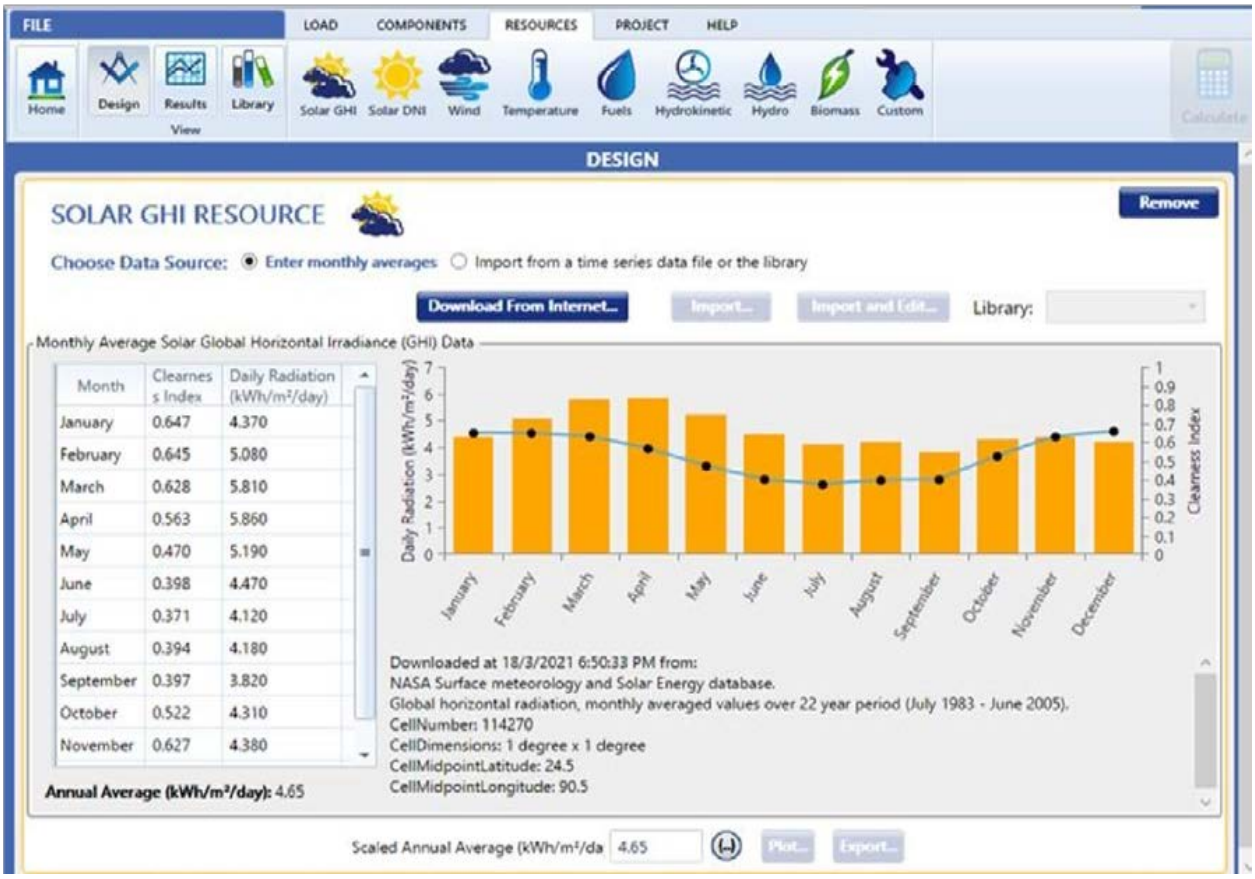

Fig- 3.4 - Solar resource part

Solar component

in component part capacity, capital, replacement cost, operation and management cost, life time, efficiency size can add

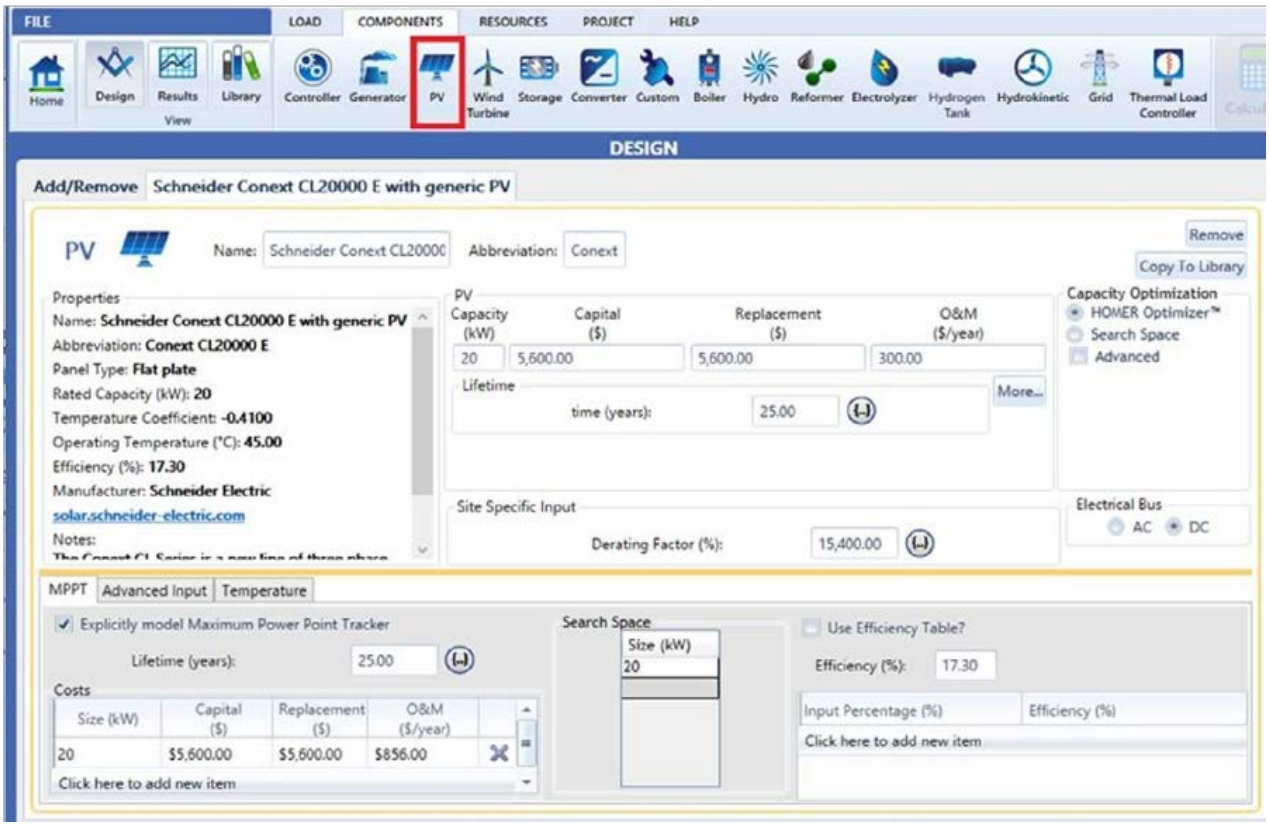

Fig- 3.5 - Solar component part

The other topics are started from the next page

3.6 Biomass Module

In Biomass module we can add biomass chemical process and biogas-fueled or cofired generators in simulation. we are able to additionally add biomass resource, the biogas fuel, and therefore the biogas-fueled or biogas cofired generator for energy generation. The Biomass module will facilitate those users UN agency model systems running on most forms of biomass feedstock and method|chemical change|chemical action} process.

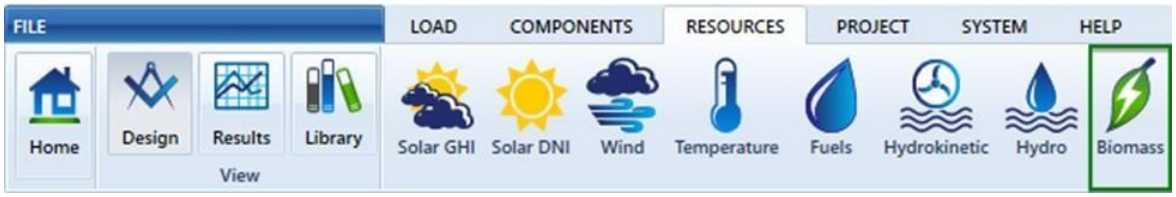

Fig- 3.6 - Biomass module part

Biomass Resource

we can specify the assembly and prices of biomass feedstock within the bio-energy menu the menu. Raw biomass usually cannot be utilized in a generator that's why we've got to convert the biomass to biogas through a method known as chemical action.

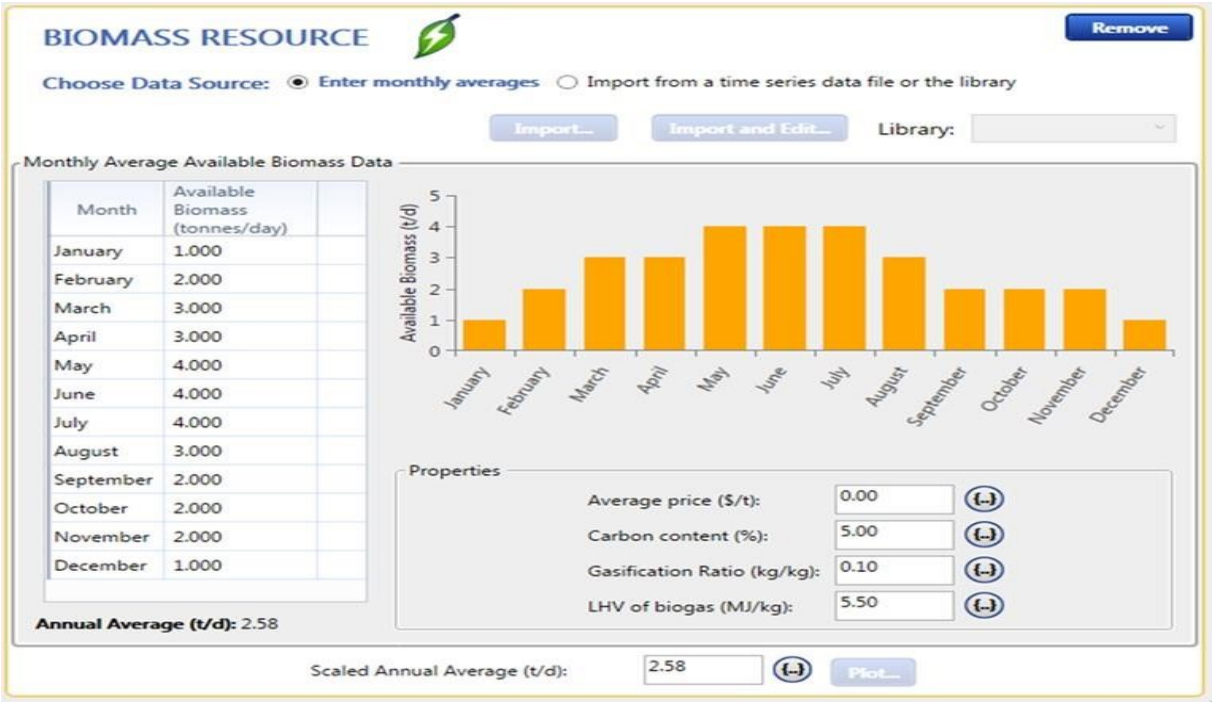

Fig- 3.7 - Biomass resource part

in the gasification ratio slot. Then biogas can be burned in a biogas or cofired generator like any other fuel. By adding available biomass amount in the data table. We can get annual

average amount of biomass (tons/day)/. We also have to add the average price, carbon content, LHV of biogas.

