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Salhi Ahmed University Centre –Naama

Institut of Science and Technology
Technology Department

DISSERTATION

To obtain a **Master's degree** in:
Renewable Energies
*Option: **Renewable Energies** in Electrical Engineering*

Entitled :

Study and Sizing of Hybrid Renewable Energy System (PV/ Biomass / Diesel Generator) for the Production of Energy in the Naama site

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Naama – Algeria - 2022

DEDICATIONS

We dedicate this work .

To our dearest Fathers

Modest, humble men, the admiration we have for you is limitless. Your love for your children, dignity, education and a sense of honor serve as a model for us. Your endless patience, your understanding and your encouragement are for me the indispensable support that you have always been able to give me. we owe you who we are today and who we will be tomorrow and we will always do our best to remain your pride and never disappoint you. This work is the fruit of your sacrifices that you have made for our education and training. May Almighty God preserve you, grant you health, happiness, peace of mind and protect you from all harm.

To our dearest Mothers

You have filled us with your tenderness and affection throughout our journey. You never stopped supporting and encouraging me during all the years of our studies, you were always there by my side to console me when needed. On this memorable day, for us as well as for you, receive this work as a sign of our deep gratitude and deep esteem. Whatever we may say and write, I could not express our deep affection and deep gratitude. we hope never to disappoint you, nor to betray your trust and your sacrifices. May the almighty give you health, happiness, success and long life so that we can fulfill you in turn?

ACKNOWLEDGEMENTS

First of all we thank the good Lord, almighty, for giving us the courage, the strength and the patience to complete this modest work, especially when he accompanied us during our journey and helped to arrive at this stage. Without him, we wouldn't be here.

we would first of all like to express our gratitude to our co-supervisors Dr. Maamri Mokhtar for having done us the honor of accepting the direction of this thesis, their patience, their availability, their orientations and especially their judicious advice, which contributed to feed our thinking.

we also thank Dr. Lahcen Riadh , Dr F.A. Benmohamed and Dr M.Brahimi to have accepted to evaluate our work within the defense jury.

we thank Dr Belaabed Zakariya , Dr Allam Bachir for his support and his availability, he provided us with moral and intellectual support throughout our years of study.

we also want to thank our dear fathers, dear mothers for their support, their trust in us, have always pushed us forward.

Also we thank our best friends and for their support,

As former US President Bill Clinton once said, "We cannot build our own future without helping others build theirs."

With this quote , we would like to thank all the people and all our teachers who trained us, helped us, were there for us and followed our steps to get to this stage.

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General introduction

General introduction

Everyone is talking about energy! Indeed, the subject of energy savings affects our daily lives as well as our future prospects. Energy is a rare and precious commodity that it is used for the production of electricity and heating.

Faced with the global growth in energy demand, the problems posed by fossil fuels, the depletion of the latter and the environmental problems caused by the emission of gases, we must necessarily develop other sources of clean energy: renewable energies.

The development of renewable energies leads to the emergence of new technologies and a new term, multi-source systems or what we know as hybrid systems. Hybrid sources are a combination of two or more energy sources.

The production of electricity by means of a hybrid system combining several renewable energy sources is of great interest for developing countries, such as the Maghreb countries. These countries have many regions that are isolated and far from conventional electricity distribution networks.

In Algeria and within the framework of the national energy policy, the mission assigned to the energy sector is to provide the entire population, throughout the national territory, with energy under the best conditions in terms of quality and continuity of service. Moreover, the satisfaction of these needs obeys a concern to optimize the costs of energy provision, to safeguard the resources of the national community.

The work that has been defined for this study concerns a technical and economic study of electrical networks based on two renewable energies (PV and Biomas energy). Our dissertation deals with two development issues of electricity grid based on renewable energies. The first problem is devoted to the technical part or how to carry out this study in the region of Naama and the second problem aims at the economic side, where the integration of resources based on renewable energies generate positively on the invoicing of fuels in order to mitigate greenhouse emissions.

In order to best accomplish this study, this thesis is structured in three main chapters in addition to the general introduction and the general conclusion.

- ✓ In the first chapter, a bibliographic research on Green energy & power supply.

- ✓ The second chapter is devoted to the General Information on the " PV / Biomass and Diesel Generator " System and the Possibility of their Activation in the Naama Site.

- ✓ Finally, the third chapter will present the results of the simulations carried out to test this multi-source system (PV/BIO/GD) in a real situation (wilaya of Naama), with homer.

Our work ends with a general conclusion, perspectives and a section of the bibliographical references used.

Chapter I: Green energy & power supply

I.1.Introduction:

For a long time, humans have used all sorts of energy in their daily routines to satisfy their needs without the perception of energy. Today, humans use energy in a variety of fields, such as transportation, heating, cooling, and cooking. Due to the environmental problems caused by the use of fossil fuels as well as the limited resources available to use, countries have been forced to rely on other sources that are not polluting on one side and inexhaustible on the other [1]. Renewable energy sources diminish greenhouse emissions and are thus extremely important and one of the crucial strategies to follow sustainability [2]. In response to the environmental and economic threats posed by fossil fuels, countries need to transition from their consumption of non-renewable energy to an increased consumption of renewable energy [3]. Transitioning to clean energy production is challenging, however, a necessary response to the current climate crisis [4]. Promoting renewable energy sources (RES) has become an important policy objective of the EU in fighting climate change and improving energy security which should be achieved by reducing greenhouse gas emissions and dependence on energy imports, respectively [5]. In turn, this is envisaged to open up new opportunities for economic growth through innovation and lead to a sustainable and competitive energy policy [6].

I.2.Green energy:

“Green energy’’ is often understood in the context of renewable energy and sustainable development by most governments and inter-governmental organizations. The concept of a green economy envisages an environmental friendly, green way of producing energy. Green Economy is still an evolving concept, but primarily could be understood as a system where certain sectors like renewable energy contribute in a major way to a country’s economy. It should also visualize revolutionary changes without compromising on the people’s aspiration for a good life. A green economy should enhance people’s quality of life, not just “without compromising’’it [7].

Renewable or green energy is produced from solar, hydro (water), biomass, wind, and geothermal energy sources [2]. we will explain them one by one as follows:

I.2.1 .Solar energy:

A photovoltaic (PV) cell convert's energy from the sun to DC electricity When sunlight is shining on the PV cell, a current and a voltage is produced to generate electric power. For this to happen, a material in which the absorption of light raises an electron to a higher energy state is required. Then the higher energy electron needs to move from the solar cell into an external circuit. In the external circuit, the electron releases its energy and then goes back to the solar cell. Almost all PV energy conversion uses semiconductor materials in the form of p-n junction. The radiation of the sun reaching the earth, distributed over a range of wavelengths from 300 nm to 4 micron approximately, is partly reflected by the atmosphere and partly transmitted to the earth's surface. Photovoltaic applications used for space, such as satellites or spacecrafts, have sun radiation availability different from that of PV applications at the earth's surface. The radiation outside the atmosphere is distributed along the different wavelengths in a similar fashion to the radiation of a 'black body' following Planck's law, whereas at the surface of the earth the atmosphere selectively absorbs the radiation at certain wave lengths . The electric field at the PN junction then causes the photon-generated-electron-hole pairs to separate with the holes being attracted to the p-region and electrons drifting towards the n-region. In order to study the electronic behavior of a PV cell, it is important to have an electrical equivalent model circuit made up of basic electrical components.The current in the solar cell that is generated from light then involves two key processes. First there is the process of absorption of incident photons to create electron-hole pairs, and then there is the collection of these energy carriers by the p-n junction, where the electron and the hole is spatially separated. In order for the solar cell to generate power, a voltage and a current also have to be generated. The voltage is generated by the photovoltaic effect, and the voltage then generates the current [8].

PV cells are put together as modules, which are further put together as arrays, to obtain an applicable amount of electricity. The construction of PV arrays from modules and cells are illustrated in Figure 1.

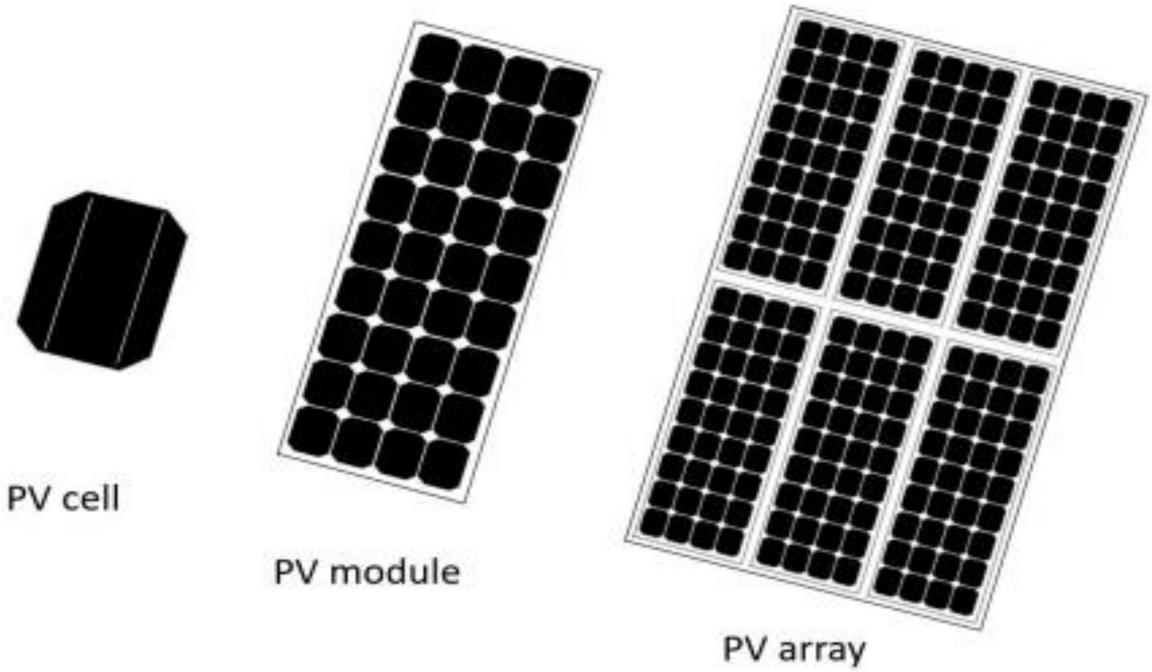

Figure I.1: A PV cell, a PV module, and a PV array

The PV module's main properties provided by the manufacturer are the nominal efficiency, the nominal power peak (corresponding to the current at maximum power point and the voltage at maximum power point), the open circuit voltage, and the short circuit current. These properties are determined during Standard Test Conditions (STC), meaning a cell temperature of 25°C and an irradiance of 1000 W/m2 with an air mass 1.5 spectrum [9]. The manufacturer also provide the Nominal Operating Cell Temperature, defined as the temperature reached by cells of open circuits in a PV module under nominal conditions (irradiance on cell surface = 800 W/m, temperature of air = 20°C, wind velocity = 1 m/s), which is used to calculate temperature losses. The PV derating factor accounts for the discrepancy between the module's rated performance and actual performance. This discrepancy occurs due to i.e. high temperature, dust, shading, wiring losses, and aging. The derating factor is typically around 90%, but can be around 70-80% in hot climates [8].

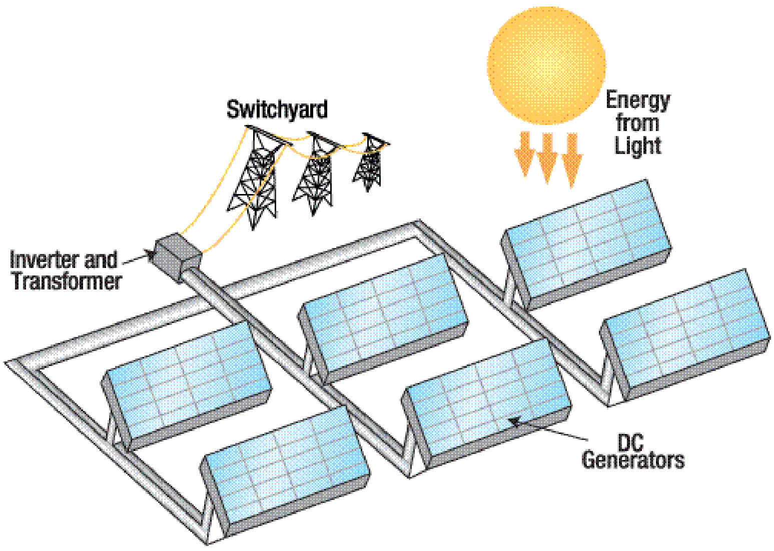

Figure I.2: Solar Photovoltaic Power Plant Diagram

I.2.1.1 Advantages and disadvantages of photovoltaic technology:

✓ **Advantages:**

- Direct conversion of solar radiation into electricity,
- No mechanical moving parts, no noise,
- No high temperatures,
- no pollution,
- PV modules have a very long lifetime,
- The energy source, the sun, is free, ubiquitous, and inexhaustible,
- PV is a very flexible energy source, its power ranging from microwatts to megawatts.

✓ **Disadvantages:**

- Photovoltaic module manufacturing is high-tech and requires high investment costs.
- Photovoltaic generators are only competitive with diesel generators for low energy demands in remote areas.
- Many of the devices sold in the market operate on 220 to 230V AC. However, the energy from the PV generator is unidirectional and of low voltage (< 30V), so it must be transformed through an inverter.
- Storage of electrical energy in accumulators which are usually lead batteries. Knowing that the batteries must not be discharged to more than 60% (70% maximum) of their maximum capacity. In addition, the batteries have a short lifespan (3 to 5 years), which leads to an additional operating cost.

I.2.2.Hydro (water) energy:

Compared to other sources of energy, hydropower is cheap and flexible; even to meet the peak load demand. With a very low life cycle emission of 15 g CO2 equivalent/kWh, hydropower has a zero carbon emission profile during generation [10]. Building large dams often create various socio political and ecological problems, such as relocation of people, submergence of vast areas of vegetation, along with the benefits of power generation, flood control and irrigation. Between 20 and 25% of world's large scale hydro potential has been developed already and generating 15.6% of world's electricity, but still harnessing the 'run of the river' potential is attractive. The potential of such small scale (less than 10 MW) hydropower projects is around 500 GW and only one fifth of such potential has been harnessed so far [11].

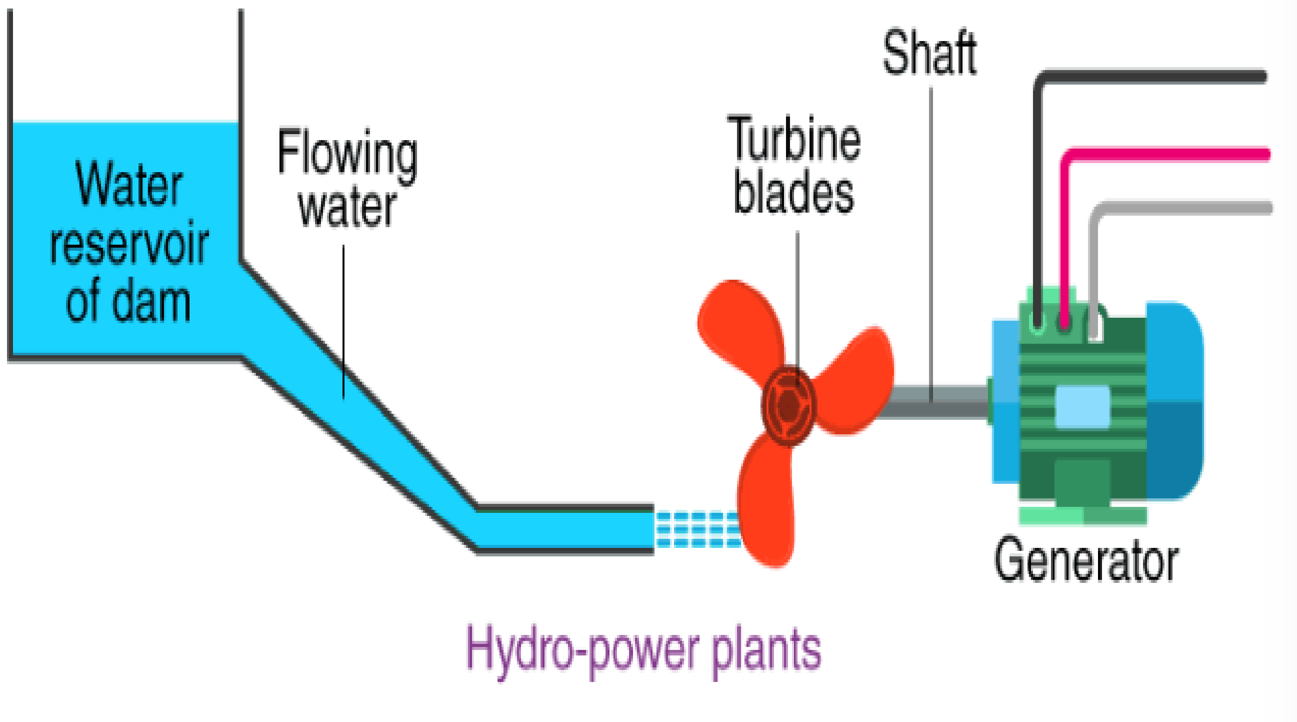

Figure I.3: hydro power plants

I.2.2.1 Pumped storage hydroelectricity storage

When there is more generation of electricity than the load available to absorb it (as during nights), excess generation capacity may be used to pump water into a reservoir at a higher elevation. When the electricity demand is high (as during daytime or due to the failure of a component of the grid), water is released back into the lower reservoir through the turbine, generating electricity. Also, Francis turbines, which are reversible turbine/generator assemblies, are capable of acting as both a pump and a turbine, could be used, as needed. One m3 of water atop a 100 m tower, has the potential energy of about 0.272 kWh. Pumped storage is thus an effective way of storing energy through water. The two reservoirs may be man-made or natural. Pumped storage is a high capacity form of grid energy storage presently available. It can be used to flatten out load variations on the power grid, which may be linked to coal-fired plants, nuclear plants or renewable energy power plants. In the context of the back-up provided by pumped storage, these plants could continue to operate at peak efficiency (Base Load Power plants), while reducing the need for “peaking’’ power plants that use costly fuels. Thermal plants are less able to respond to sudden changes in the electricity demands, and may cause voltage and frequency instabilities. In contrast, pumped storage plants, like the normal hydropower plants, can respond to load changes almost instantly (less than 60 seconds). Pumped storage is expected to become important for load balancing in tandem with large capacity solar and wind mill plants. A recent technological development is the variable speed turbines which can generate electricity in synchronization with the network frequency.

Pumped storage system involves the evaporation losses from theexposed water surface and conversion losses. Approximately 70–85% of the electrical energy used to pump the water to the elevated reservoir is regained, depending upon the capital costs and geographic setting. This loss of about 20% of electricity is more than compensated by selling more electricity during periods of peak demand, when the electricity prices are highest. Pumped storage capacity worldwide now is about 100 GW, which is about 2% of the hydropower generation capacity. Pumped storage capacity has the potential of 1 000 GW, which is roughly half of the global hydropower potential. [12]

I.2.3 Wind energy:

Wind is created as the sun unevenly heat up the surface of the earth. Patterns of wind flow vary by the terrain of the earth, the bodies of water, and vegetative cover. Wind energy or wind power is the kinetic energy of this wind flow exploited for generation of electricity by wind turbines. The kinetic energy of the wind is converted into mechanical energy by the wind turbine, which is then being converted into electricity by a generator. The wind energy can as well be used directly as mechanical energy for tasks like grinding grain or pumping water. The power produced from wind is proportional to the area swept by the rotor. The amount of air entering and leaving a wind turbine must be equal (according to conservation of mass), and the maximal achievable extraction of wind power by a wind turbine is 16/27 (59.3%) of the total kinetic energy of the air flowing through the turbine (according to Beltz law) [13]. The maximum theoretical power output of a wind turbine is therefore 0.59 times the kinetic energy of the air that passes through turbine's effective disk area. The wind's energy content is proportional to the cube of the wind velocity [14], which means that a small increase of the average speed yields a significantly greater energy output. The wind velocity is thereby an important parameter and significantly influences the power per unit available in the wind.

Wind power turbine production depends on the interaction between the rotor and the wind, and the wind may be considered to be a combination of the mean wind and turbulent fluctuations about that mean flow. The actual power production of a wind turbine must take into account the fluid mechanics of the flow passing through a power producing rotor, and the aerodynamics and efficiency of the rotor/generator combination. In practice, maximum 45 % of the available wind power can be gathered by the most efficient horizontal axis wind turbines. [13]

Wind power production can be divided into the two categories of on shore wind and off shore wind energy production. On shore wind, or land-based wind (if the installations that are located inland, and not on the shore), refers to energy generated by wind turbines set up on the mainland. Land-based wind is a mature technology with an extensive global supply chain, that has evolved over the last years to maximize electricity produced per megawatt capacity installed .It is the second largest renewable source for electricity generation in the world, and it leads the global renewable growth, accounting for over one-third of the capacity and generation increase of renewable energy[14].

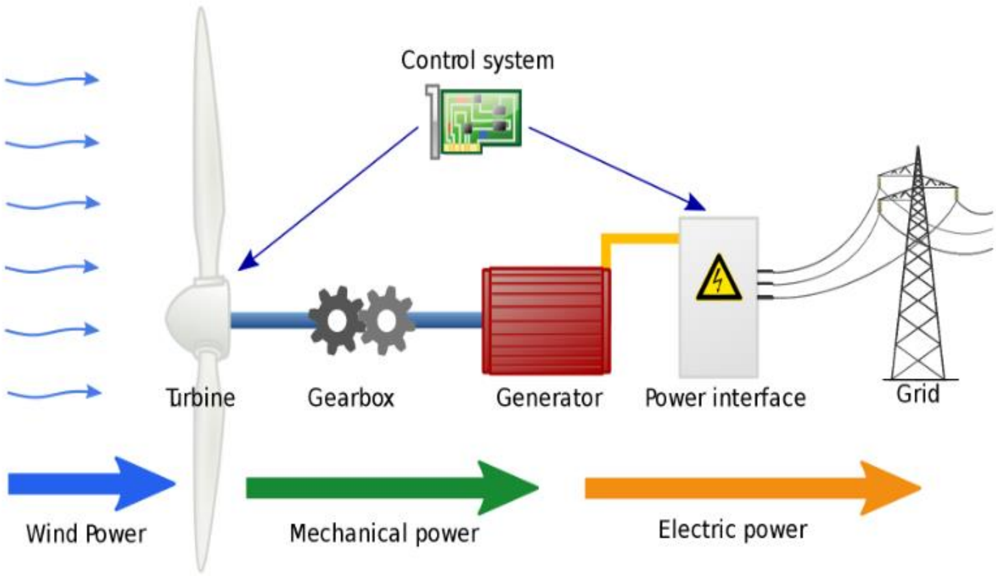

Figure I.4: wind energy power

I.2.4 Biomass energy:

The definition of the term "Biomass" can be subject to various interpretations. Different definitions can be applied based on the field of the application by scientists, policymakers, managers and etc. and almost all of the definitions consider crops, crop residues, plants, algae, animal waste, food waste, and yard waste as appropriate biomass feedstock. The term biomass was first used in 1934 in journals and scientific publications [15].Since 2004, most notably, the definition of biomass has evolved over time. Examples of the different definitions of biomass are [16]:

1. The total amount of living material in a given habitat, population, or sample. Specific measures of biomass are generally expressed in dry weight (after removal of all water from the sample) per unit area of land or unit volume of water.
2. Renewable organic materials, such as wood, agricultural crops or wastes, and municipal wastes, especially when used as a source of fuel or energy. Biomass can be burned directly or processed into bio fuels such as ethanol and methane.
3. The organic material on Earth that has stored sunlight in the form of chemical energy.

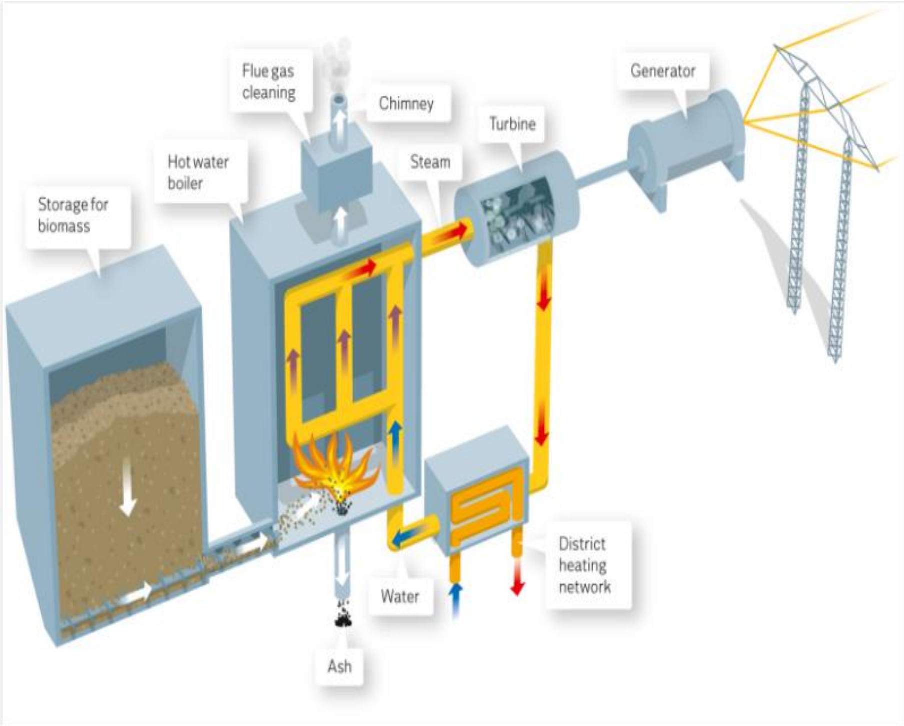

Figure I.5: Biomass energy

I.2.4.1 Advantages and disadvantages of biogas :

- ✓ **Advantages:**

- It is a renewable energy source: The feedstocks used in biogas production are renewable. Trees and crops will grow continuously, which means that manure, food scraps and crop residues will be constantly available.
- It's environmentally friendly: Biogas production is done without oxygen, which technically means that there is no combustion involved. No combustion means that there are no greenhouse gas emissions into the atmosphere. However, carbon dioxide is produced during the biological degradation process (anaerobic digestion), as well as during the use of the biogas. The difference is that the carbon dioxide produced is much less than that produced by fossil fuels. In fact, the amount of carbon dioxide produced during the use of biogas is equal to the amount needed for plant growth. This, in a way, balances the carbon dioxide in the atmosphere.
- Reliable**:** The fact that it is produced from renewable sources makes it reliable. Other renewable energy sources, such as solar and wind, are dependent on weather or diurnal factors to continuously produce electricity. Biogas production continues regardless of

the weather. The biogas production process continues without interruption (24 hours a day).

- Reduces the amount of waste going to landfills: Overflowing landfills have environmental impacts such as foul odors and toxic liquids flowing into groundwater sources. Instead of disposing of these organic materials in landfills, they can be used to produce biogas.

✓ **Disadvantages:**

- Little technological progress: Today, the systems used in biogas production are not efficient. There are no new technologies yet to simplify the process and make it abundant and low cost. This means that large-scale production to satisfy a large population is still not possible. Although the biogas plants available today are capable of meeting some energy needs, most individuals and governments are not willing to invest heavily in the sector. This has led many people to install biomass systems in their homes, which lack capacity.
- Contains impurities: Biogas still contains impurities even after refining and compression. When used as a fuel to power automobiles, it can corrode your engines and cause extraordinary maintenance costs.
- It can't work in every country: Biogas production is only possible in certain locations where raw materials are abundant. Rural areas offer the best locations to build biogas plants. However, it is not possible to build biogas plants in large cities.
- Not economically viable: Compared to other biofuels, biogas production is not economically attractive, especially on a large scale. It is difficult to increase the efficiency of biogas plants, which is why people and most governments are reluctant to invest in this field [17].

I.2.5 Geothermal energy:

Geothermal energy, which is environmentally friendly, green, reliable and sustainable, is classified as one of the important types of renewable energies. It is basically the heat generated and stored beneath the crust of Earth originating from the formation of the planet. However, geothermal energy generally refers to the part of the Earth's heat that can be found from the shallow ground and employed for various industrial applications such as electricity generation, space heating/cooling and aquaculture, and for domestic and therapeutic applications such as bathing and swimming (Dickson and Fanelli, 2004, 2013).

A number of techniques are used to harness the geothermal energy potential, all of which exert to utilize the thermal energy stored within the Earth, basically shallow and deep geothermal techniques are employed to exploit respectively low and high enthalpy resources [18].