3.7 Hydro Module

In the Hydro module provides the hydro and hydro elements. The stream flow may be delineate as twelve monthly values or Associate in Nursing foreign statistic for the Hydro resource. Hydro module is appropriate for customers WHO use ancient, portable, or micro-hydropower generation model systems.

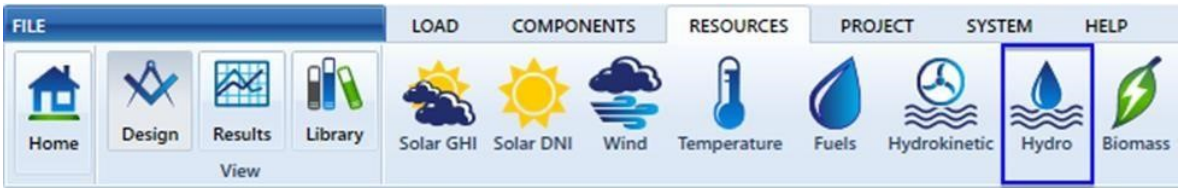

Fig- 3.8- *Hydro module part*

Hydro Resource

Fig- 3.9 - Hydro resource part

Hydro Component

In the Hydro-Component menu we will determine the hydro system prices, available heads, configuration flow speeds, operational ranges and losses.

Fig- 3.10- Hydro component part

3.8 Combined Heat and Power Module

The integrated heat and module would be needed for building heating systems. types of systems could embody boilers, cogeneration, heat recovery and different energy device. within the combined heating and module, 2 thermal masses ar added: the warmth load controller, the warmth recovery half, and also the generator parameter.

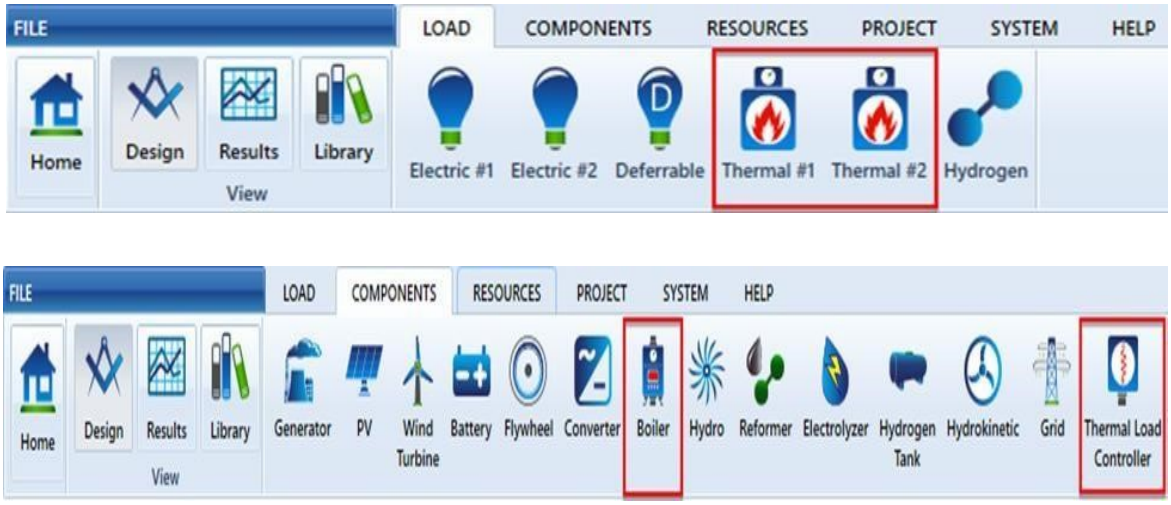

Fig- 3.11 and Fig- 3.12- Combined Heat and Power Module

Thermal Loads

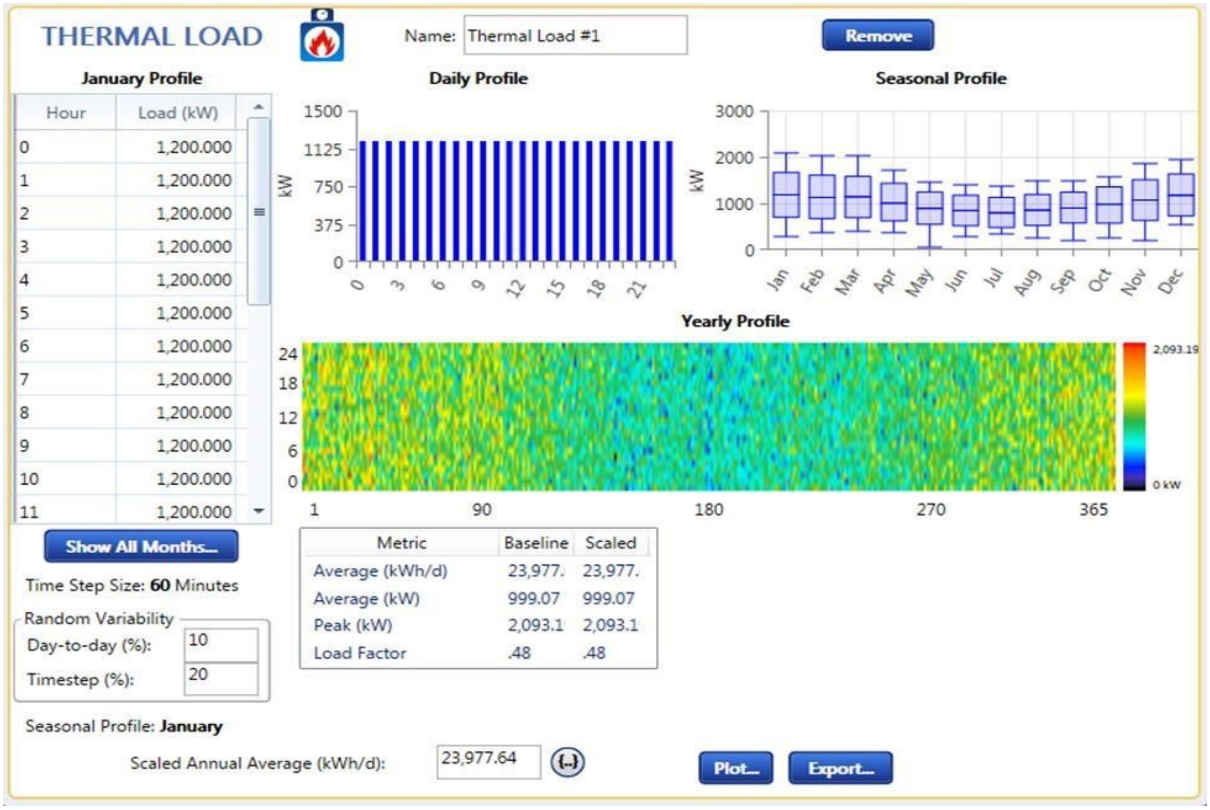

Fig- 3.13 - Thermal load

An industrialised building or appliances like a hair-raiser for thermal extraction, or another heat power device, could also be designed by a thermal load. additionally to the generator menu, the integrated thermal and module adds the warmth convalescence magnitude relation parameter. Sets this parameter to variety beyond zero to piece the integrated heat and power grid.

Boiler Component

We need to put in a boiler if we've a thermal load. HOMER won't take into thought the thermal load power insufficiency, therefore the boiler will offer the portion that haven’t met. that is why the boiler has infinite power.

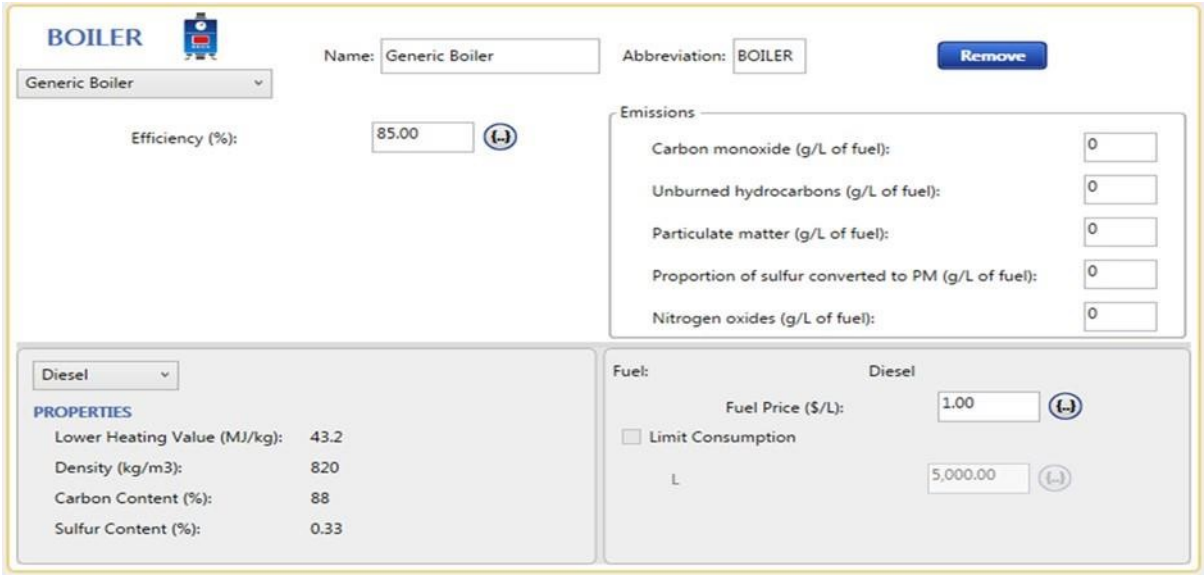

Fig- 3.14 - Boiler component

Thermal Load Controller The thermal load controller transforms further power into liquid. The 'Not enclosed within the optimisation' different would disregard the thermal load controller's prices and permit unrestrict

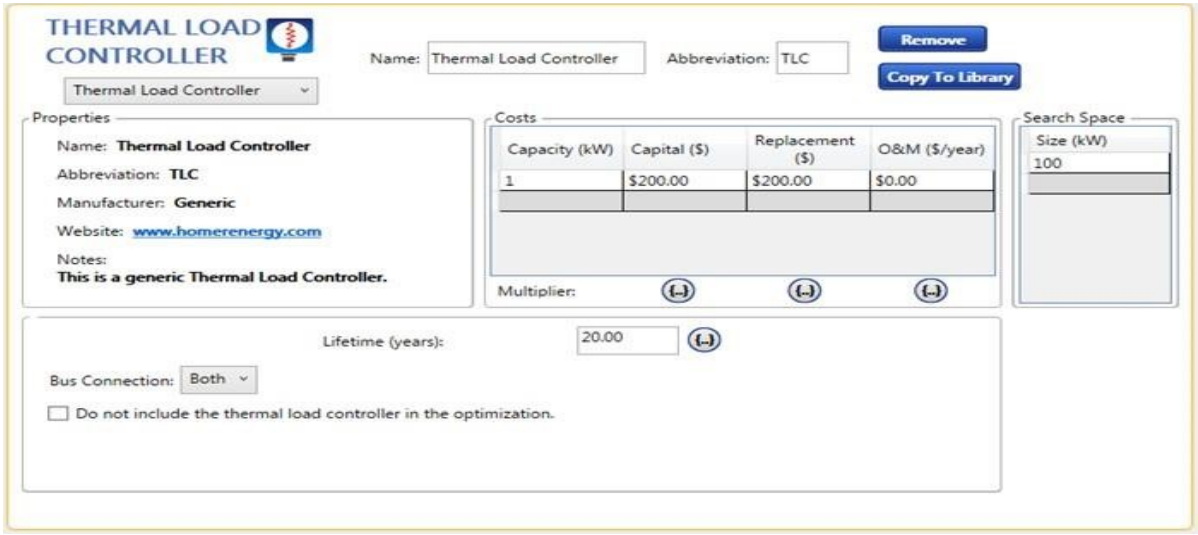

Fig- 3.15 - Thermal Load Controller

3.9 Advanced Load Module

The Advanced Load module can serve **SERS** who build models of both AC and DC loads or want to model deferred loads, such as pumping or HVAC.