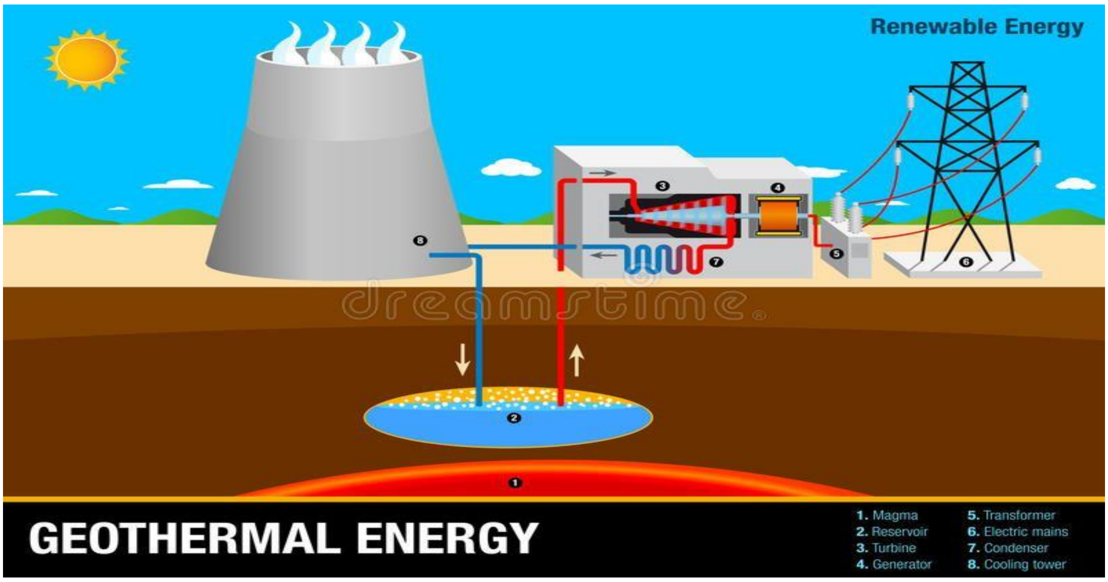

Figure I.6 : Geoyhermal Energy

I.3.Conclusion :

Green energy should be considered as the energy of the future. That said, the most important challenge facing the renewable is to bring down their costs. In this chapter, we have recalled some notions on renewable energies in general and we based on two energies the solar energy and the biomass energy that what we will see in chapter twoin detail.

Chapter II: General Information on the " PV / Biomass and Diesel Generator " System and the Possibility of their Activation in the Naama site

II.1.Introduction:

In this chapter we present the well-detailed general Information on the " PV and general Information on the biomas energy, we will also know the studied area (Naama site) and the possibility of applying solar energy and biomas energy

II.2.General information on the '' PV

The photovoltaic effect remained a laboratory curiosity from 1839 until 1959, when the first silicon solar cell was developed at Bell Laboratories in 1954 by Chapin et al. [19]. It already had an efficiency of 6%, which was rapidly increased to 10%. The main application for many years was in space vehicle power supplies.

Terrestrial application of photovoltaic's (PV) developed very slowly. Nevertheless, PV fascinated not only the researchers, but also the general public.

Knowledge of the sun is very important in the optimization of photovoltaic systems [20]. The radiation of the sun reaching the earth, distributed over a range of wavelengths from 300 nm to 4 micron approximately, is partly reflected by the atmosphere and partly transmitted to the earth's surface. Photovoltaic applications used for space, such as satellites or spacecrafts, have sun radiation availability different from that of PV applications at the earth's surface. The radiation outside the atmosphere is distributed along the different wavelengths in a similar fashion to the radiation of a 'black body' following Planck's law, whereas at the surface of the earth the atmosphere selectively absorbs the radiation at certain wavelengths.[21]

A PV module consists of multiple cells connected in series and parallel [22].The cell is a specially designed PN junction or Schottky barrier device used for converting photons usually from sunlight directly into electricity. A typical photovoltaic cell is only capable of producing about 3 watts of electrical energy at approximately 0.5 DC voltage [23]. The efficiency of this cells depends on the technology used for the its fabrication. Non-crystalline, multi-crystalline and thin film technologies are the three dominating cell technologies with the non crystalline cells having the highest efficiency and being the most expensive. There is a substantial amount of ongoing research to improve the arguably poor efficiency of PV cells. In June 2016, the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) validated the Sun Power R X-Series silicon based solar panel to have reached an efficiency of 24.1% which was the highest at that time.

A PV cell is made of two slices of semi-conductor materials, usually silicon sandwich together to form a PN junction that absorbs photons mainly from sunlight, and allows incident photons to produce electron-hole pair with the atoms of the cell. The electric field at the PN junction then causes the photon-generated-electron-hole pairs to separate with the holes being attracted to the p-region and electrons drifting towards the n-region. In order to study the electronic behavior of a PV cell, it is important to have an electrical equivalent model circuit made up of basic electrical components. A PV cell can ideally be represented as a current source connected in parallel to a diode, while a practical model includes a series and shunt resistance connected to the source (Fig. II.1).[24]

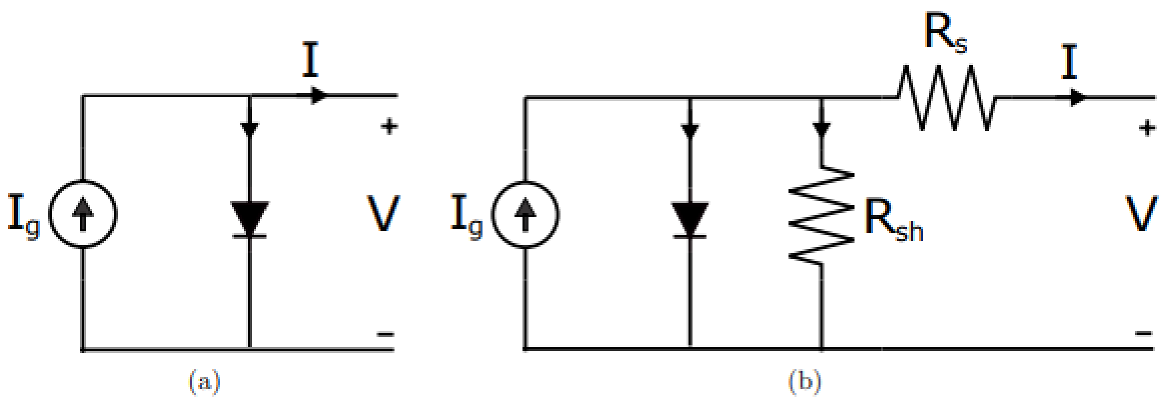

Figure II.1: Equivalent circuit diagram of PV cell (a) ideal and, (b) real.

II.3.General Information on the biomas energy:

- 1812: A gas company in London, England, tests the first commercial use of pyrolysis, a process that heats biomass in oxygen to produce a fluid oil [17].
- 1876: The Otto cycle, invented by German scientist Nicolaus August Otto, is the first combustion engine to use ethanol gasoline.
- 1880: Henry Ford uses ethanol to power one of his first automobiles, the quadricycle.
- 1900: Vegetable oil is used as a replacement for diesel when German inventor Rudolf Diesel demonstrates that a diesel engine can run on peanut oil.
- 1945: After World War II, the ethanol fuel industry ceases to operate with the advent of affordable petroleum-based fuels.
- 1990: Public environmental concerns such as air pollution and climate change prompt governments to climate change spur governments to make greater use of renewable energy sources such as biomasstoenergy sources such as biomass to reduce greenhouse gas emissions. In the U.S., the CleanAir Act requires the sale of

oxygenated fuels (such as gasoline) to be oxygenated fuels (such as ethanol-blended gasoline) in areas of the country with high levels of carbon monoxide. carbon monoxide levels. Increased environmental concerns and government policy changes are driving the production of government policy changes are driving biodiesel production in Europe and the United States. in the United States. According to the United Nations, biomass energy consumption accounts for about 6.7 percent of total energy consumption worldwide. [25].

II.3.1 Definition

Biomass is the biodegradable fraction of products, wastes and residues of biological origin from agriculture and animal husbandry, fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste. Biomass can be used in two main ways:

- During the fermentation of waste, methane gas can be captured and used as an energy source,
- The biomass itself can be incinerated. In both cases, the thermal energy can be used to produce electricity in thermal power plants. The interest is that the carbon dioxide released into the atmosphere during the incineration of biomass or methane is compensated by that absorbed by the regrowth of plants, which, among other things, are the main source of biomass.[26]

II.3.2. Biomass by combustion :

Waste is directly burned producing heat, electricity or both (cogeneration). This concerns wood, waste from wood processing industries and agricultural vegetable waste (straw, sugar cane, peanuts, coconuts, etc.) [27].

matter (nitrogen, phosphorus, potassium, etc.) and water: digestate . Biomass is the biodegradable fraction of products, wastes and residues of biological origin from agriculture and animal husbandry, fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste. Biomass can be used in two main ways [19]:

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released into the atmosphere during the incineration of biomass or methane is compensated by that absorbed by the regrowth of plants, which, among other things, are the main source of biomass.

II.3.3. Biomass by methanization:

The waste is first transformed into a biogas, through fermentation by microorganisms (bacteria). The biogas is then burned. This biogas is close to natural gas and mainly composed of methane. This concerns household waste, animal manure and slurry, sludge from wastewater treatment plants, paper and cardboard, etc. Biomass energy emits almost no pollutants and has no impact on the greenhouse effect. The quantity of CO2, a greenhouse gas, that it releases corresponds to the quantity absorbed by the plants during their growth. Moreover, the valorization of biogas into electricity avoids the emission of methane, another greenhouse gas, into the atmosphere. It represents a very important energy potential, mainly from landfills, but also from sewage sludge and urban and agricultural waste [27].

II.3.3.1. Methanization:

Methanization is a biological process of degradation of organic matter, by bacteria, in the absence of oxygen and at constant temperature[17]. This process leads to the formation of two products: a gaseous mixture composed mainly of methane: biogas; and a digested product containing undegraded organic matter, mineral

II.3. 4 Theoretical notion on biogas energy:

Biogas is the gas produced by the fermentation of organic matter in the absence of oxygen. It is a combustible gas composed essentially of methane and carbon dioxide. It can be burned at its place of production to obtain heat and electricity or purified to obtain bio-methane that can be used as natural gas for vehicles or injected into the natural gas distribution network. The main part of a biogas plant is the digester, which is a sealed container in which bacteria decompose organic waste through an anaerobic fermentation process. This generates a gas (biogas) that is mainly methane and carbon dioxide (CO2). This gas can be used for cooking, heating and lighting, and to generate electricity. As more material added to the digester, liquid

waste (slurry) is also produced, which can be used as fertilizer [25]

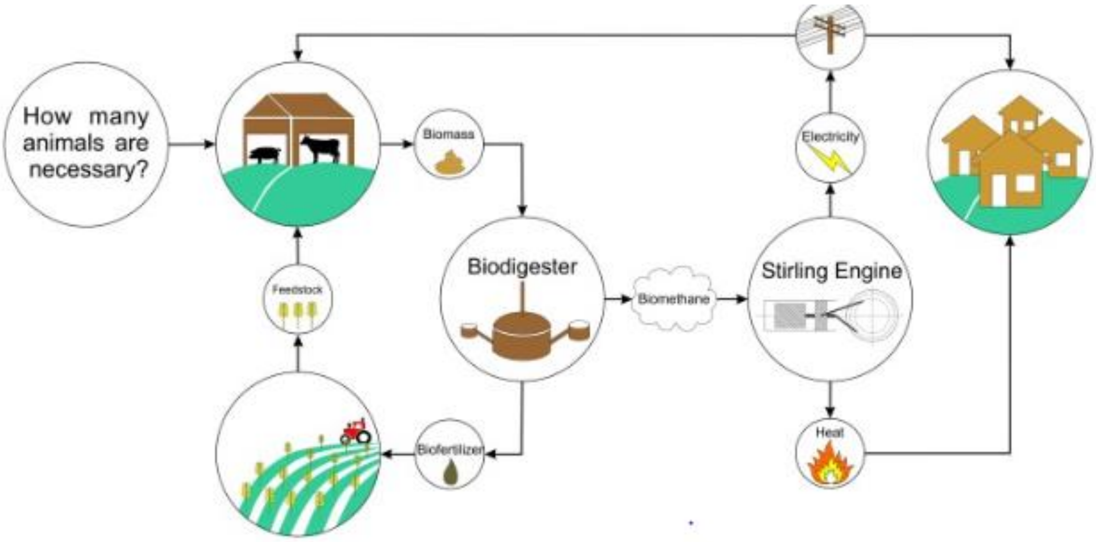


Figure II.2 biomass to electricity diagram

II 3.4.1. Biogas digester:

Biogas digesters can vary considerably in capacity, from small units used by households, to larger communal and industrial digesters. The feedstock added to the digester can include many types of biomass such as animal, food and agricultural waste, but materials that are difficult for the bacteria to digest (e.g. wood) should be avoided. The amount of biogas produced depends on a range of factors, including the type and amount of biomass used, the size and temperature of the digester [25].

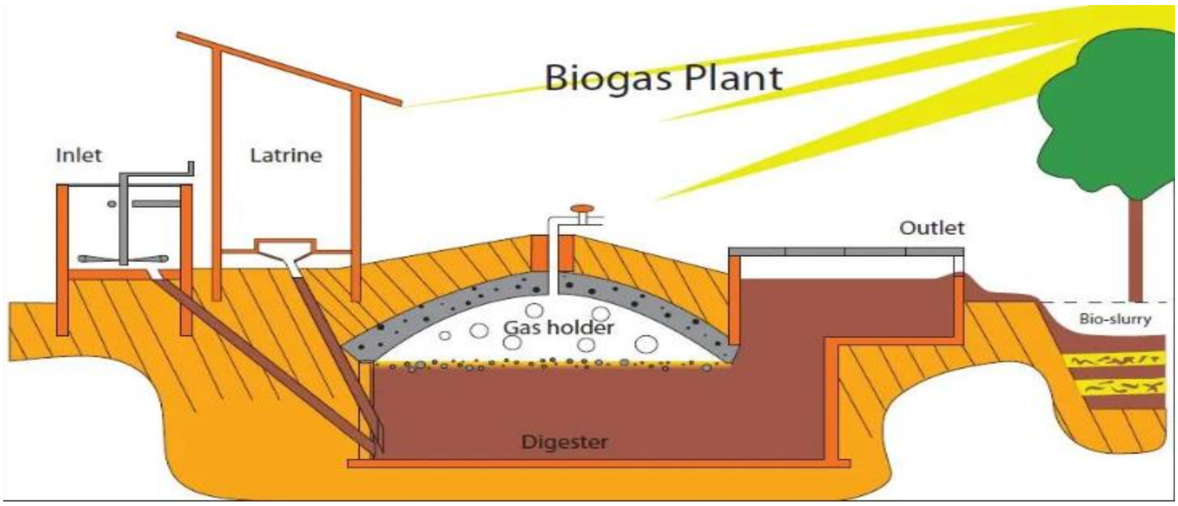


Figure II.3 Digester septek tank

II.3.5.Power generation:

The generator consumes fuel (biogas) to produce electricity. Therefore, the power generation system consists of a combination of an internal combustion engine (ICN) and a synchronous generator or alternator. In most cases, portable generators are used. The choice of the size of the generator needed depends on the daily consumption. The generators consume about 0.5-0.9 m^3 of biogas to generate each KWh [28].

II.4 General information on the diesel generator:

In the case of stand-alone renewable energy facilities, it is necessary to use storage or to add one or more diesel generators. In a hybrid power system, the conventional generator is usually the diesel engine directly coupled to the synchronous generator (Figure II.3) . The AC frequency at the output is maintained by a speed governor (speed controller) on the diesel engine[29].The governor works by adjusting the fuel flow to the diesel, to keep the engine speed and the generator speed constant .The grid frequency is directly related to the rotational speed of the generator and is therefore maintained at the desired level.

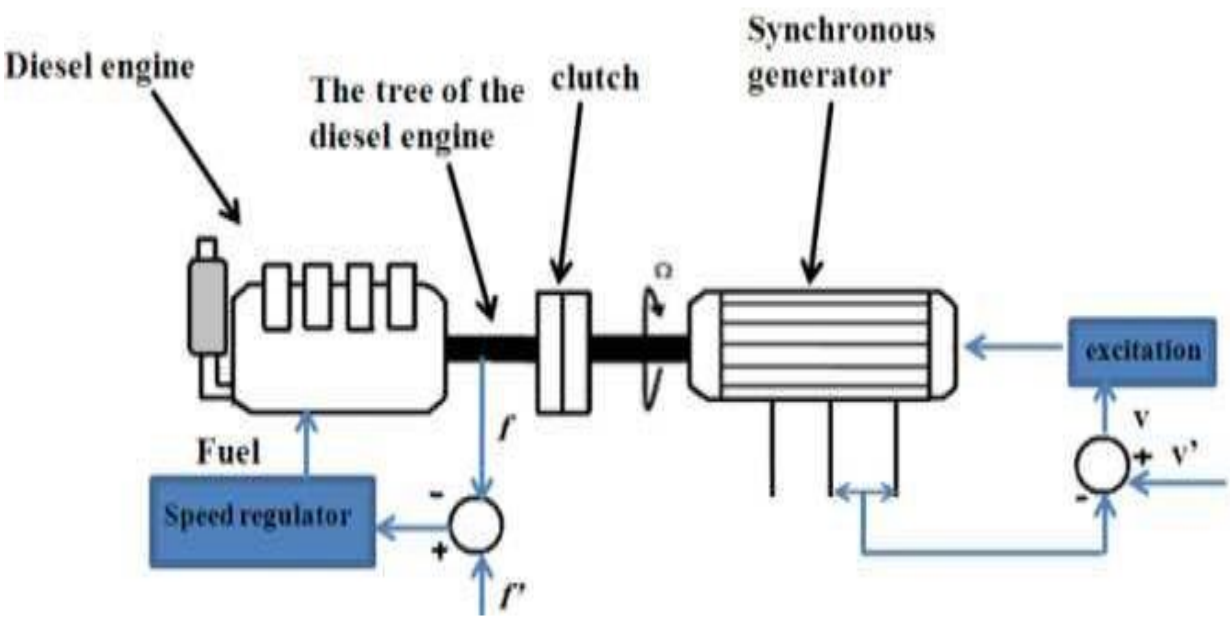


Figure II.4 Configuration du générateur diesel

Diesel AC networks, as well as interconnected ones, provide two forms of energy for their loads: active and reactive. When several diesel generators provide energy to the network, they are usually connected to an AC bus. In this case, a control system must be used to correctly distribute the power supplied by the diesel generators.[30]

II.5 Weather naama:

The wilaya of Naâma is the result of the last administrative division instituted by the law 84-09 of april 4, 1984. It is composed of seven (07) daïras grouping twelve (12) communes, it is located between the Tellian Atlas and the Saharan Atlas and extends over an area of 29,819.30 Km² for a population estimated on 31/12/2018 at 281,168 inhabitants, that is to say a density of 9.43 hab/Km²

Geographical situation :

Naâma, a border wilaya with the Kingdom of Morocco, is limited

- To the north by the wilayat of Tlemcen and Sidi-Bel-Abbès,
- To the east by the wilaya of El Bayadh,
- In the south by the wilaya of Bechar. [31]

Mois	Max tem (°)	Min tem(°)
Janvier	**25**	**6**
Février	**26**	**14**
Mars	**31**	**10**
Avril	**33**	**14**
Mai	**36**	**22**
Juin	**40**	**23**
Juillet	**47**	**33**
Août	**46**	**30**
Septembre	**41**	**27**
Octobre	**31**	**20**
Novembre	**28**	**10**
Décembre	**24**	**10**

Table II.1Average temperatures for 12 months of the year 2021 in naama

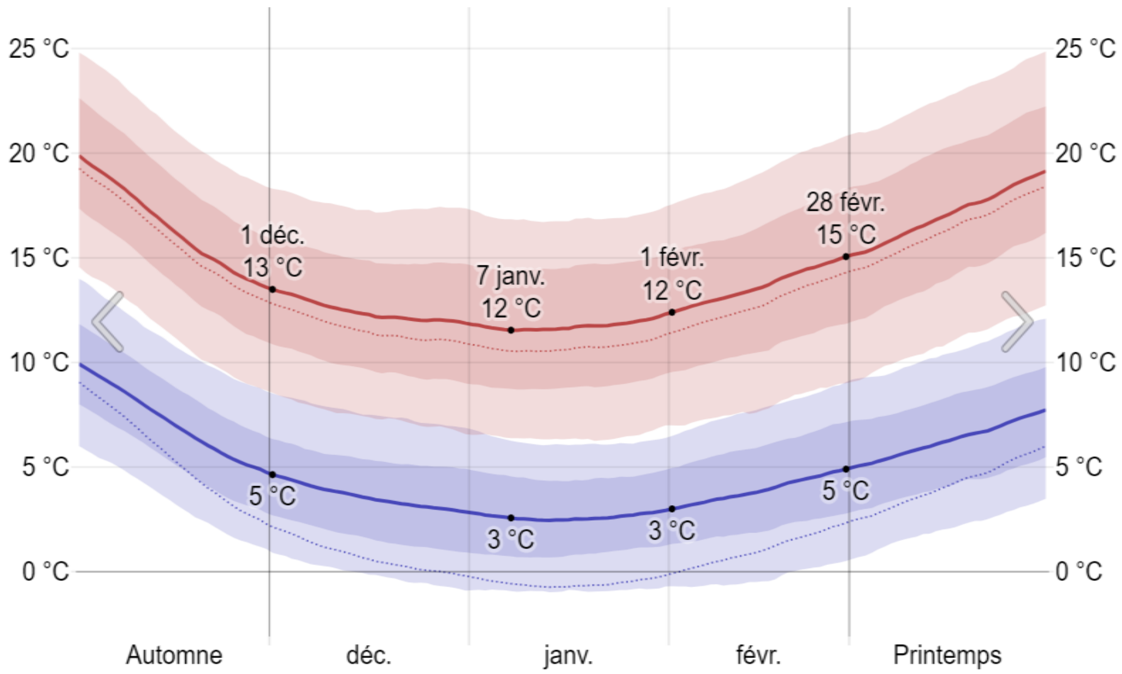


Figure II.5 Average maximum and minimum temperature in winter in Naama

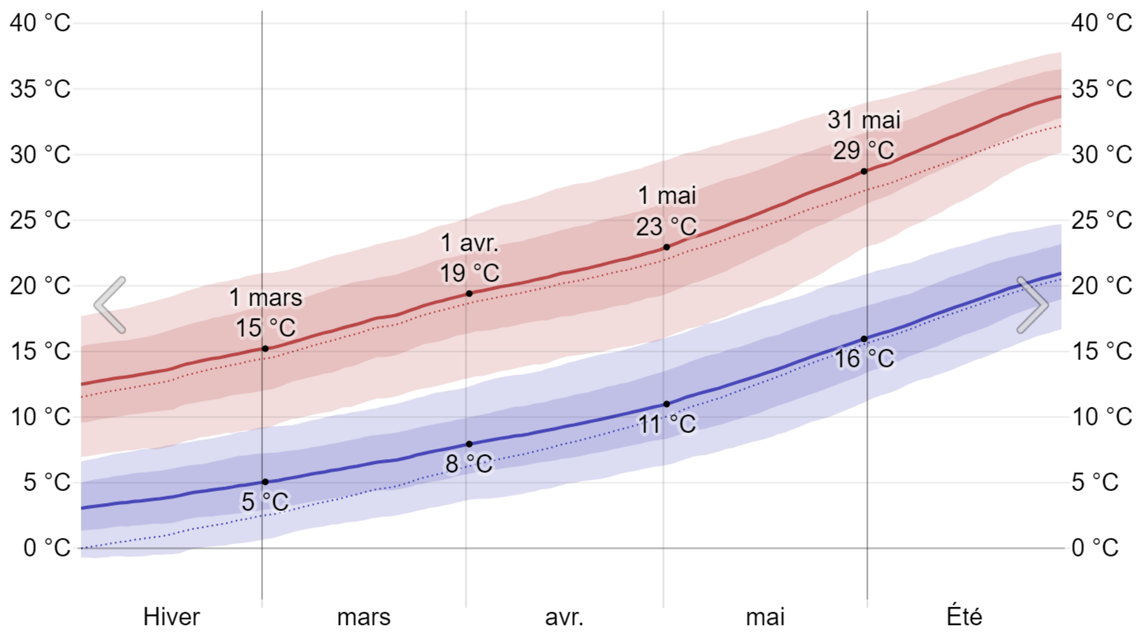


Figure II.6 Average high and low temperature in spring for Naama

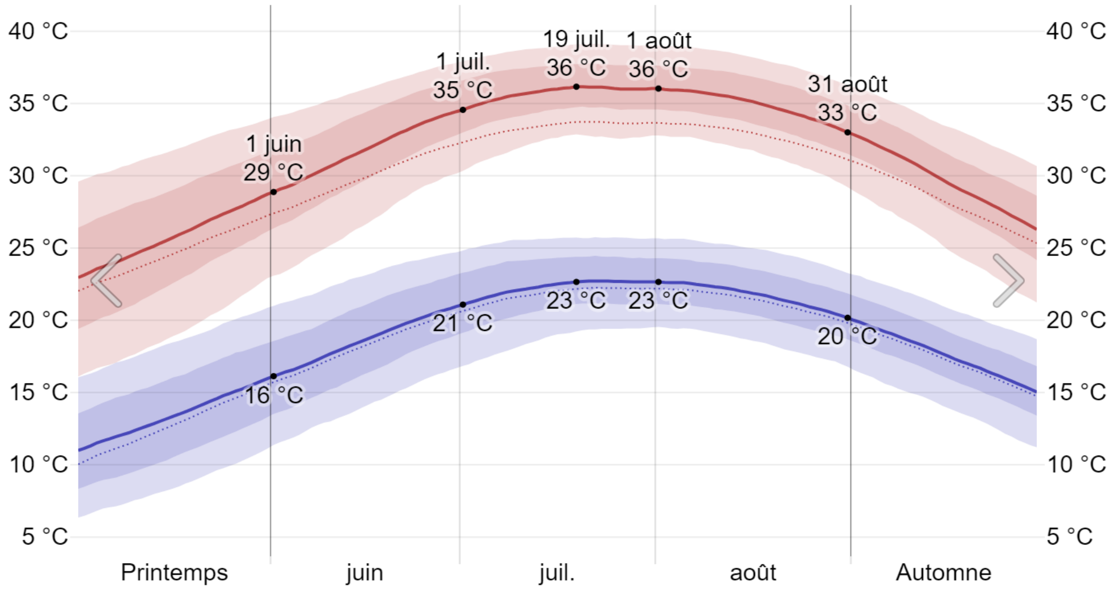


Figure II.7 Average summer high and low temperature for Naama

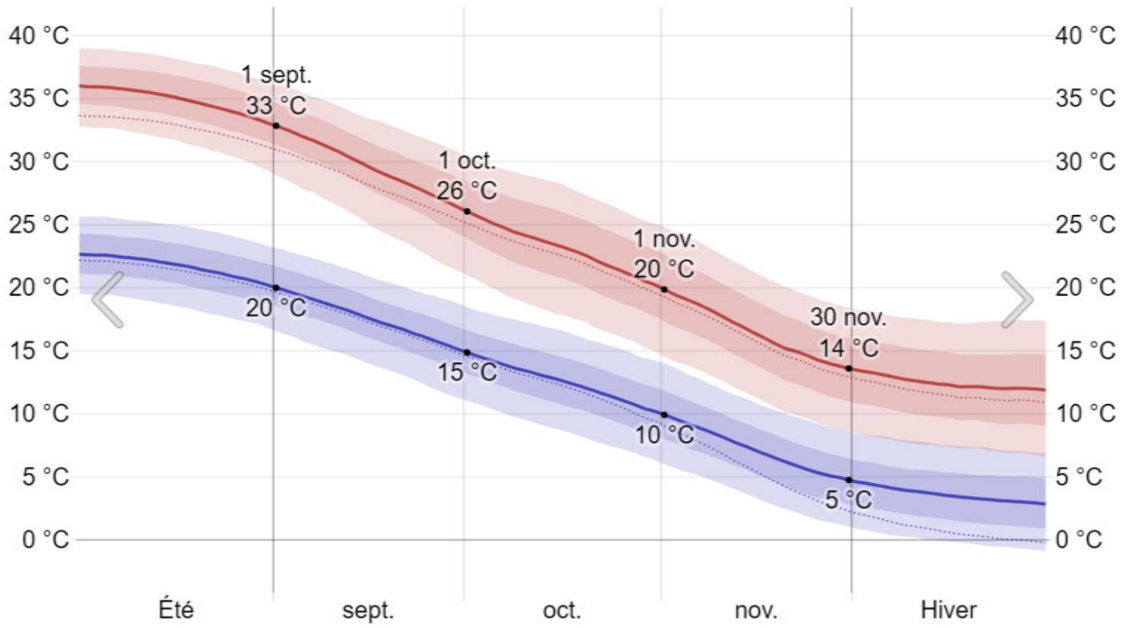


Figure II.8 Average high and low temperature in autumn for Naama

II.6 Conclusion:

This chapter has allowed us to give a general overview of two systems that are currently very popular in the renewable electric power generation market, biomass systems and solar systemsIn addition to non-renewable energy, a diesel generator. The first part of the chapter was devoted to solar systems and more specifically those of photovoltaic origin. The second part and after a reminder of the basic concepts necessary to understand the chain of conversion of biomass energy into electrical energy.

in the third chapter, we talked about the diesel generator. In the next chapter we will do the Modelling of the Components of the System Studied in the Naama site with homer.

Chapter III: Simulation of the components of the system studied in the Naama site

III.1.Introduction:

This chapter presents a simulation of a hybrid system in 4 scenarios. Firstly Pv generator biogas generator diesel, secondly PV generator biogas and Pv generator diesel finely generator biogas generator diesel .