Fig- 3.16 -Advanced Load Module

Deferrable Load

An extra electrical load and defraudable load is applied to the advanced load. Deferrable masses square measure masses that need some energy equipped, however will look ahead to electricity and wish not be delivered at any given time.

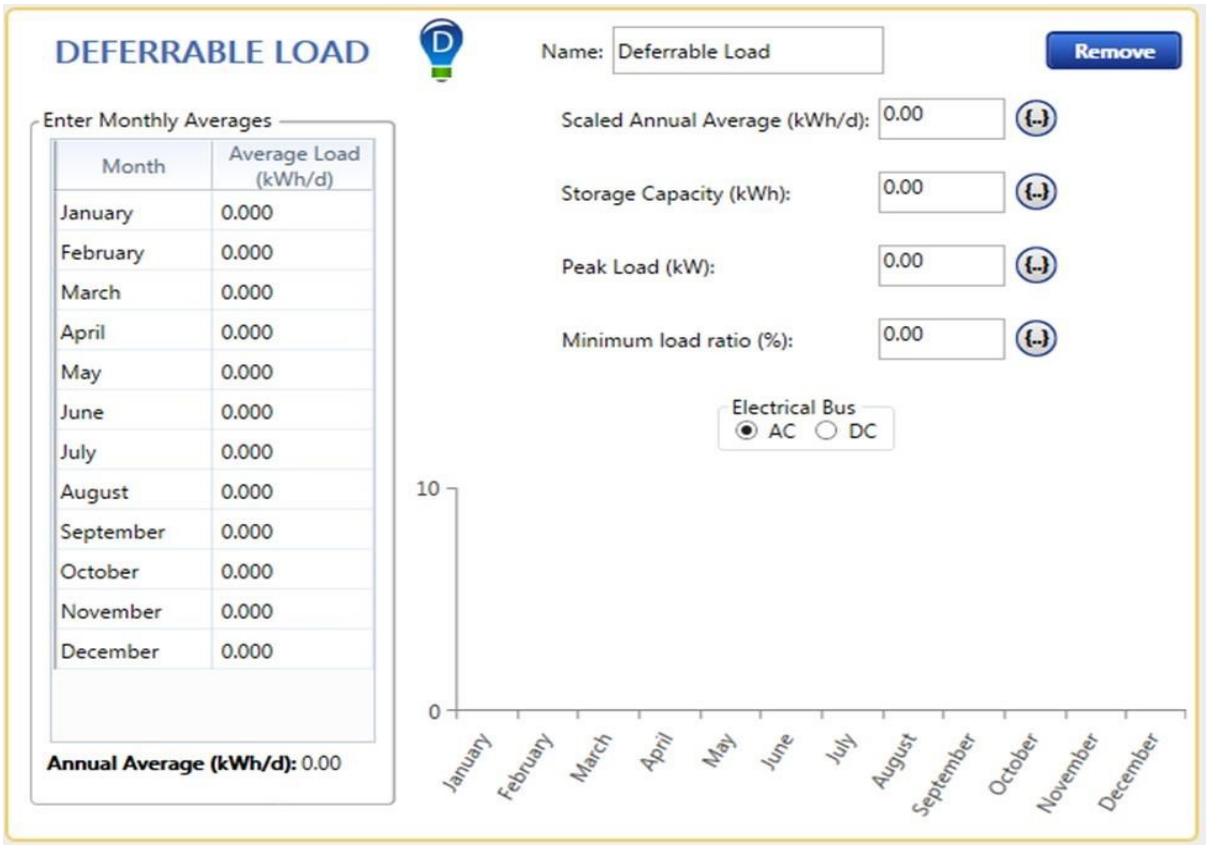

Fig- 3.17 - Deferrable Load

3.10 Advanced Storage Module

HOMER's changed Kinetic Battery Model is free via the publicised Storage Module. The MKBM (Modified Kinetic Battery Model) includes rate-based losses and temperature performance variation. we'll build new batteries utilizing MKBM and apply them to our HOMER models, yet as live results for HOMER models with A battery that's incorporated during this model, utilizing the Advanced Storage Module.

Details

The MKBM has been designed for convenience. though the interior functions of the model area unit rather difficult, the specifications for planning the battery with the MKBM area unit rather simple. Users with Advanced Storage Module purchases will build advanced storage elements for themselves. several knowledge sheets contain all the knowledge needed.

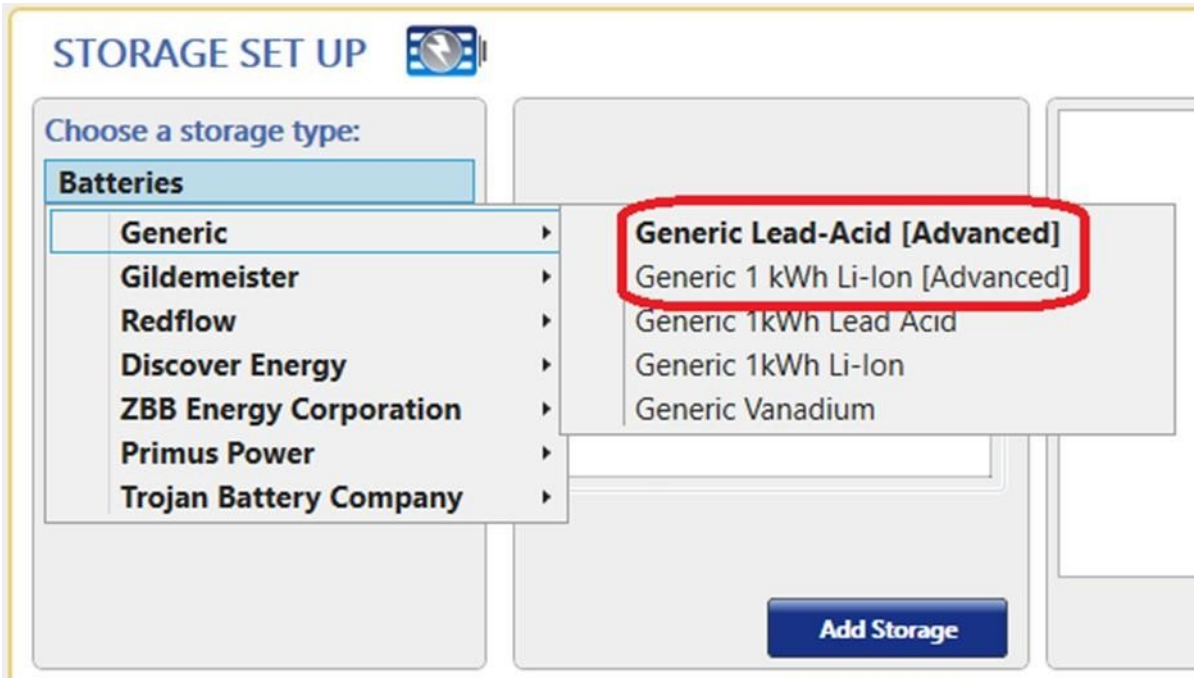

Fig- 3.18 - Advanced Storage Module

The MKBM incorporates a series battery resistance that increases the precision of the model. This upgrade may be considerable for certain batteries, under some circumstances.

In combination with the Multi-Year Module, the Advanced Battery Module is a lot of economical. The updated kinetic battery model involves degrading potency over the battery's lifetime whereas HOMER is operated in multi-year mode. throughout the tests, this measure of decay tracks the temperature, period and partial depth of the discharge amount. The multiannual module permits America to simulate changes which will occur throughout the course of a project. Degraded PV, escalating grid value, load rise, and fuel price rises square measure simply a number of of the merchandise criteria we have a tendency to could use in a very HOMER Package with the multi-year module.

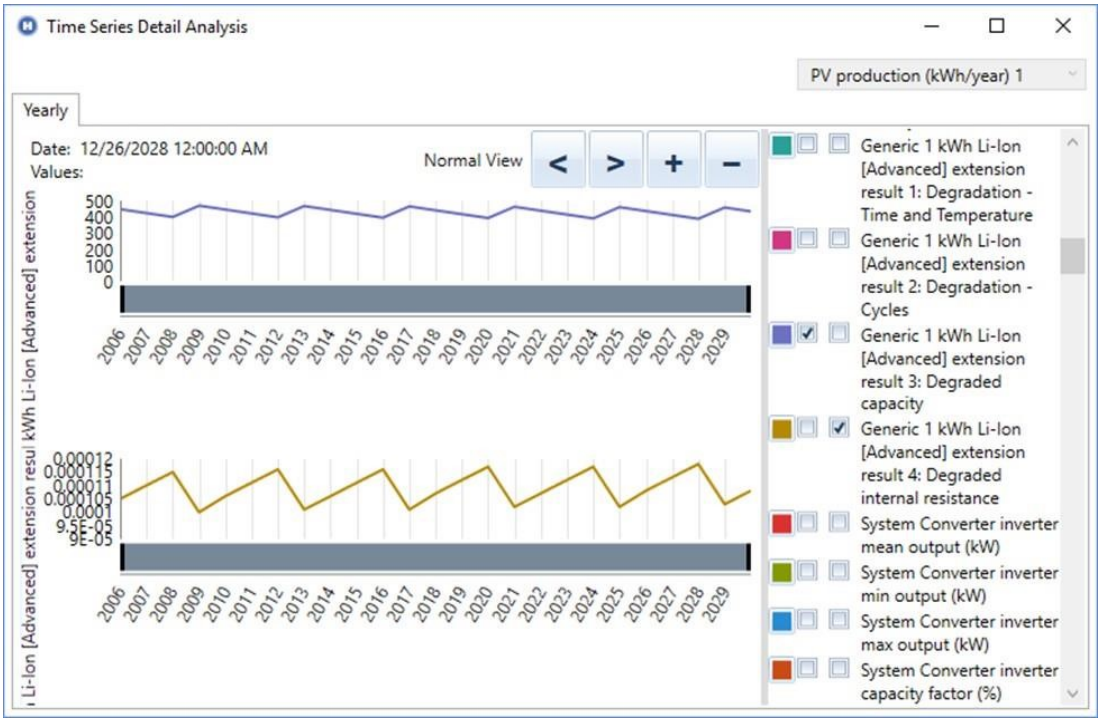

Fig- 3.19: Time series detail analysis

The multi-annual module permits us to simulate changes which will occur throughout the course of a project. Degraded PV, escalating grid worth, load rise, and fuel price rises are just a number of of the merchandise criteria we have a tendency to may use in a very HOMER Package with the multi-year module.

3.11 Multi-Year module

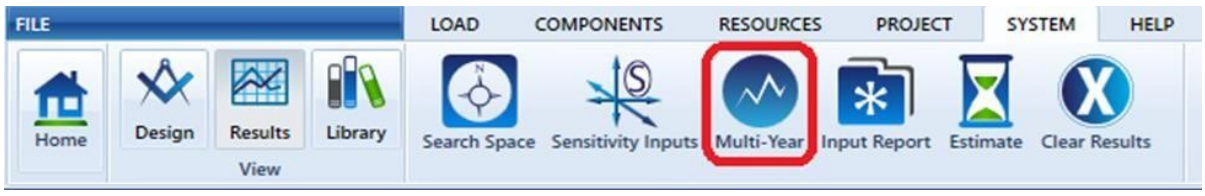

Fig- 3.20 - Multi-Year Module

The multi-year module allows us to see annual share depreciation or growth. additionally, variety of multipliers are entered each year to balance a prediction that isn't simply a share annually.

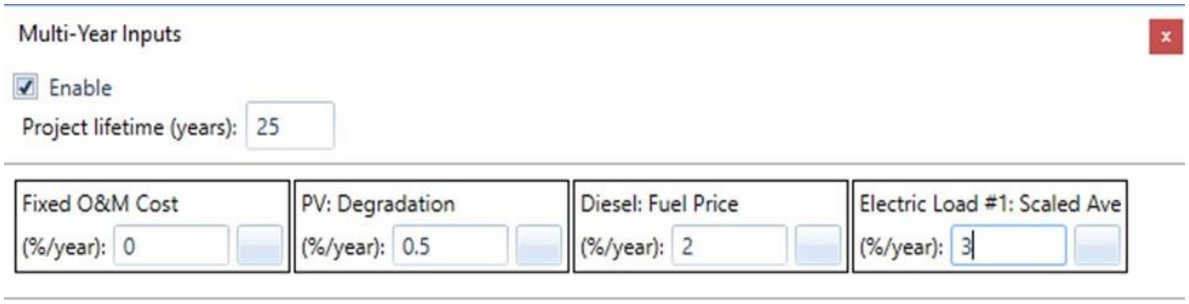

Fig- 3.21 - Multi-Year input

The multi-annual module offers HOMER results some options. per annum within the simulation results, we'll examine the project life. additionally, the Multi-Year Kit adds a multi-year bundle that helps U.S. to trace the results throughout the method.

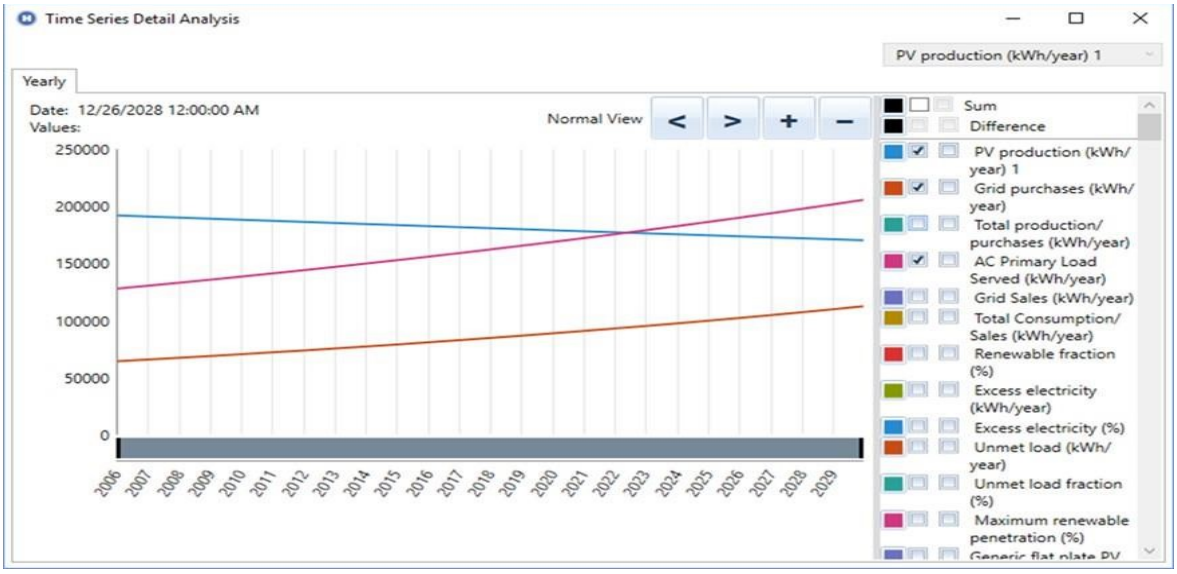

Fig- 3.22- Multi-Aannual Module

The Advanced search module unlocks the total ability of those 2 modules victimization the trilateral Module. Includes the potential to model battery degeneration over battery life. The Innovative Energy Modul. solely with the multi-year module can the side of advanced storage be usable.

3.1 MATLAB Link Module

The parts that are operated to succeed in load over a selected length of your time are highlighted in HOMER's "dispatch Strategy Algorithm" (solar, battery, turbines, etc.). mistreatment the MATLAB Link Module, we have a tendency to could develop and use our own dispatch strategy within HOMER professional. The user's MATLAB primarily based transmittal rule are enforced into the HOMER professional application. we have a tendency to could have complete management over our work model mistreatment the MATLAB affiliation tool. The MATLAB affiliation is simply one in every of several capabilities that permit engineers to nearly management the operation of a microgrid. HOMER professional is evolving on the far side modeling to turning into a microgrid and DER operations network, because of the final half, the Generator Order Dispatch, and 2 Apis. this can be attainable as a result of to the Controller API, that permits controller makers to distribute their algorithms among HOMER. The controller algorithms is engineered and tested in HOMER mistreatment MATLAB, and so disseminated to our own engineers or shoppers mistreatment the general public edition of HOMER. The controls are distributed likewise. A separate MATLAB license from Mathworks is critical for the MATLAB affiliation Module.

CHAPTER 4

SIMULATION

4.1 User Load Profile

We'll begin by determining the amount of consumers in our distribution space. This equates to around 18,000. The substation then gives us an estimation of what proportion energy is consumed per month therein location. to get a winter calculation from the station, and that we notice that the energy used over the winter is 360,000 units. The industrial unit of electricity is that the unit. throughout the summer, the number of electricity consumed rises to 500,000 units. one unit equals one kilowatt-hour. However, in Homer package, we have to utilize kW. currently we'll treat the 3600000 units that are used as one quality wasted unit. Since it has been a month, we'll split it by thirty in thirty days and gift it as per day. This equates to 3600000/30 = 120000 units. This interprets to a hundred and twenty thousand units per day consumed by eighteen thousand people. However, as a result of we'd like to specify the worth of kW in Homer's package, we should set it to twenty four for twenty-four hours. we are going to acquire the hourly unit computation by doing therefore. 120000 kWh divided by twenty four hours equals 5000 kw. Then we'll program Homer to use 5000 kW. However, the common price is 5,000 kw, indicating that consumers oft use it during this manner. However, the hour is calculated to work out that hour is a smaller amount or a lot of, and it's consumed during this manner. As a result, we are going to additionally install Homer package in such the simplest way that once we calculate in Homer package, we are able to figure a hundred and twenty,000 units despite what percentage units we have a tendency to enter.

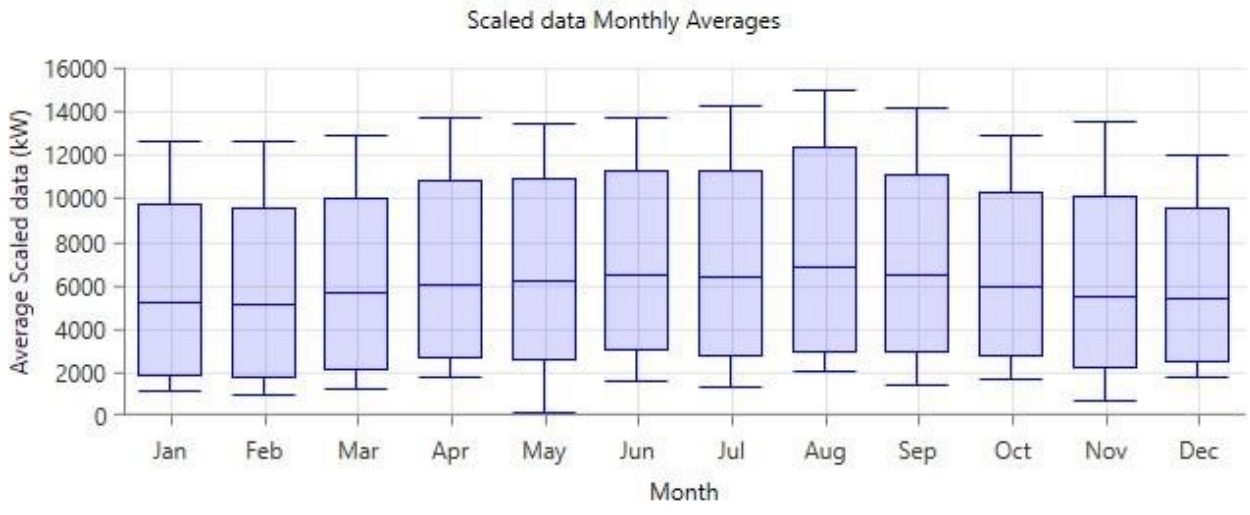

Fig:4.1 Monthly average load profile

4.2 Solar resources

Solar radiation knowledge was collected from HOMER software package for location Patbazar Rd, Gouripur, bangladesh (24°45.3'N, 90°34.1'E) from "NASA surface meteorology and solar power Database". The annual scaled average solar radiations were found to be 4.56 kwh/m2/day and therefore the most solar radiations were found to be 5.860 kwh/m2/day throughout April. information shows that the potential for radiation of this location is nice and might manufacture huge quantity electricity by using electrical phenomenon panels. A profile indicating radiation and clearance index created by the HOMER for the situation is shown in

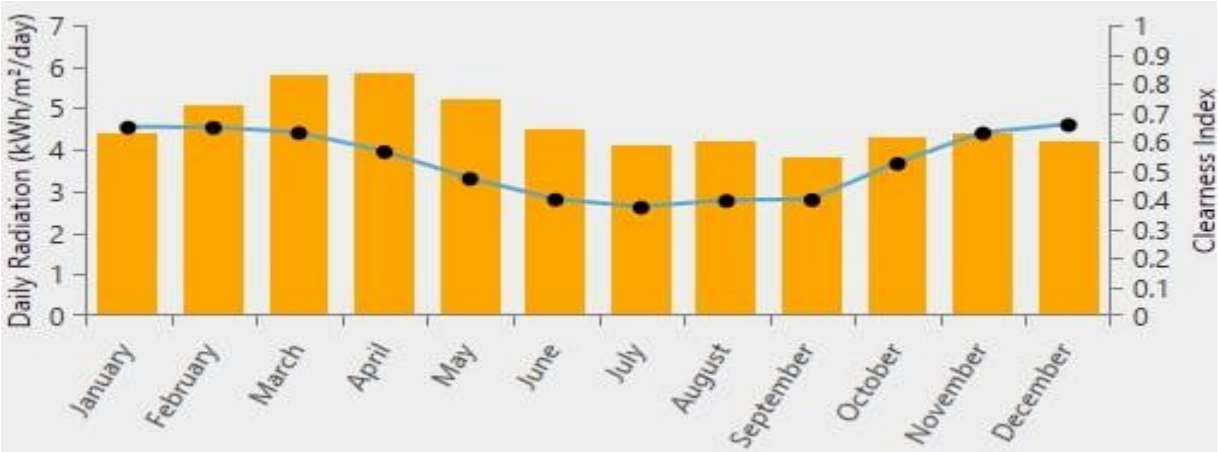

Fig:4.2- Solar radiation profile

4.3 System design & analysis

In this off gird and on grid power generation system, four main elements square measure solar panels, converter, battery and grid. so as to gift the economical comparison off-grid system and on grid system, we are going to use virtually same elements the pv panels, converters, batteries can keep same. throughout on-grid association, grid are utilized in Homer package to induce the results we are going to let the homer optimisation to decide on the facility setting for pv panels, and converters. And for batteries, seven string was hand-picked, the quantities of batteries can declare by homer. .