III.2.Information of pc:

- ✓ **Nom pc :** dell
- ✓ **Processor :** Intel(R) Core(TM) i5CPU @1.70GHz 1.70 GHz
- ✓ **Ram:** 4,00 Go
- ✓ **Rom :** 464.5 Go
- ✓ **Type de System:** System exploitation 64 bits, processor x64
- ✓ **Ecran:** 15,6 pouces

FigureIII.1 pc for simulation

III.2.1.Simulation:

SoftwareHomer 3.14x64

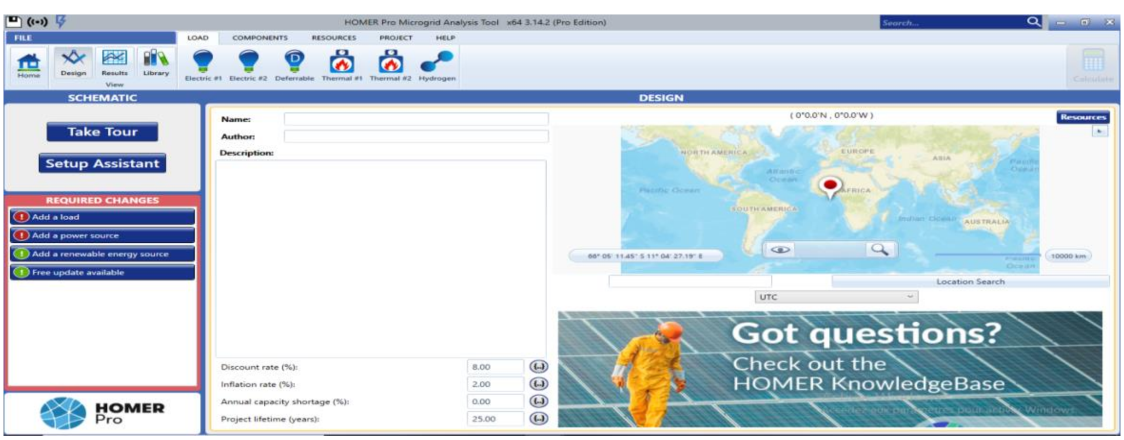


Figure III.2 Program interface

III.2.2.Naama prefecture:

Prefecture since: 1984

Code prefecture: 45

Web site:www.wilaya-naama.dz

Location: 33°16’N - 0°18.8’

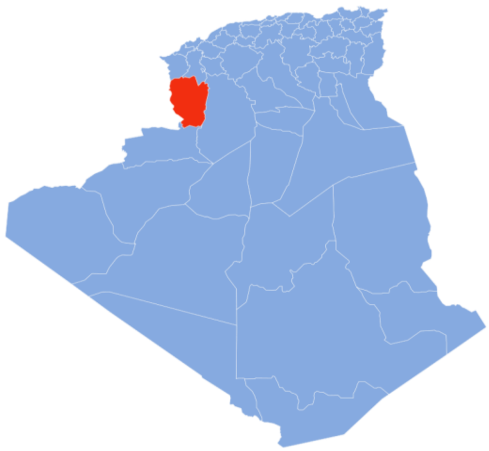
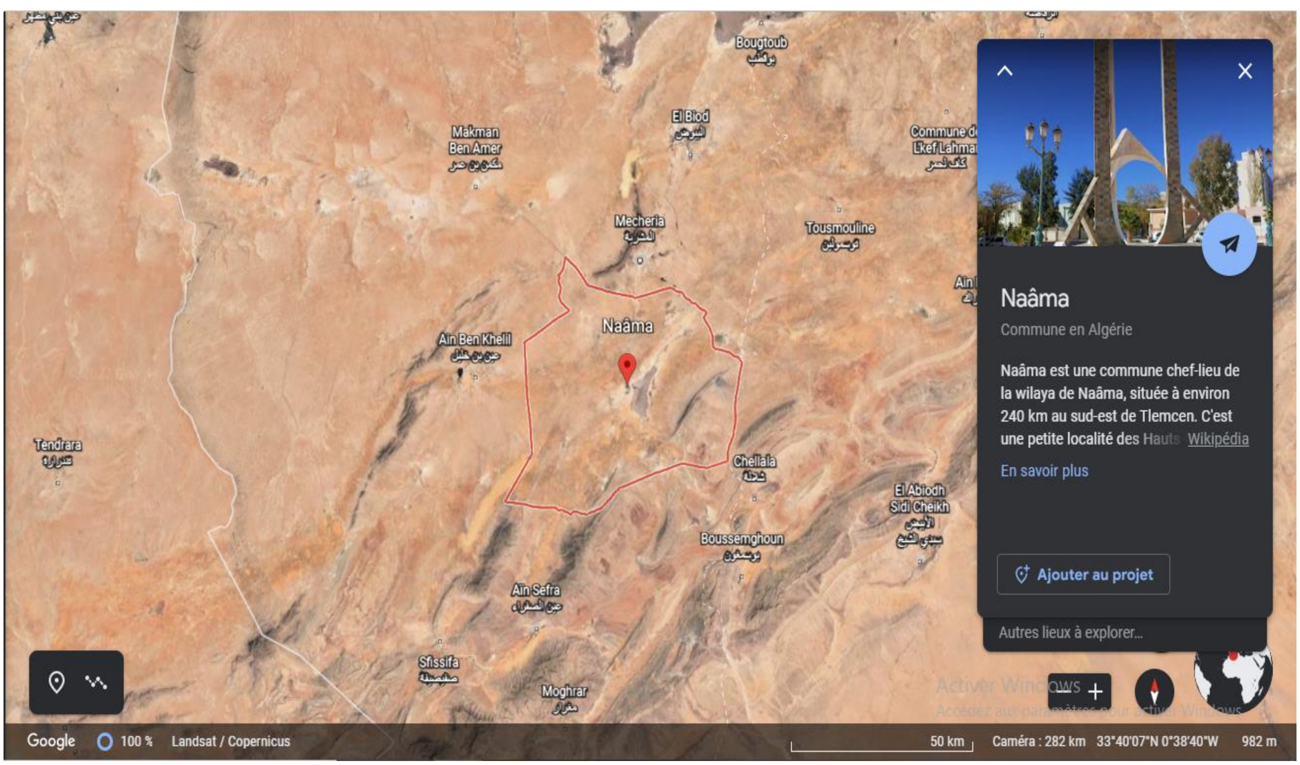


Figure III.3 location of Naama



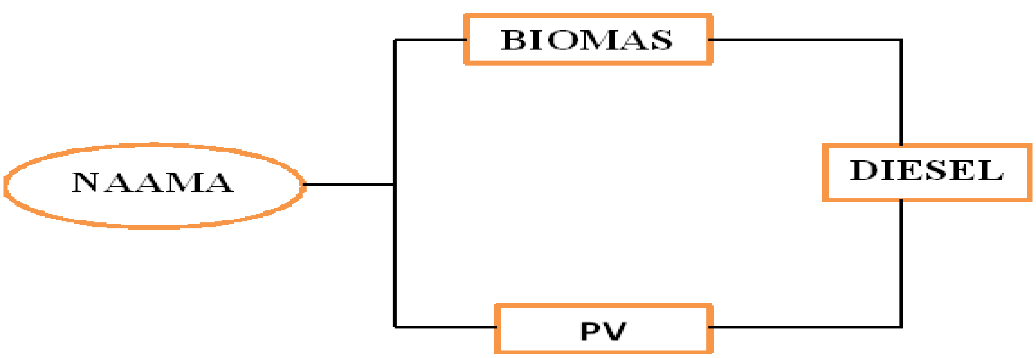
FigureIII.4 Naama with Google Earth

The total purchase direction Naama is300Gwh during the period from

01/01/2021 to 31/12/2021 [32]

We found out through the program that we must take values less than 300Gwh to facilitate the simulation and to take a shorter period of time.32h is enough for 300 GWh simulated

Our project is represented by the figureIII.5



FigureIII.5 Our project

a) Biogas Generator :

- **Capacity :** 500kW
- **Fuel curve intercept** :50kg/hr
- **Fuel curve slope** : 2kg/hr/kW
- **CO (g/kg fuel)** : 2

FigureIII.6 Generic 500KW Biogas Genset

b) photovoltaic :

- **Panel Type** : Flat plate
- **Rated capacity (kW)** : 0.330
- **Operating Temperature (°C)** : 45
- **Efficiency (%)** : 16.97
- **Manufacturer** : Canadian Solar

FigureIII.7 Photovoltaic

c) Diesel Generator:

- **Capacity** : 1000kW
- **Fuel** : Diesel
- **Fuel curve intercept** : 14L/hr
- **Fuel curve slope** : 0.244L/hr/kW
- **CO (g/kg fuel)** : 13.566

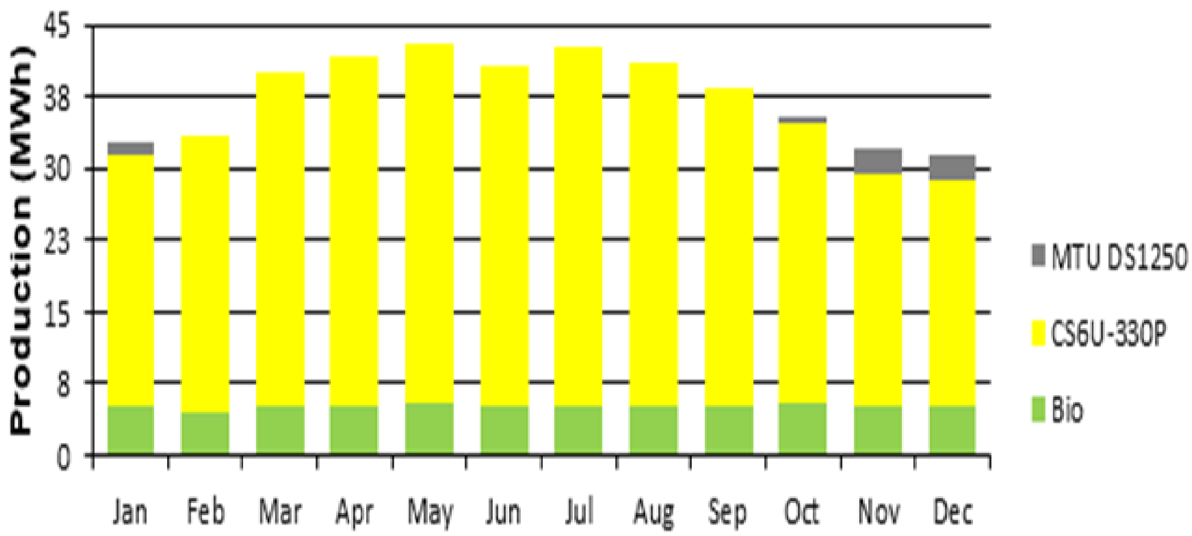
FigureIII.8 Diesel generator

III.3 First Scenario:

simulation of a hybrid system Pv + Biogas + Diesel Generator

III.3.1.Current system

Production of energy is represented by the figureIII.9



FigureIII.9 Production of energy Histogram

III.3.2. Pv Canadian solar max power CS6U-330P

The Canadian solar PV system has a nominal capacity of 221 kW. The annual production is 384,410 kWh/yr.

Rated Capacity	221 kW	Total Production	384,410 kW
Capital Cost	DA116,497	Maintenance Cost	1,165 DA/yr
Specific Yield	1,737 kWh/kW	LCOE	0.0265 DA/kWh
PV Penetration	0 %		

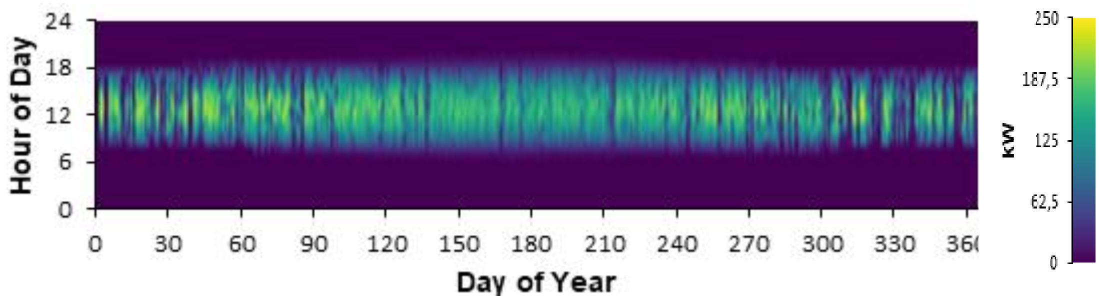


Figure III.10 The annual production of Pv

III.3.3Generatorgeneric 500kw biogas genset (Biogas)

Power output from the generic generator system, ratedat 500 kW using biogas as fuel, is 60,500 kWh/yr .

Capacity	500 kW	Generator Fuel	Biogas
Operational Life	165 yr	Generator Fuel Price	1.00 DA/kg
Capital Cost	DA1.50M	Maintenance Cost	3,630 DA/yr
Fuel Consumption	127 tons/yr	Electrical Production	60,500 kWh/yr
Hours of Operation	121 hrs/yr	Marginal Generation Cost	0 DA/kWh
Fixed Generation Cost	61.3 DA/hr		

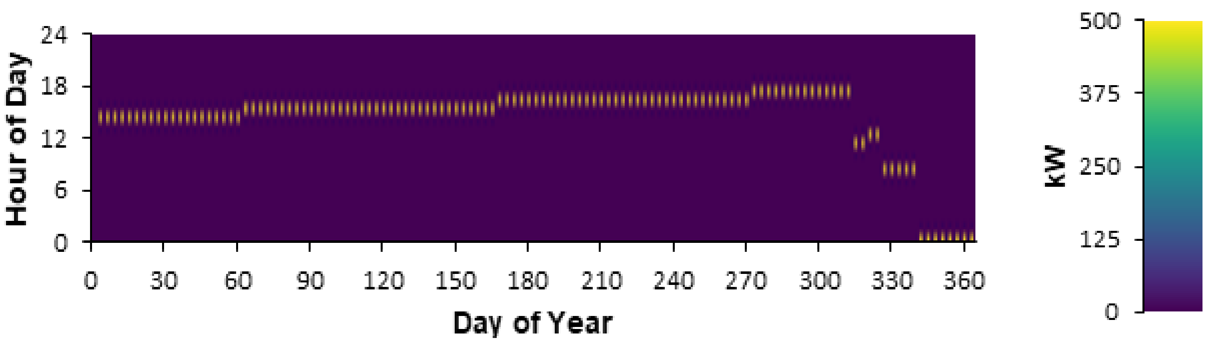


Figure III .11 The annual production of generator biogas

III.3.4.Generator MTU 18V2000 DS1250 (Diesel)

Power output from the MTU generator system, rated at 1,000 kW using diesel as fuel, is 7,623 kWh/yr

Capacity	1,000 kW	Generator Fuel	Diesel
Operational Life	66.7 yr	Generator Fuel Price	1.00 DA/L
Capital Cost	DA9.00M	Maintenance Cost	420 DA/yr
Fuel Consumption	1,944 L	Electrical Production	7,623 kWh/yr
Hours of Operation	12.0 hrs/yr	Marginal Generation Cost	0.242 DA/kWh
Fixed Generation Cost	125 DA/hr		

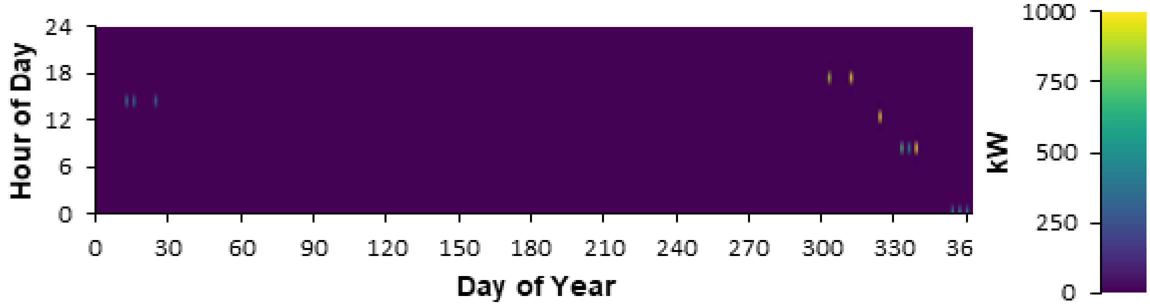


Figure III.12 The annual production of Generator diesel

III.3.5.Storage: Generic 1kWh Li-Ion

The Generic storage system's nominal capacity is 2,782 kWh. The annual through put is 150.638kWh/yr.