4.4 Photovoltaic modules:

The capability of the entire alternative energy capability can return from Homer, homer can optimize the capability in line with the load demand throughout day time and night time. Peimar SG370M is seventy two CELLS monocrystalline solar panels, Nominal Output (Pmax) 370 W, Voltage at Pmax (Vmp) 40.1 V, Current at Pmax (Imp) 9.23 A, most Series Fuse Rating fifteen A, Module potency nineteen.07%. value for every panel is 250 U.S. dollar, with thirty years linear power assurance and twenty years product assurance. the whole details is given below table 4.1

Sr No	Parameters	Units	Values
01	Capital cost	per panel/$	250
02	Replacement cost	per panel/$	195
03	Operation & maintenance cost	per panel/$	5
04	De-rating factor	%	80
05	Lifetime	Years	20/30
06	Slope	Degree	24.775
07	Rated power	W	370
08	Open circuit voltage, Voc	V	48.93
09	Short circuit current Isc	A	9.81
10	Maximum power voltage, Vpm	V	40.1
11	Maximum power current, Ipm	A	9.23

Table 4.1: Peimar SG370M parameters and values

4.5 Converter

converter convert dc power that comes from pv panels into ac power for ac load. ordinarily a device is rated with the regard to the facility of star module, however during this analysis Homer software system can give the facility of device for the ultimate answer. The device can operate 24hours each day till its life time expire cause there's no power supply except the solar energy.

KEHUA France KF-BCS 630K-B

Converter with 630 kw capacity, max dc voltage (input) 1000 Vdc. Dc working voltage range 500-900 Vdc, max dc current 1167.

For grid connection		
Parameters	**Units**	**Values**
Rated Ac output power	kw	63
max Ac output power	Kva	693
rated output voltage	Vac	400
output voltage range	%	(-15%-10%) settable
max output current	A	1000
For off-grid connection		
Parameters	**Units**	**Values**
rated AC output voltage	Vac	400
output voltage precision	%	1
max output current	A	1000
rated output frequency	Hz	50,60 (50) selected
Overload capability	%	110
max efficiency	%	99.03
cooling type		intelligent air cooling

Table 4.2: KEHUA France KF-BCS 630K-B parameters and values

4.6 Storage Battery

Batteries will hold the extra power that will come from the pv panels and will supply that power when load demand needs it.

Parameters	Value	parameters	values
Capital cost	318750$	Maximum capacity	590Ah
Replacement cost	318750$	Roundtrip efficiency	96%
Operation/maintenance cost	360$	Maximum charging current	1570A
Lifetime	30	Maximum discharge current	1569.7A
Nominal voltage	720V	Minimum state of charge	35%
Nominal capacity	425kWh		

Table 4.3: NEC DSS 425kWh 923kW parameters and values

The resulting schematic of the hybrid plant after adding all the required components is shown in the ***fig 4.3 and fig 4.4***

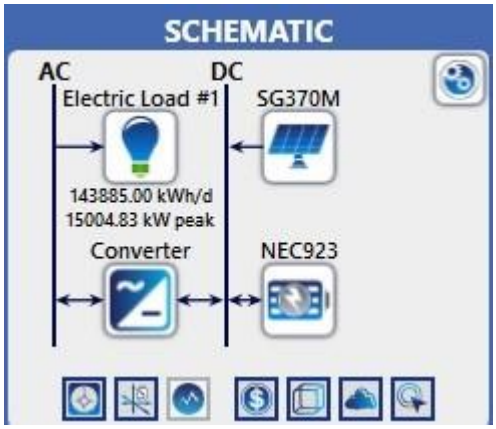

Fig 4.3: Schematic of the off-grid plant

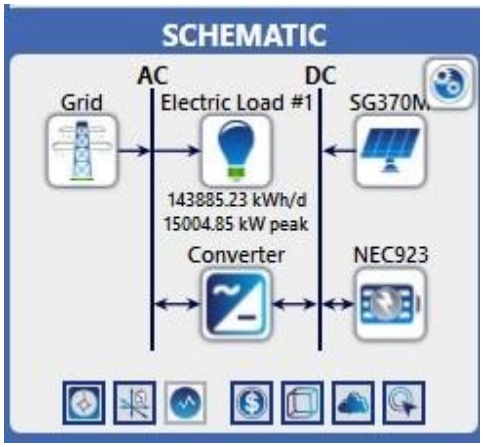

Fig4.4: Schematic of the grid connected plant

CHAPTER 5
RESULT AND DISCUSSIONS

In this study electrical phenomenon power generation system designed to fulfil the demand of a community. System was simulated in Homer software system to optimize the look and system configuration with reference to the load profile. the system was optimized by the HOMER optimizer to line the ability parameters of PV panels, converter, and battery quantities to produce the optimize result for the given load.

5.1 Sensitive result analysis

For economic analysis purpose system ought to introduced with some constraints or sensitive information, that effects the system output, overhead, power setting for every element, internet gift price of the complete system. Annual capability shortage unbroken zero cause the load required to

Sensitivity		Architecture						Cost			
Solar Scaled Average (kWh/m²/day)	Temp Scaled Average (°C)	SG370M (kW)	NEC923	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial capital ($)
4.65	24.6	210,690	399	21,119	CC	$0.551	$354M	$6.86M	$270M
4.65	30.0	176,535	525	36,448	CC	$0.567	$364M	$6.29M	$287M
4.65	35.0	195,954	469	19,643	CC	$0.566	$364M	$6.66M	$282M
4.65	40.0	185,825	518	18,878	CC	$0.577	$371M	$6.51M	$291M
5.86	24.6	156,634	441	30,902	CC	$0.490	$314M	$5.51M	$247M
5.86	30.0	165,266	420	36,379	CC	$0.492	$316M	$5.69M	$246M
5.86	35.0	169,124	420	16,850	CC	$0.497	$319M	$5.79M	$248M
5.86	40.0	182,592	385	32,566	CC	$0.500	$321M	$6.06M	$247M
5.00	24.6	204,598	371	21,421	CC	$0.526	$338M	$6.62M	$257M
5.00	30.0	210,237	371	22,216	CC	$0.535	$344M	$6.78M	$261M

Fig5.1: *Sensitivity results for the off-grid*

PV system be totally glad. radiation scale average thought of for sensitive analysis. Price, replacement, operation and management value, life time of every part and set the scale of every part to HOMER improvement to urge the foremost optimum and economical system for the given style condition. Result from sensitivity analysis of the off-grid and on-grid ar shown below

Sensitivity		Architecture									Cost			
Solar Scaled Average (kWh/m²/day)	Temp Scaled Average (°C)					PV (kW)	NEC923	Grid (kW)	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial capital ($)
4.65	24.6					97,267		999,999	67,524	CC	$0.0110	$22.1M	-$3.65M	$66.7M
4.65	26.0					97,369		999,999	67,524	CC	$0.0114	$22.6M	-$3.61M	$66.7M
4.65	27.6					97,473		999,999	67,524	CC	$0.0117	$23.3M	-$3.56M	$66.8M
4.65	27.0					97,423		999,999	67,524	CC	$0.0116	$23.0M	-$3.58M	$66.8M
5.86	24.6					96,149		999,999	67,524	CC	$0.000335	$760,965	-$5.33M	$65.9M
5.86	26.0					96,515		999,999	67,524	CC	$0.000580	$1.32M	-$5.30M	$66.2M
5.86	27.6					96,908		999,999	67,524	CC	$0.000866	$1.96M	-$5.27M	$66.4M
5.86	27.0					96,804		999,999	67,524	CC	$0.000755	$1.71M	-$5.29M	$66.4M
5.00	24.6					95,924		999,999	67,524	CC	$0.00686	$14.3M	-$4.21M	$65.8M
5.00	26.0					95,924		999,999	67,524	CC	$0.00715	$14.9M	-$4.16M	$65.8M

Fig 5.2: Sensitivity results for the grid connected PV system.

The modification in radiation input on solar array caused varied effects and changes within the system economy. The radiation was varied from four.65 to 5.86 kWh/m2/day, annual capability shortage is zero. The temperature varied from twenty four.58°C,30°C,35°C,40°C.

Results obtained from the sensitivity analysis of the PV system by square measure shown in Fig:5.1 and Fig5.2, that show the variation within the internet gift value, value of electricity (COE), operation prices because of the variation in star radiations. From the results it are often ascertained that by increasing the number of temperature and considering the variations in radiation, internet gift and operational prices conjointly will increase.

the price of electricity (COE) generated from the PV system is premeditated on the surface plot superimposed with internet gift cost (NPC), for each off-grid and On-grid.as shown in Fig.5.3 and Fig5.4. Temperature daily average provide is taken on coordinate axis and star radiations on coordinate axis. It are often seen from the plot of off-grid and gird that by increase in star radiations, internet power production from PV-arrays will increase rising temperature cause the federal agency to extend therefore COE multiplied