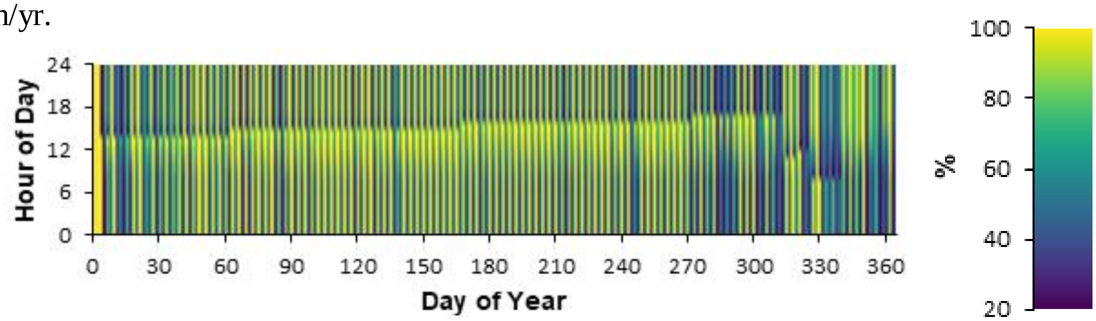
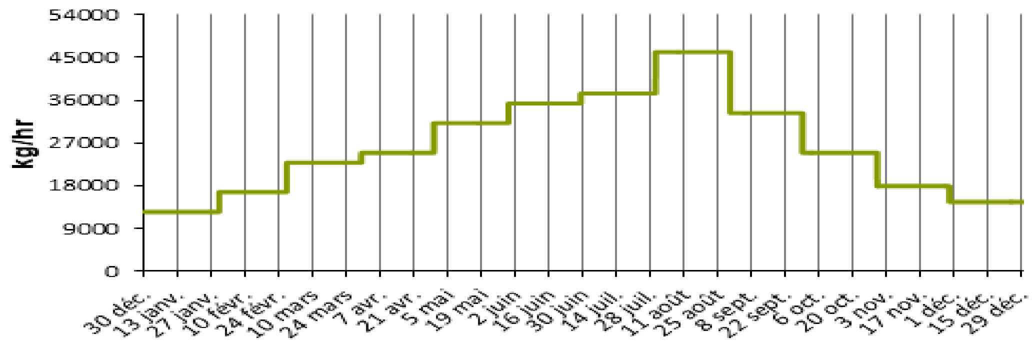


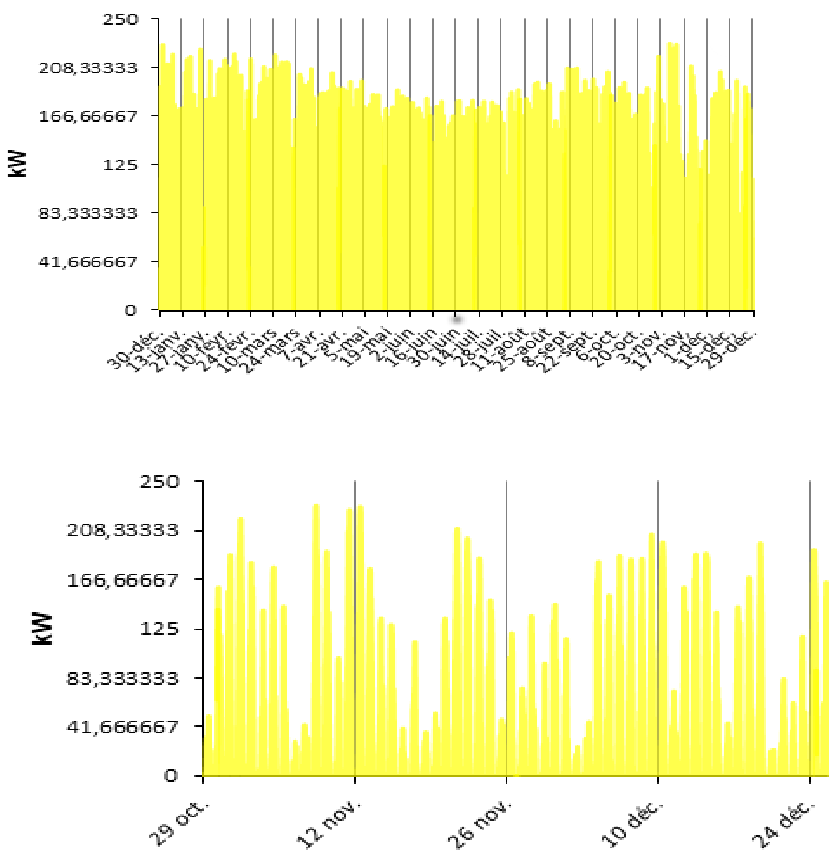
Figure III.13 Theannual production of battery

Biomass resource is represented by figureIII.14



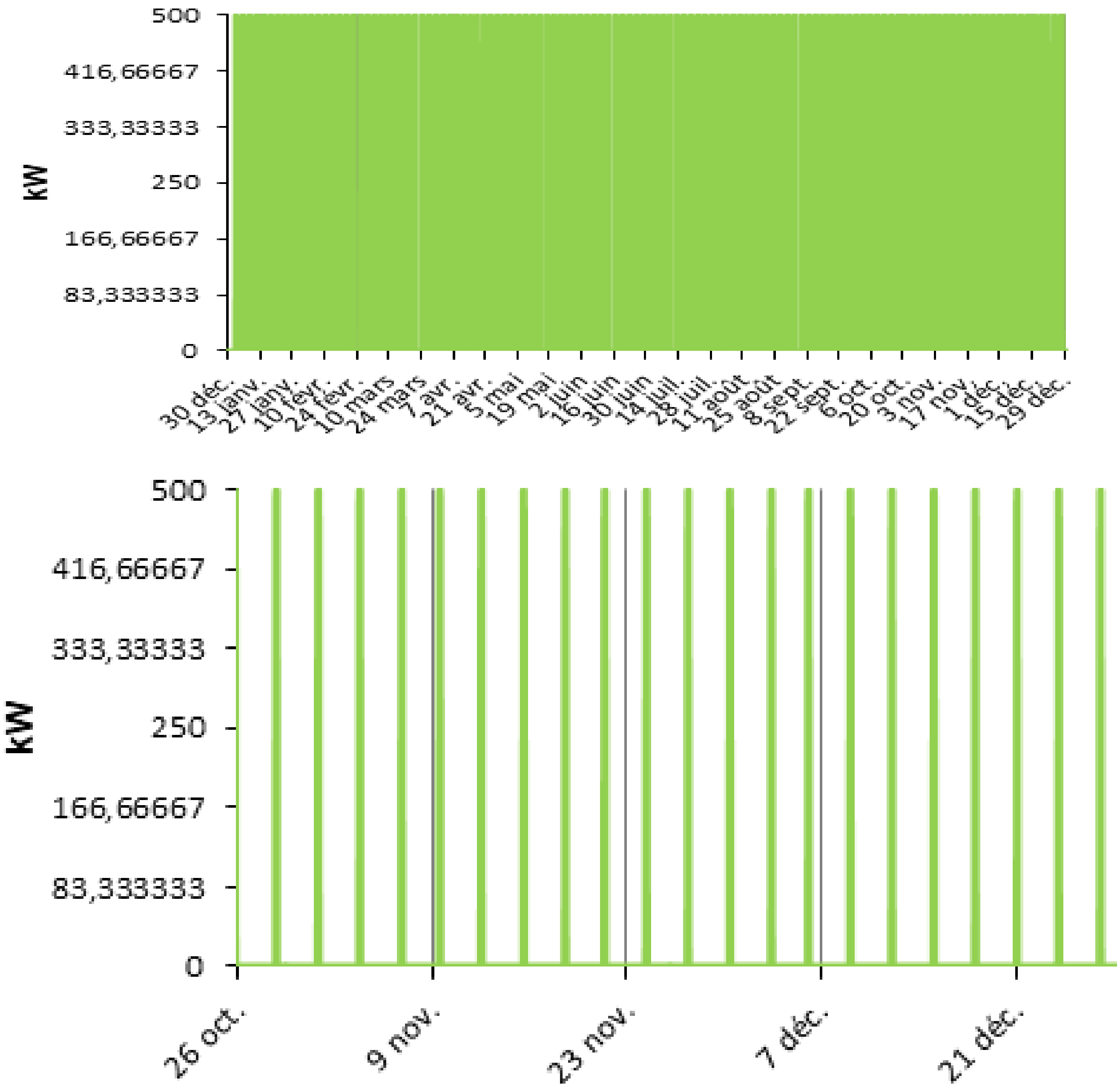
FigureIII.14 Biomass Resource

Canadian solar max power CS6U-330P power output is represented by figureIII.15



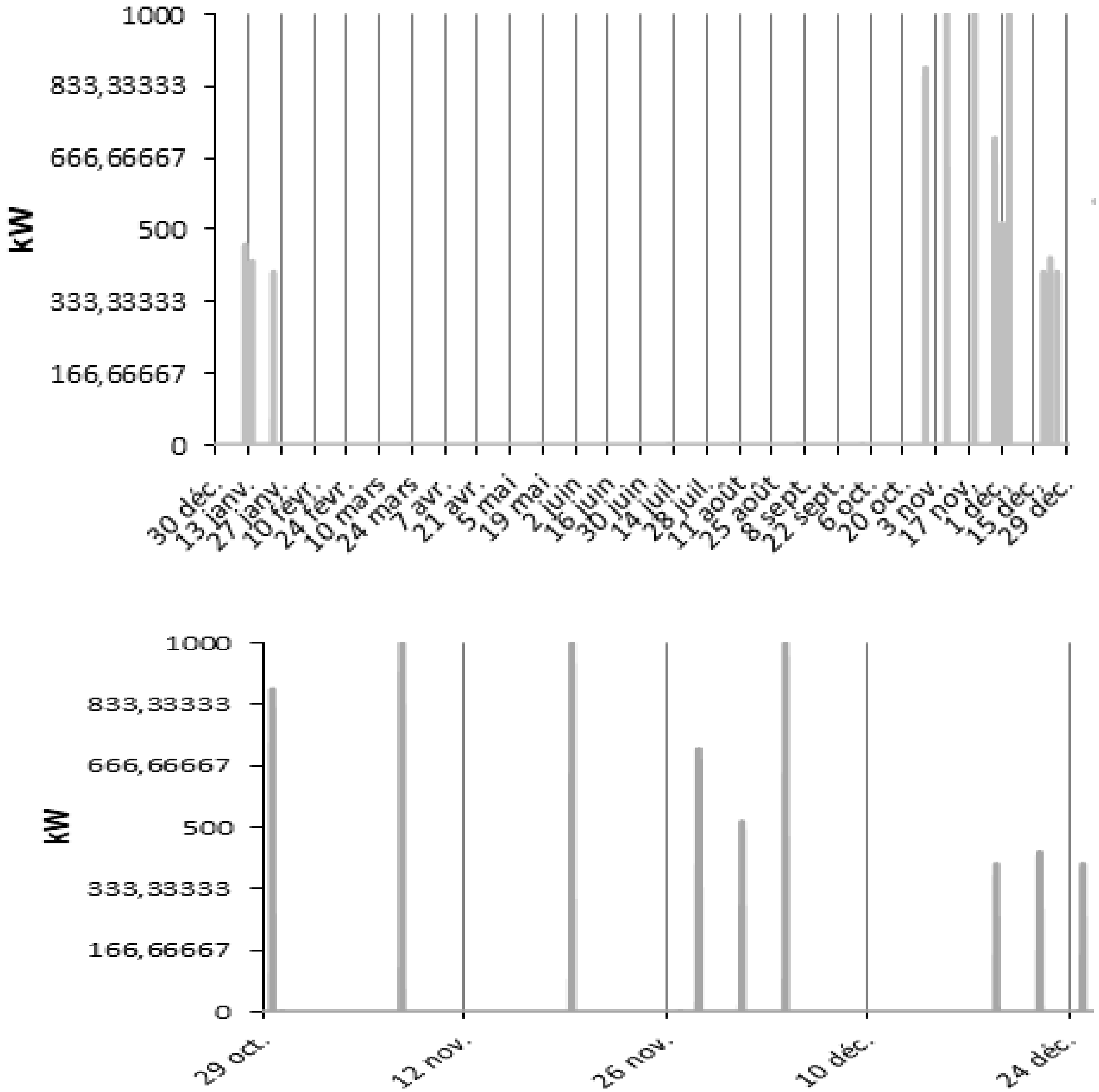
FigureIII.15 Canadian Solar max power CS6U-330P power output

Generic 500kw biogas genset power output is represented by figureIII.1



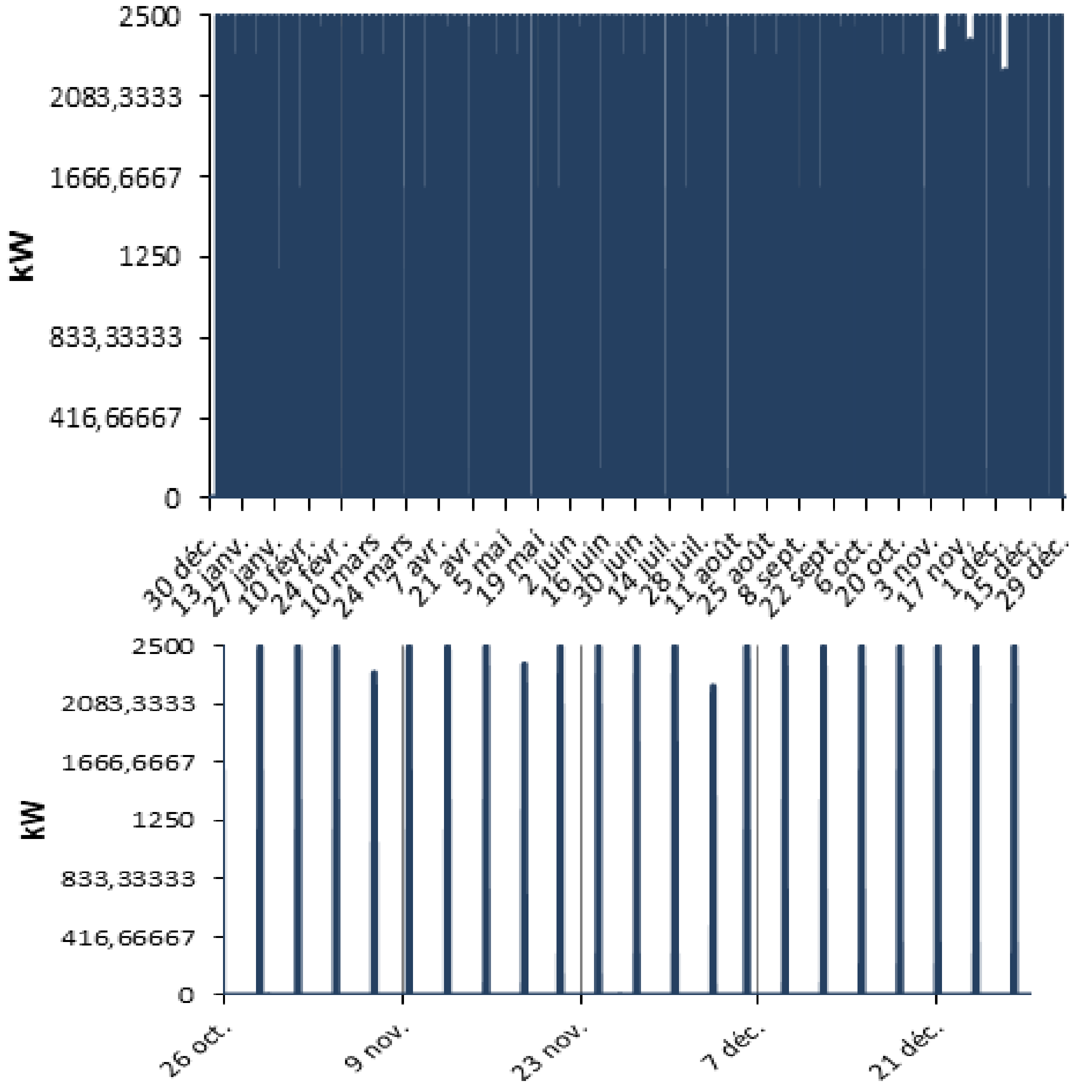
FigureIII.16 Generic 500kW biogas genset power output

MTU 18v2000 ds1250 power output is represented by figureIII.17



FigureIII.17 MTU 18V2000 DS1250 Power Output

Total electrical load served is represented by figureIII.18



FigureIII.18 Total Electrical load served

Total production of energy relative circle is represented by the figure III.19

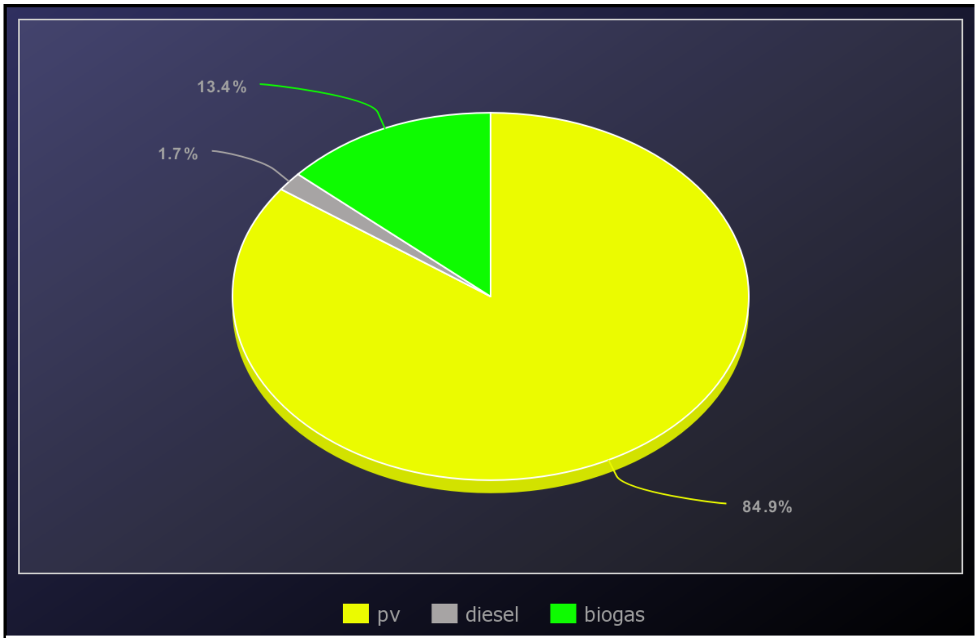


Figure III.19 Total production of energy relative circle

III.3.6.Result:

- The production of green energy has been 98.3%.
- Diesel generator in resting state 1.7% production electrical annual.
- Very low Emissions.
- Pv are first production energy in Naama site .
- Great productions 452.533kW/yr.
- Very low cost.
- Great Storage 150.638kWh/yr.
- Consumption 301,895kWh/yr.

III.4.Second scenario:

simulation of a hybrid system Pv + Biogas

III.4.1. Current system:

Total production of energy histogram is represented by the figureIII.20

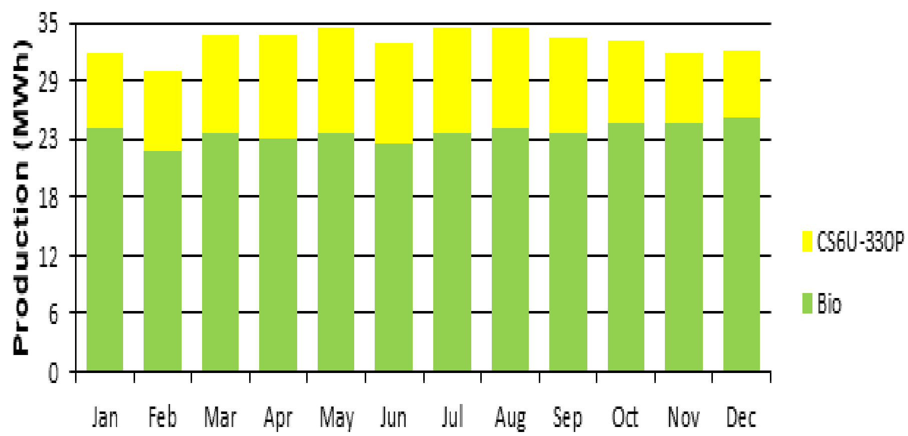
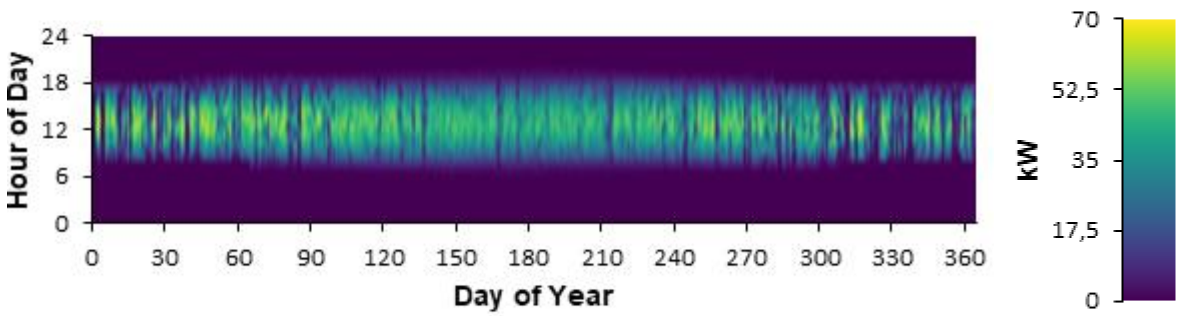


Figure III.20 Total production of energy histogram

III.4.2.PV Canadian Solar Max Power CS6U-330P

The Canadian Solar PV system has a nominal capacity of 62.3 kW. The annual production is 108,283 kWh/yr.

Rated Capacity	62.3 kW	Total Production	108,283 kW
Capital Cost	DA 320, 816	Maintenance Cost	3280 DA/yr
Specific Yield	1,737 kWh/kW	LCOE	0.265 DA/kWh
PV Penetration	0 %		

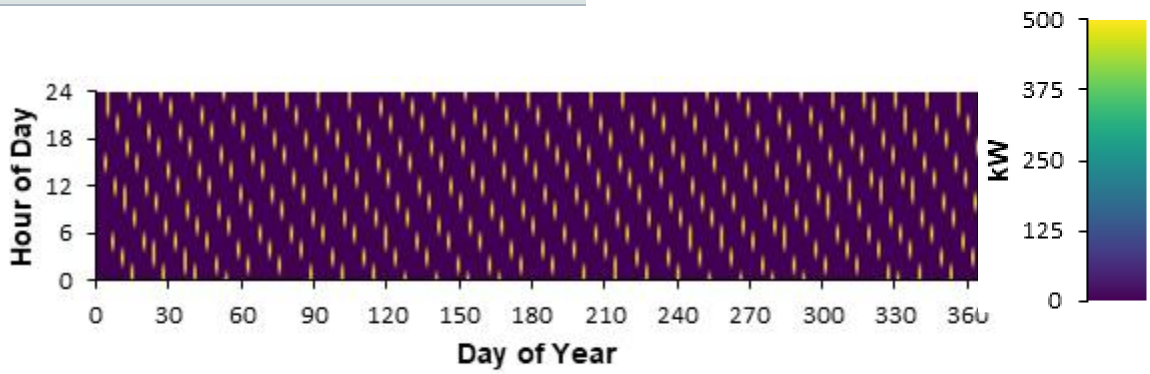


FigureIII.21 The annual production of the Pv

III.4.3.Generic 500kW Biogas Genset (Biogas)

Power output from the generic generator system, rated at 500 kW using biogas as fuel, is 289,000 kWh/yr.

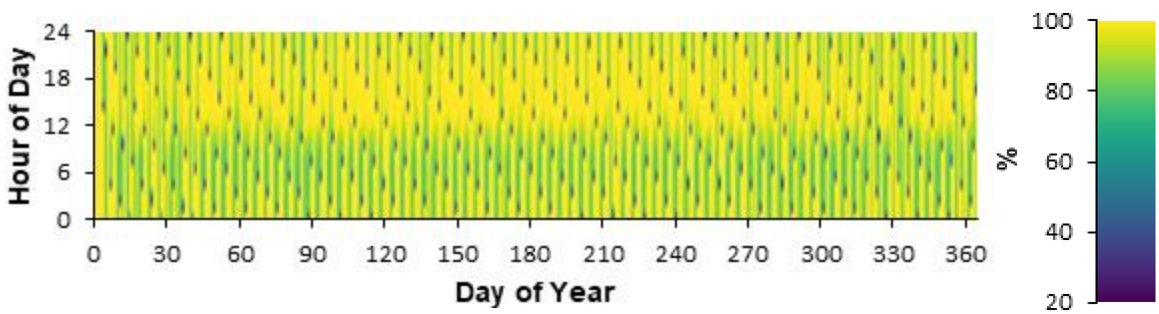
Capacity	500 kW	Generator Fuel	Biogas
Operational Life	34.6 yr	Generator Fuel Price	1.00 DA/kg
Capital Cost	DA1.50M	Maintenance Cost	17,340 DA/yr
Fuel Consumption	607 tons/yr	Electrical Production	289,000 kWh/yr
Hours of Operation	578 hrs/yr	Marginal Generation Cost	0 DA/kWh
Fixed Generation Cost	61.3 DA/hr		



FigureIII.22 The annual production of the generator biogas

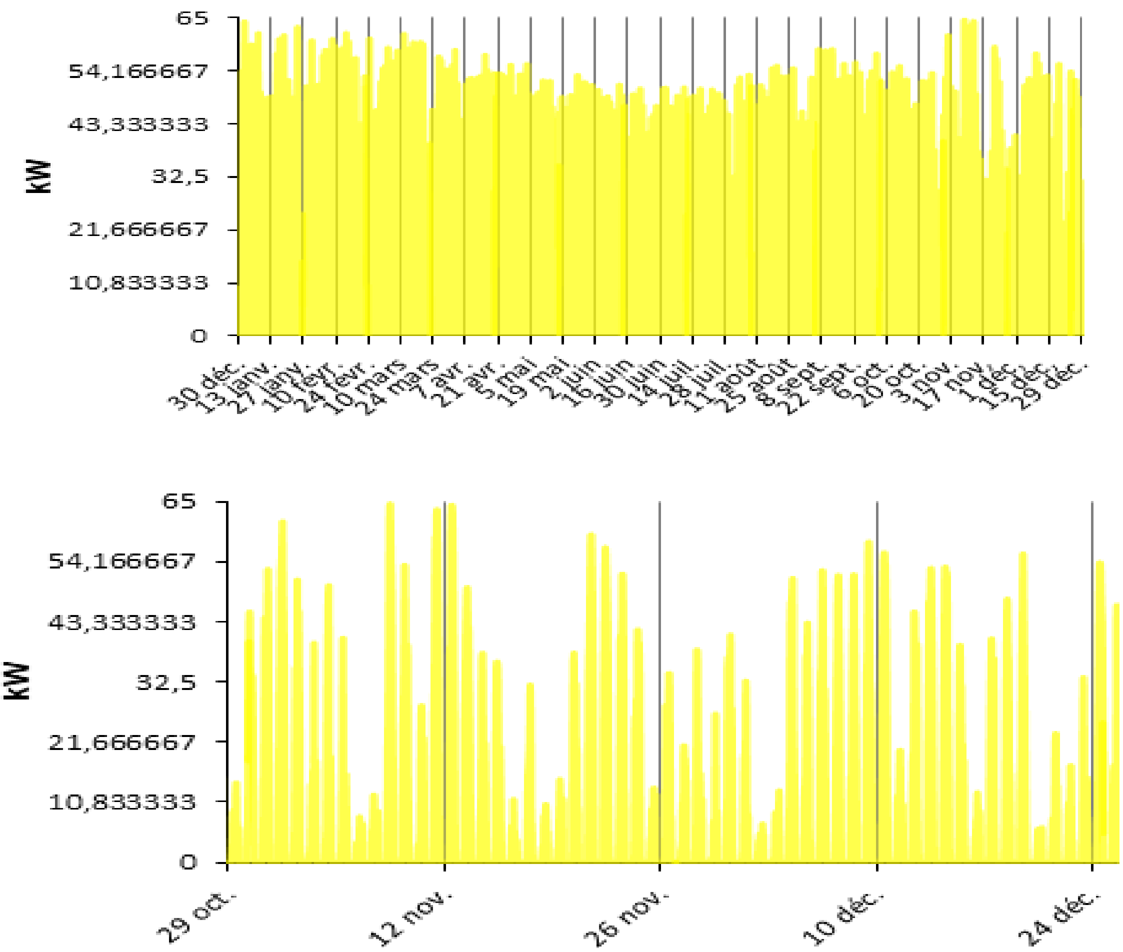
III.4.4. Storage: Generic 1kWh Li-Ion

The generic storage system's nominal capacity is 1,012 kWh. The annual throughput is 95.405 kWh/yr.