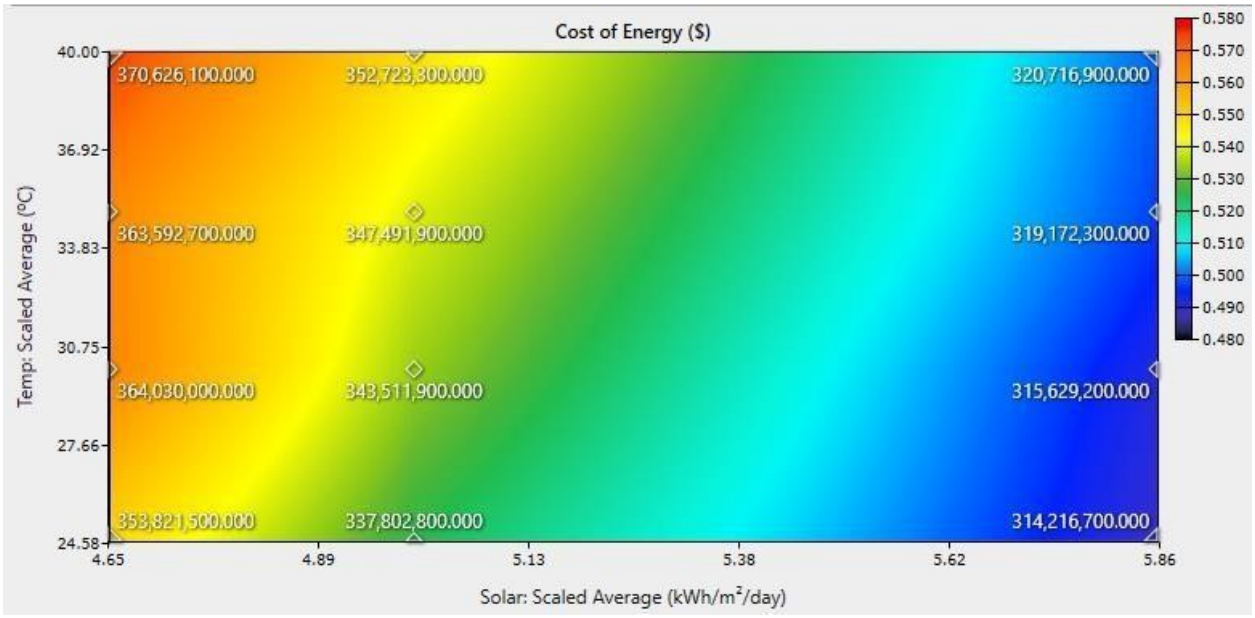

Fig 5.3: *Surface plot for the net cost of electricity* ***(COE)*** *off grid*

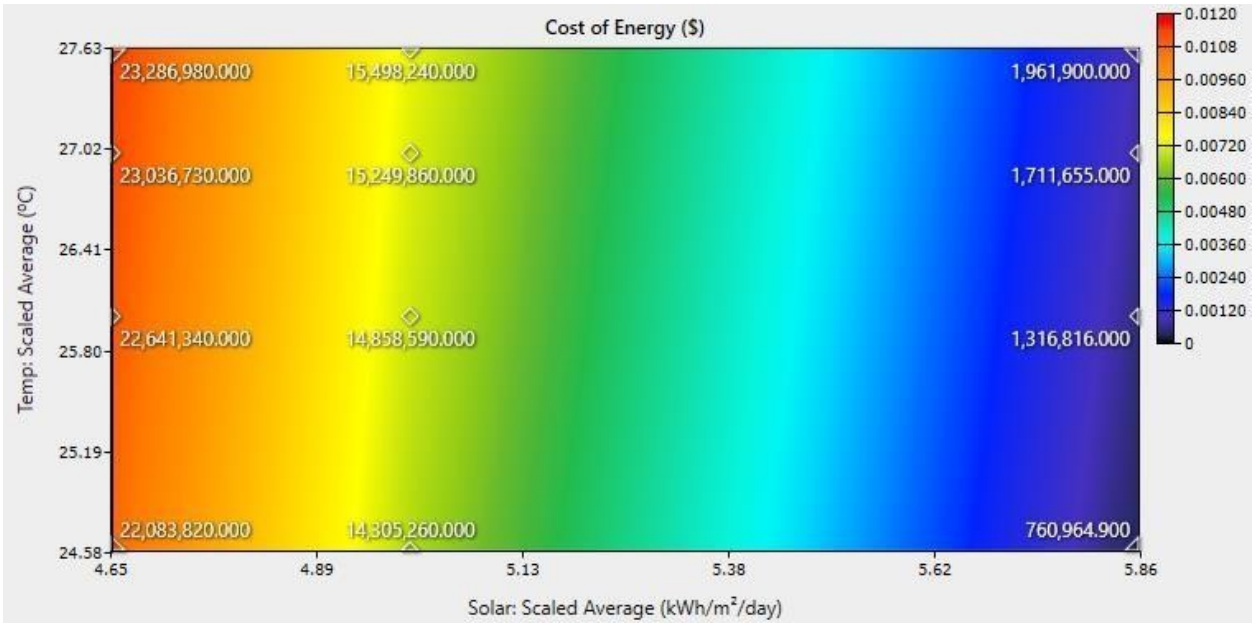

Fig 5.4: *Surface plot for the net cost of electricity* ***(COE****) grid connected*

Architecture							Cost			
	SG370M (kW)	NEC923	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial capital ($)
	210,690	399	21,119	CC	$0.551	$354M	$6.86M	$270M
	210,864	399	21,186	CC	$0.552	$354M	$6.87M	$270M
	211,069	399	21,053	CC	$0.552	$354M	$6.88M	$270M
	211,222	399	21,261	CC	$0.552	$354M	$6.88M	$270M
	218,644	378	20,947	CC	$0.552	$354M	$7.02M	$269M
	211,401	399	21,107	CC	$0.552	$355M	$6.88M	$270M
	204,097	420	21,192	CC	$0.552	$355M	$6.74M	$272M
	214,036	392	21,283	CC	$0.553	$355M	$6.94M	$270M
	209,196	406	21,240	CC	$0.553	$355M	$6.84M	$271M
	211,913	399	21,341	CC	$0.553	$355M	$6.90M	$271M
	211,948	399	21,188	CC	$0.553	$355M	$6.90M	$271M
	209,643	406	21,106	CC	$0.553	$355M	$6.86M	$271M
	209,774	406	21,176	CC	$0.554	$355M	$6.86M	$271M

Fig 5.5 - Optimal system analysis results for off-grid PV system

Architecture							Cost			
	PV (kW)	NEC923	Grid (kW)	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($/yr)	Initial capital ($)
	97,267		999,999	67,524	CC	$0.0110	$22.1M	-$3.65M	$66.7M
	97,339	7	999,999	67,524	CC	$0.0123	$24.6M	-$3.63M	$69.0M

Fig 5.6- Optimal system analysis results for grid PV system

5.2 System optimization results

The designed PV system for each off grid and grid reference to sensitivity inputs were simulated in HOMER code by varied the radiation and therefore the temperature to work out the simplest optimized and economical system for the territory. the dimensions for all the part was set to HOMER optimizer for optimize system fulfilling the electricity load. optimum style of off-grid PV system for this study consisting of the various renewable parts comprising 210,690 kW PV array, 399 storage batteries and converter of 21,119 kW resulted as best optimized and economic configuration simulated, as shown in Fig. 5.5 And for grid PV system 97,339 kW PV array, seven storage batteries and convertor of 67,524 kW resulted as best optimized and economic configuration simulated, as shown in Fig.5.6 As HOMER provides these optimized results sorted on the bottom of agency, COE and initial capital investment. For off grid in Fig 5.7 total internet gift value (NPC), total cost of capital and price of electricity (COE) of the simplest optimized PV configuration ar USD 353million

821thousand 519 USD, 269million 839 thousand 502 USD and zero.551 USD/kWh. For grid in Fig five.8 total internet gift price (NPC), total cost of capital and price of electricity (COE) of the simplest optimized PV configuration square measure twenty four million 551 thousand 899 USD, sixty eight million 959 thousand 878 USD, 0.0123 USD/KW. alternative configurations having capability to meet constant electricity load with totally different instrumentation filler have higher initial cost of capital, COE and internet gift price. Fig 5.7 and Fig five.8 shows a outline of the prices of the individual system parts and also the total internet gift cost for each systems.

5.3 Cost Summary

Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
KEHUA France KF-BCS 630K-B	$300,020.61	$78,091.76	$6,151.34	$0.00	-$3,194.83	$381,068.88
NEC DSS 425kWh 923kW Copy	$127,181,250.00	$12,638,933.38	$1,757,217.73	$0.00	-$903,886.83	$140,673,514.28
Peimar SG370M	$142,358,232.02	$37,095,585.77	$34,830,744.90	$0.00	-$1,517,626.20	$212,766,936.49
System	$269,839,502.63	$49,812,610.91	$36,594,113.98	$0.00	-$2,424,707.86	$353,821,519.65

Fig 5.7: Cost summary of the off-grid PV system.

Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Generic flat plate PV	$65,769,359.33	$17,138,123.14	$16,091,768.95	$0.00	-$701,141.77	$98,298,109.64
Grid	$0.00	$0.00	-$77,432,575.18	$0.00	$0.00	-$77,432,575.18
NEC DSS 425kWh 923kW	$2,231,250.00	$221,735.67	$30,828.38	$0.00	-$15,857.66	$2,467,956.39
System Converter	$959,269.52	$249,686.34	$19,667.95	$0.00	-$10,214.98	$1,218,408.83
System	$68,959,878.85	$17,609,545.15	-$61,290,309.91	$0.00	-$727,214.41	$24,551,899.68

Fig 5.8: Cost summery of the grid PV system

5.4 Electrical Summary

ction	kWh/yr	%
ic flat plate PV	143,967,770	85.5
urchases	24,351,416	14.5
	168,319,186	100

Consumption	kWh/yr	%
AC Primary Load	52,518,110	32.1
DC Primary Load	0	0
Grid Sales	111,057,718	67.9
Total	163,575,827	100

Quantity	kWh/yr	%
Excess Electricity	3,379,527	2.01
Unmet Electric Load	0	0
Capacity Shortage	0	0

Quantity	Value
Renewable Fraction	85.1
Max. Renew. Penetration	137

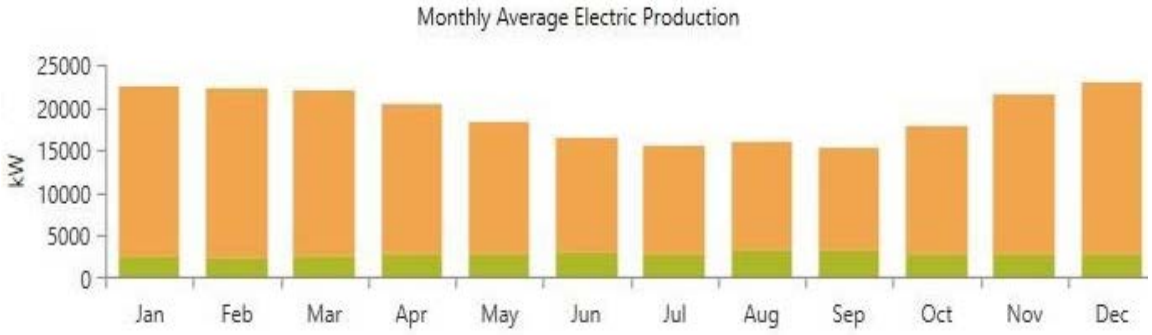

Fig 5.9: Electrical summery of off-grid PV system

Production	kWh/yr	%
Peimar SG370M	311,619,232	100
Total	311,619,232	100

Consumption	kWh/yr	%
AC Primary Load	52,466,777	100
DC Primary Load	0	0
Total	52,466,777	100

Quantity	kWh/yr	%
Excess Electricity	257,710,157	82.7
Unmet Electric Load	51,248	0.0976
Capacity Shortage	51,248	0.0976

Quantity	Value
Renewable Fraction	100
Max. Renew. Penetration	7,248

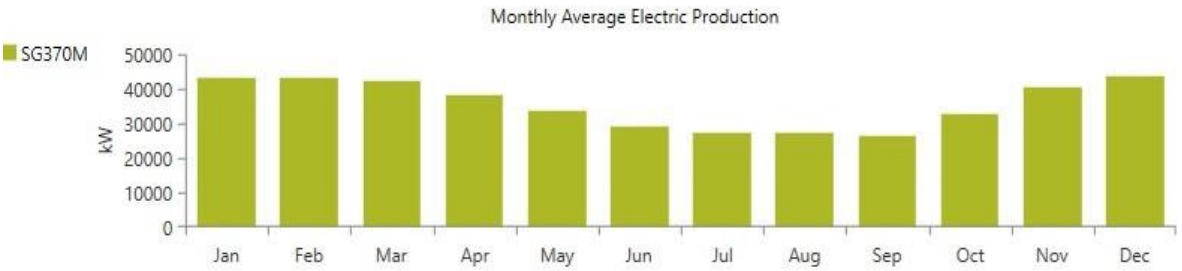

Fig 5.10: Electrical summery of on-grid PV system

In **Fig 5.9 and Fig 5.10** energy production for each component like PV panels and power purchased from grid are shown. The consumption of power, quantity of excess electricity, renewable fraction and maximum renewable penetration are also present here for both PV system.

5.5 Storage summary

Quantity	Value	Units
Batteries	399	qty.
String Size	7.00	batteries
Strings in Parallel	57.0	strings
Bus Voltage	5,040	V

Quantity	Value	Units
Autonomy	18.4	hr
Storage Wear Cost	0.153	$/kWh
Nominal Capacity	169,576	kWh
Usable Nominal Capacity	110,224	kWh
Lifetime Throughput	717,171,043	kWh
Expected Life	30.0	yr

Quantity	Value	Units
Average Energy Cost	0	$/kWh
Energy In	24,351,094	kWh/yr
Energy Out	23,422,708	kWh/yr
Storage Depletion	46,600	kWh/yr
Losses	974,985	kWh/yr
Annual Throughput	23,905,701	kWh/yr

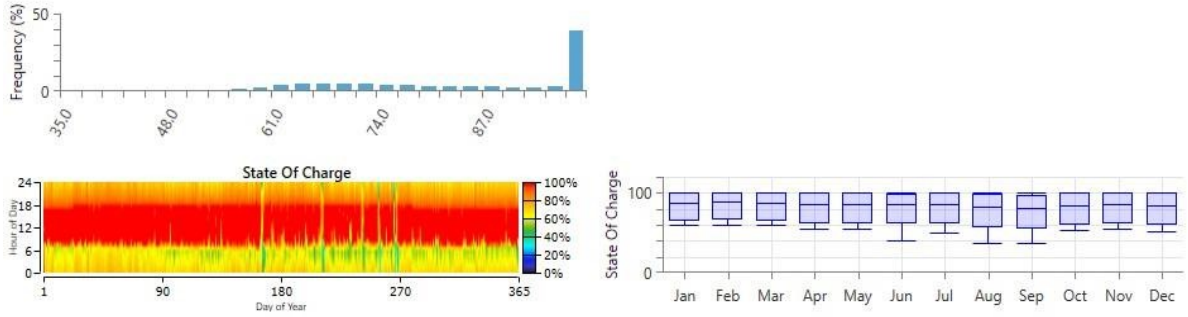

Fig5.11: Storage summary for off-grid

Quantity	Value	Units
Batteries	7.00	qty.
String Size	7.00	batteries
Strings in Parallel	1.00	strings
Bus Voltage	5,040	V

Quantity	Value	Units
Autonomy	0.347	hr
Storage Wear Cost	0.153	$/kWh
Nominal Capacity	2,975	kWh
Usable Nominal Capacity	2,083	kWh
Lifetime Throughput	62,475	kWh
Expected Life	30.0	yr

Quantity	Value	Units
Average Energy Cost	0.694	$/kWh
Energy In	2,125	kWh/yr
Energy Out	2,040	kWh/yr
Storage Depletion	0	kWh/yr
Losses	85.0	kWh/yr
Annual Throughput	2,083	kWh/yr

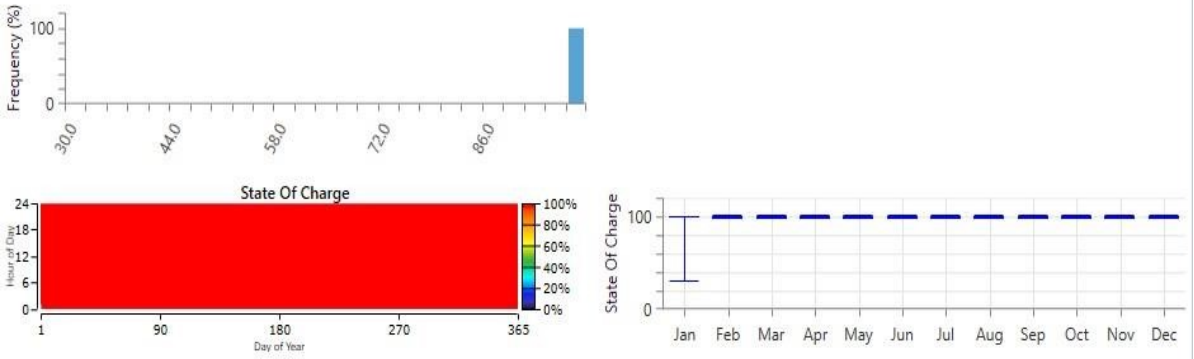

Fig 5.12: Storage summary for On-grid

In figure 5.11 and figure 5.12 galvanic battery estival is gift by homer. throughout planning the plant, the particular string in parallel range was unknown. however within the estival homer showing us the precise range of strings in parallel that is fifty seven strings for off-grid and one string in on grid. Batteries string size is ready to seven for each systems. Batteries quantities for off-grid is 399 and seven for on grid. seven is that the minimum range of batteries taken for simulation, however when calculation and simulation homer provides U.S. the result with the given numbers of batteries.

different knowledge like Autonomy (period of your time electric battery can last for at a mere lead level within the event of an influence outage), Storage wear value (the value of athletics energy through the strange

bank), Nominal capability (the quantity of energy that may be withdrawn from it at a specific constant current, ranging from a totally charged state), Usable Nominal capability (the quantity of charge that may be used), time period Throughput(the quantity of energy that cycles through the storage bank in one year), Average Energy price, Energy in, Energy out, Storage Depletion, Losses, Annual turnout square measure given for each PV system. From fig 5.11 the state of charge graph, from vi to eighteen hour the state of charge is 100 percent, few days between these hours is hour. From zero to six hour the state od charge is sixty to four-hundredth as a result of it's dark. From eighteen to twenty four hour the state of charge is decrease from 100 percent to hour. From fig 5.12 the state of charge is 100 percent throughout the year.

5.6 PV Summary

From **fig 5.13** rated capacity is 210,690 kw, mean output is 35,573 kw and 853,751kwh/d, capacity factor is 16.9%, total production 311.679232 kwh per year. Maximum output 200,521 kw, pv penetration 593%, hours of operation 4,378 hours per year, levelized cost 0.0558 $/kw

Quantity	Value	Units
Rated Capacity	210,690	kW
Mean Output	35,573	kW
Mean Output	853,751	kWh/d
Capacity Factor	16.9	%
Total Production	311,619,232	kWh/yr

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	200,521	kW
PV Penetration	593	%
Hours of Operation	4,378	hrs/yr
Levelized Cost	0.0558	$/kWh

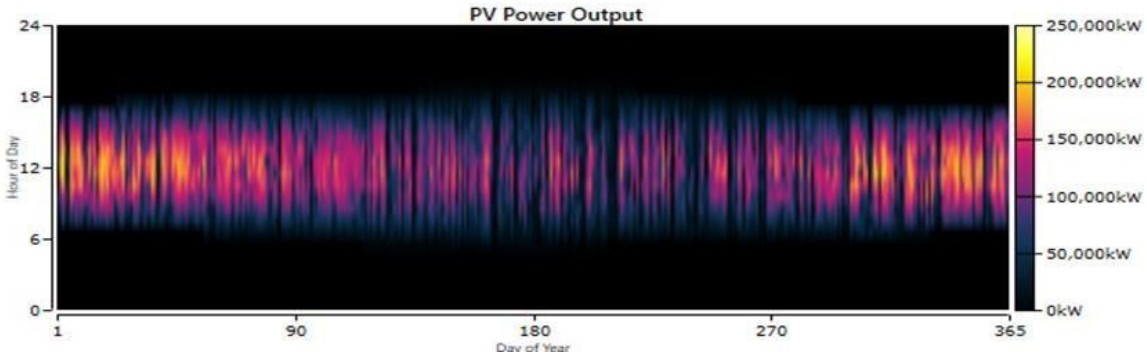

Fig 5.13: PV-Module summary for off-grid

Quantity	Value	Units
Rated Capacity	97,339	kW
Mean Output	16,435	kW
Mean Output	394,432	kWh/d
Capacity Factor	16.9	%
Total Production	143,967,770	kWh/yr

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	92,640	kW
PV Penetration	274	%
Hours of Operation	4,378	hrs/yr
Levelized Cost	0.0558	$/kWh

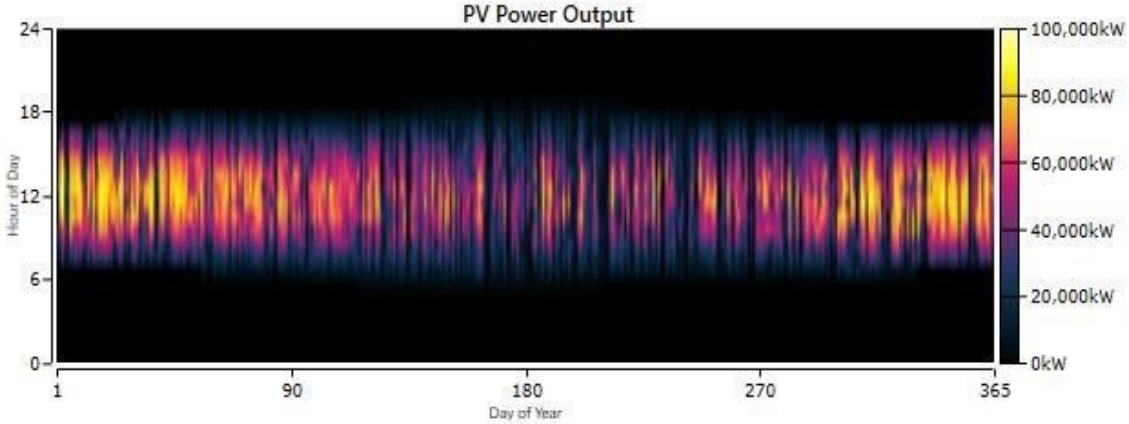

Fig 5.14: PV-Module summary for on-grid

For on grid in **fig 5.14** rated capacity of pv panels is 97,339 kw, mean output 16,435 kw and 394,432 kwh/d, capacity factor 16.9%, total production 143967770 kwh per year.

Maximum output ninety two,640 kw, pv penetration 274 nothing, hours of operation 4378 hours p.a., levelized value zero.0558 $/kwh. For each on-grid and off-grid from 6-18 hours production is high, because of atmospheric phenomenon some days throughout the day won't manufacture any energy from enough to none.

5.7 Converter summary

Quantity	Inverter	Rectifier	Units
Capacity	21,119	21,119	kW
Mean Output	5,989	0	kW
Minimum Output	0	0	kW
Maximum Output	15,005	0	kW
Capacity Factor	28.4	0	%

Quantity	Inverter	Rectifier	Units
Hours of Operation	8,748	0	hrs/yr
Energy Out	52,466,777	0	kWh/yr
Energy In	52,980,690	0	kWh/yr
Losses	513,913	0	kWh/yr

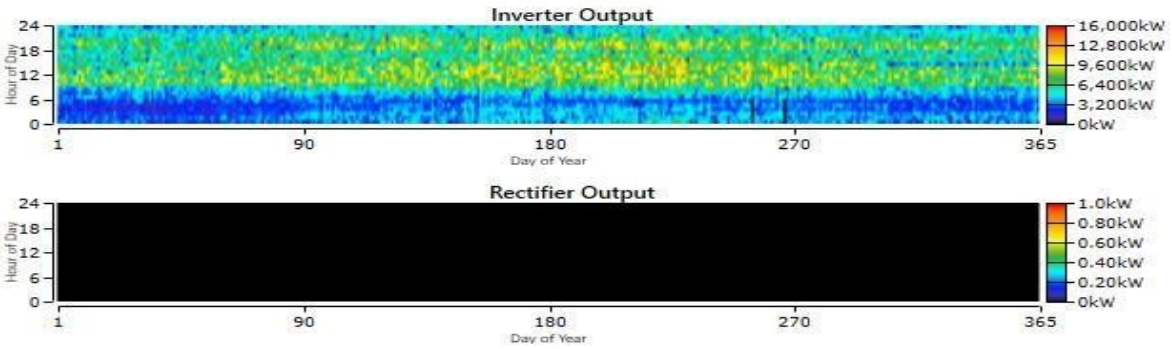

Fig 5.15: Converter summary for off-grid

Only dc current was converted to ac current therefore rectifier is neglected. From fig 5.15 electrical converter capability is 21,119kw, mean output 5989 power unit, most output 15,005 kw, capability issue 28.4%. ours of operation 8,748 hours per annum, energy out 52,466,777 kwh per annum, energy in 52,980,690 kwh per annum, losses 513,913 kwh per annum.

Quantity	Inverter	Rectifier	Units
Capacity	67,524	67,524	kW
Mean Output	15,893	0.243	kW
Minimum Output	0	0	kW
Maximum Output	67,524	2,125	kW
Capacity Factor	23.5	0.000359	%

Quantity	Inverter	Rectifier	Units
Hours of Operation	4,379	1.00	hrs/yr
Energy Out	139,226,557	2,125	kWh/yr
Energy In	140,590,283	2,146	kWh/yr
Losses	1,363,726	20.8	kWh/yr

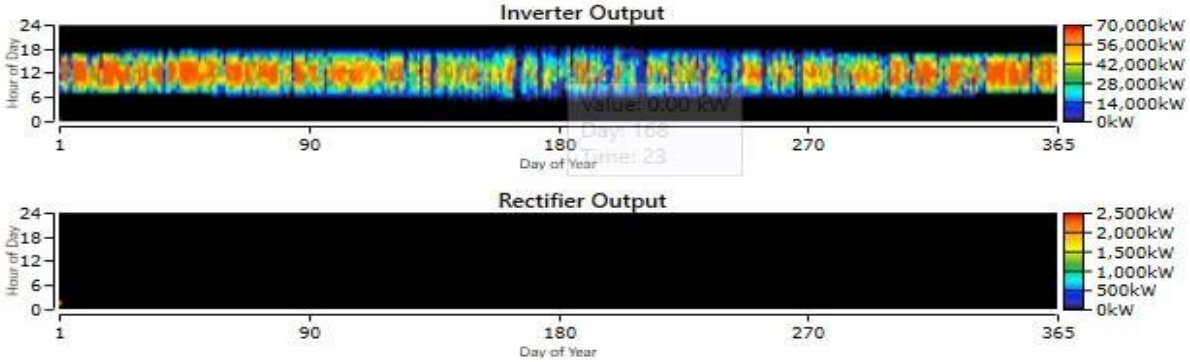

Fig 5.16: Converter summary for on-grid

Only dc current was converted to ac current so rectifier is neglected. From fig 5.16 Inverter capacity is 67,524 kw, mean output 15,893 kw, maximum output 67,524 kw, capacity factor 23.5%. ours of operation 4,379 hours per year, energy out 139,226,557 kwh per year, energy in 140,590,283 kwh per year, losses 1363,726 kwh per year.

5.8 Grid summary

Month	Energy Purchased (kWh)	Energy Sold (kWh)	Net Energy Purchased (kWh)	Peak Demand (kW)	Energy Charge ($)	Demand Charge ($)
January	1,917,980	11,839,900	-9,921,920	11,186	$0	$0
February	1,541,308	10,821,799	-9,280,491	9,649	$0	$0
March	1,824,685	11,625,027	-9,800,342	11,591	$0	$0
April	1,951,969	10,193,632	-8,241,663	13,750	$0	$0
May	2,047,658	8,751,348	-6,703,691	13,479	$0	$0
June	2,093,843	6,975,073	-4,881,230	13,304	$0	$0
July	2,142,595	6,507,818	-4,365,223	11,836	$0	$0
August	2,361,425	6,538,219	-4,176,794	13,132	$0	$0
September	2,269,222	6,196,665	-3,927,444	12,725	$0	$0
October	2,079,783	8,667,890	-6,588,107	11,825	$0	$0
November	1,984,072	10,813,209	-8,829,137	13,591	$0	$0
December	2,136,878	12,127,138	-9,990,260	11,820	$0	$0
Annual	24,351,416	111,057,71	-86,706,30	13,750	-$6,329,56	$0

Fig 5.17 Grid summery for ON-grid

From grid summery in **figure 5.17** energy purchase for each month has shown in KWH, Energy sold to the grid, Net energy purchased peak demand, energy charged (-6.33Million) and demand charge is zero dollar. Also annual value is shown for each factor and months.

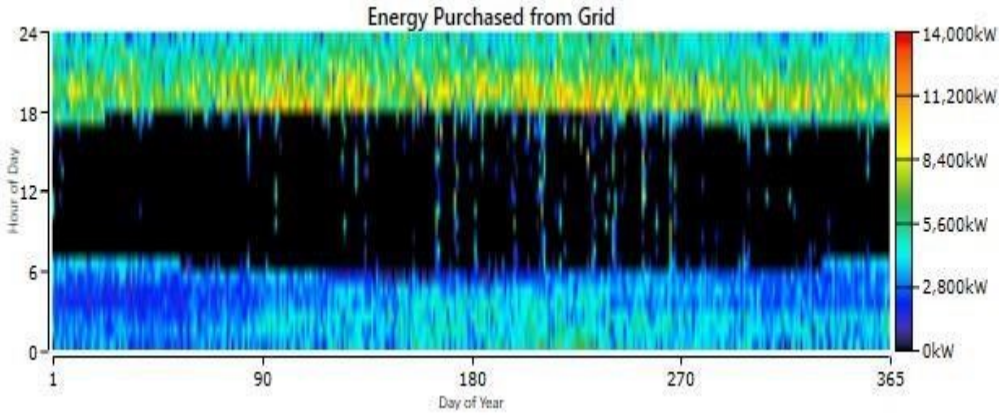

Fig 5.18: Energy purchased from grid.

From 6-18 hour once the radiation quantity is high, nearly no energy was purchased. however once throughout an equivalent time radiation was gift, as within the graph shows 5600 power unit to 8400 power unit and slightly a lot of power was purchased deciding by the colours chart outlined with power unit levels. Quite few days the system was trusted grid.

During 0-6 hours the purchased of electricity was 2800 kW at the start of the year, however it climbed up to 2800 and reaches to 5600 kW within the middle of the year. then the electricity purchased limit occupy the center of 5600kw to 2800 kW and it shift up and down and still the tip of the year. For eighteen to twenty four hour the electricity was purchased 5600 kW to 8400 kW and a lot of. throughout the summer and peek months, the electricity demand went up to 14000 kW as we will anger spot on the 18-24 hours portion of the graph in fig five.18 between ninety days and eighteen0 days and 270 days.

At the tip of the twenty four hour the electricity purchase level went right down to 5600kw and 2800 kW.

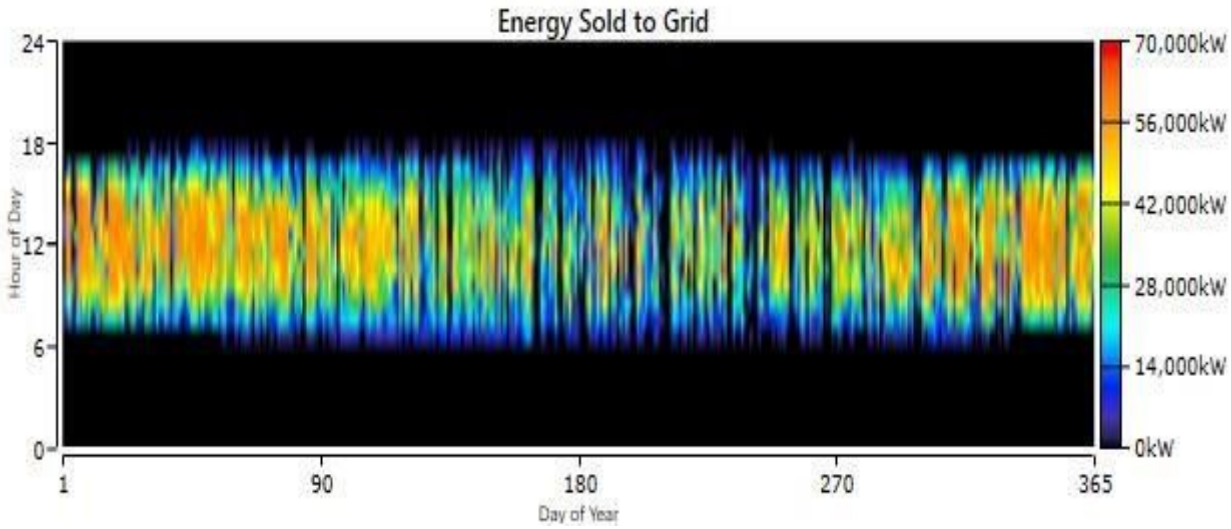

Fig 5.19: Energy sold to grid

In figure-19 throughout 6-18 hour once the soler radiation is high, up to 42,000 kw, 56,000 kilowatt electricity were sold-out to grid. someday the number went up to between seventy,000 kilowatt and fifty six,000 kw. within the middle of a year because of atmospheric condition sometime the system couldn't sell power to the grid. manus 100-110 days energy production is high, from then the assembly is random.From two hundred to twelve months the assembly the assembly redoubled.

5.9 Compare economics

Architecture							Cost	
				SG370M (kW)	NEC923	Converter (kW)	NPC ($)	Initial capital ($)
				218,644	378	20,947	$354M	$269M
				210,690	399	21,119	$354M	$270M

Fig: 5.20: Base case is highlighted in green for off-grid

*i*n **figure 5.20** and **5.22** a base case is highlighting in green area. Which net economic cost and also net present cost and initial capital slightly negotiable from others area which is not highlighted.

Metric	Value
Present worth ($)	$625,530
Annual worth ($/yr)	$51,133
Return on investment (%)	11.0
Internal rate of return (%)	11.2
Simple payback (yr)	13.23
Discounted payback (yr)	19.31

Fig 5.21: Economics for off-grid

In **figure 5.21** and **figure 5.23** the metric value such as present worth, annual worth, return on investment, simple pay back, discount payback etc are shown which compare of both off-grid and on-grid supply

Architecture								Cost	
					PV (kW)	NEC923	Grid (kW)	Converter (kW)	NPC ($)	Initial capital ($)
					23,981		999,999	18,757	$167M	$16.5M
					97,339	7	999,999	67,524	$24.9M	$69.0M

Fig 5.22: Base case is highlighted in green for on-grid

Metric	Value
Present worth ($)	$141,728,100
Annual worth ($/yr)	$11,585,260
Return on investment (%)	27.3
Internal rate of return (%)	32.2
Simple payback (yr)	3.10
Discounted payback (yr)	3.71

Fig 5.23: Economics for on grid

The green marked placed is provided by HOMER software to compare with the system that We chose for our operation and showed us the benefits we will gets like in present net worth, Annual worth, return of investment etc.

CHAPTER 6

CONCLUSION

We can see from this study that a comparative economic analysis of power generated by star PV plants on and off the grid in a very specific space. Through the employment of Homer package during this study, a cheap-effective and technical resolution to satisfy the electricity demand of the area's customers could also be found quickly and at an inexpensive cost for the customers' convenience. within the developed world, this renewable energy supply meets the bulk of their electrical demand. Bangladesh is taking steps therein direction presently. Among all the renewable energy sources on the market in Bangladesh, solar power is that the most accessible and sensible. though the value of installation is considerably higher, once it's turned on, we are going to have a totally free energy provide. what is more, CO2 is unlikely to be created throughout the method. As a result, the procedure is very eco-friendly. we are able to meet the ability deficit whereas additionally lowering the value of electricity generated from renewable energy sources, lowering the value and value of electricity for patrons. With the assistance of a star PV plant, we might be able to deliver electricity to 16000 users in Mymensingh Gauripur (a specific residential neighborhood) for roughly fifty years, each off grid and on grid. However, by scrutiny the 2 systems, off grid and on grid, mistreatment Homer's package, we are able to confirm that the advantages of the on-grid system outweigh the advantages of the off-grid technique. On-grid power prices zero.0124 USD per unit, whereas off-grid prices zero.551 USD per unit. and therefore the current on-grid internet value is twenty four million 551 thousand greenbacks, while moving off-grid prices around 353 million 821 thousand greenbacks. there is a heap of distinction between here and there. Off-grid capital prices ar likewise considerably larger than on-grid capital prices.

So, in any case of the analysis and discussion, we've determined that employing a grid system tie is that the best resolution.

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