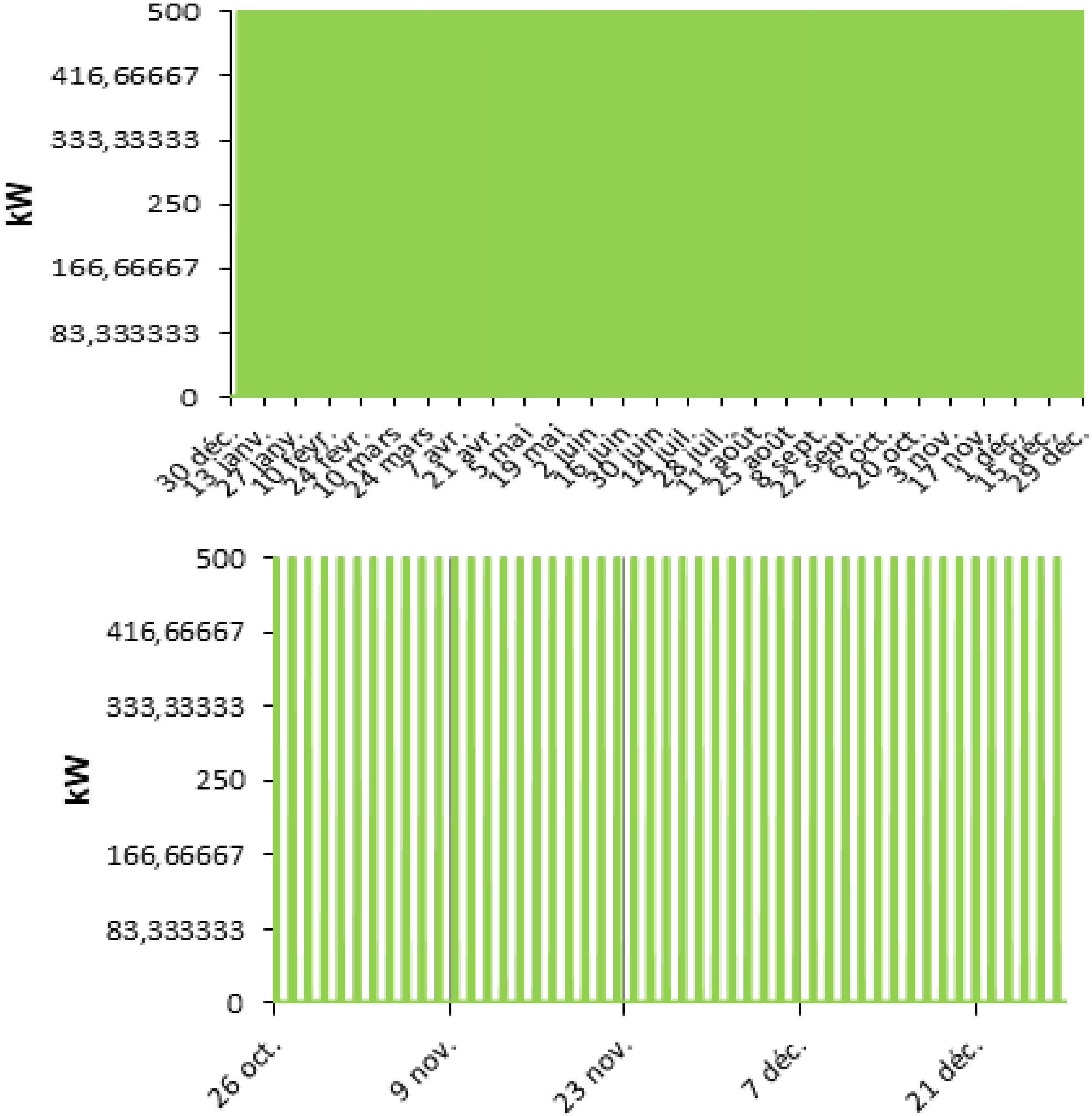
FigureIII.23 The annual production of the battery

Canadian Solar max power CS6U-330P power output is represented by figureIII.24



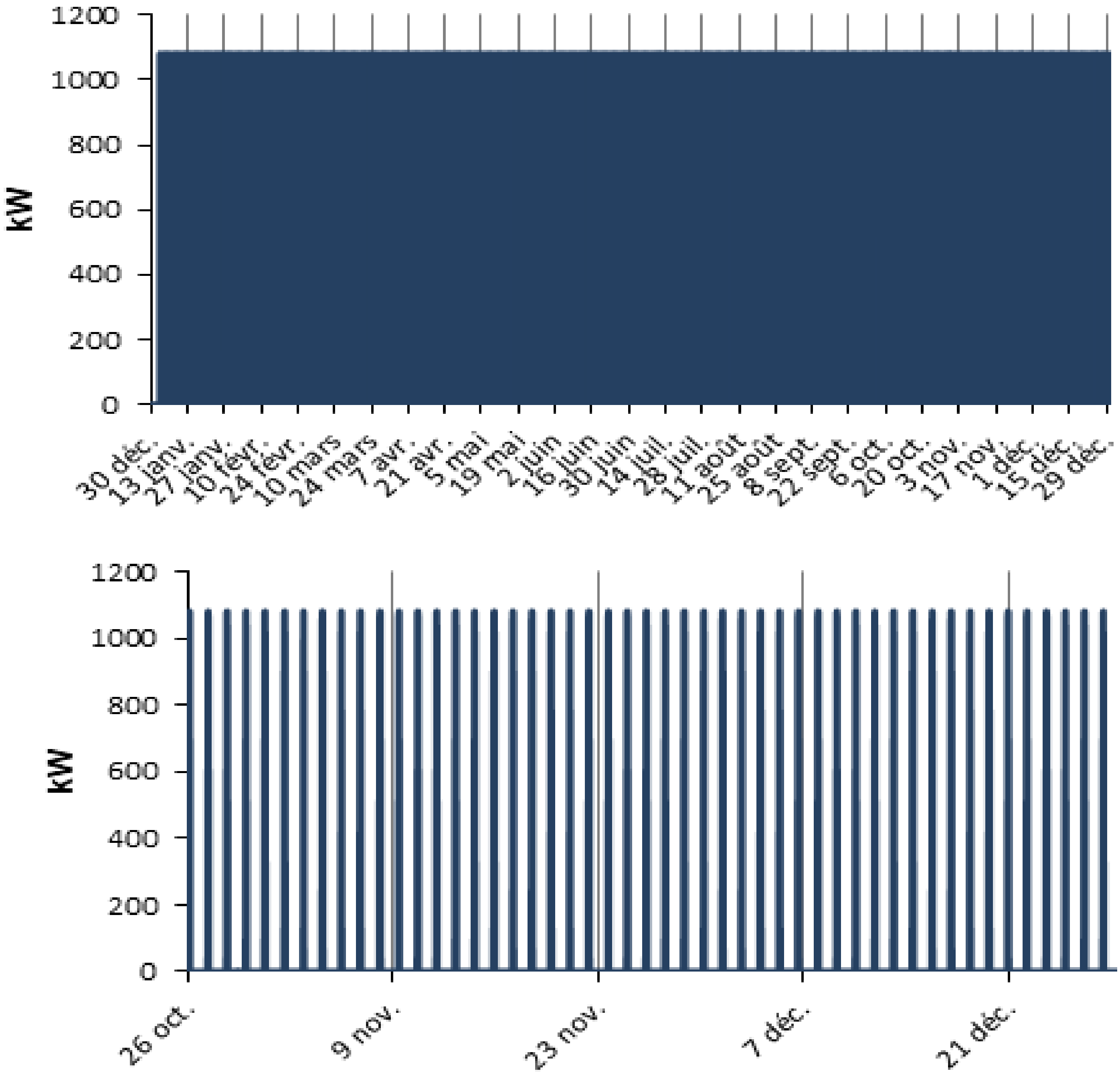
FigureIII.24 Canadian Solar max power CS6U-330P power output

Generic 500kW biogas genset power output is represented by figureIII.25



FigureIII.25 Generic 500kW biogas genset power output

Total electrical load servedis represented by figureIII.26



FigureIII.26 Total electrical load served

Total production of energy relative circle is represented by the Figure III.27

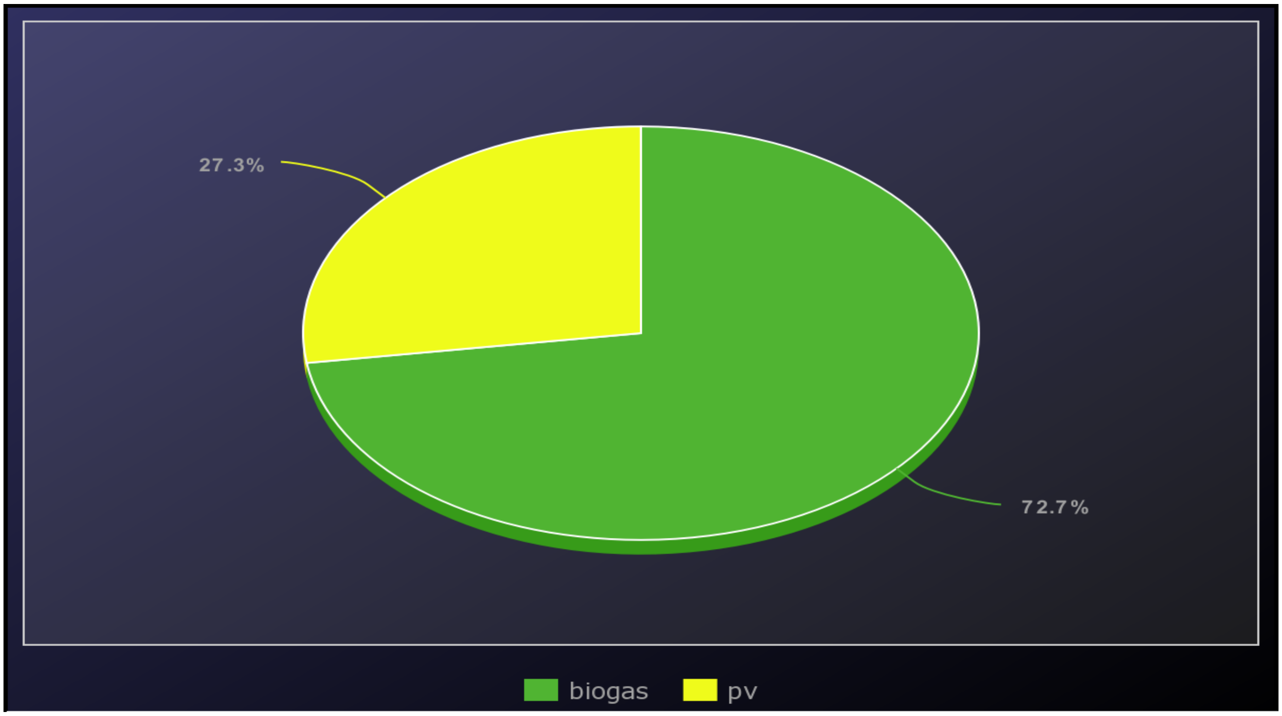


Figure III.27 Total production of energy relative circle

III.4.5.Result:

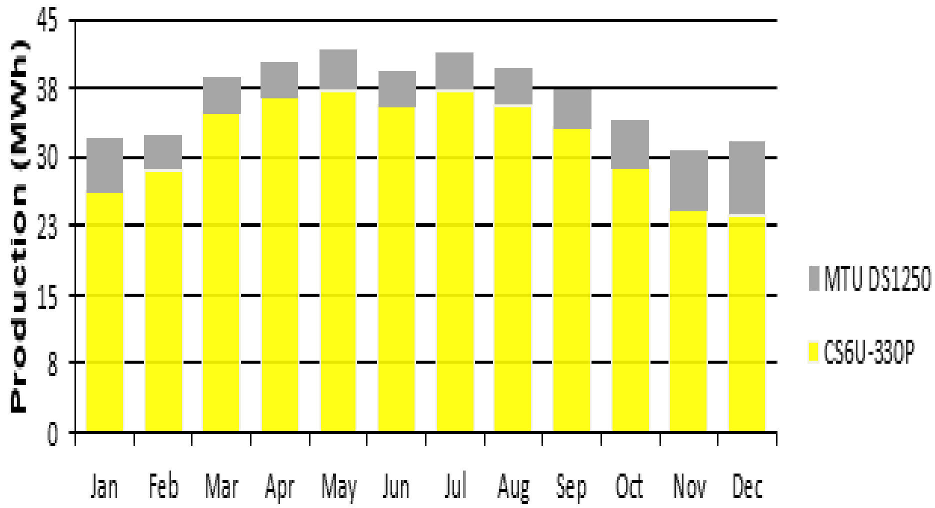
- 100% green energy
- Biogas are best production energy 289.03kW
- Pvproduction electrical annual 108.28kW
- 0 Emissions
- medium production   397.28kW
- Almost no cost
- Medium storage 95.405kWh/yr.
- Consumption 301,878kWh/yr

III.5.Third scenario:

simulation of a hybrid system Pv + Generator diesel

III.5.1.Current system:

Total production of energy histogram is represented by the figureIII.28.



FigureIII.28: Total production of energy histogram

III.5.2.PV Canadian Solar Max Power CS6U-330P The Canadian Solar PV system has a nominal capacity of 220 kW. The annual production is 381,809 kWh/yr.

Rated Capacity	220 kW
Capital Cost	DA115,709
Specific Yield	1,737 kWh/kW
PV Penetration	0 %

Total Production	381,809 kW
Maintenance Cost	1,157 DA/yr
LCOE	0.0265 DA/kWh

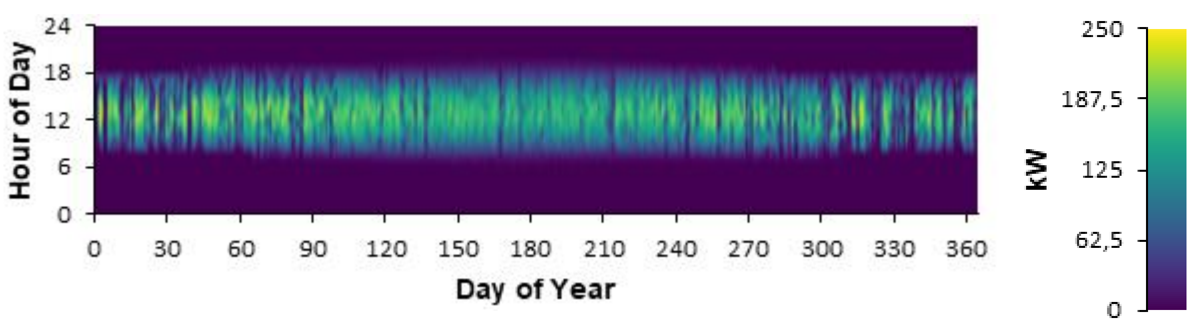


Figure III.29 The annual production of Pv

III.5.3.Generator: MTU 18V2000 DS1250 (Diesel)

Power output from the MTU generator system, rated at 1,000 kW using Diesel as fuel, is 57,967 kWh/yr.

Capacity	1,000 kW	Generator Fuel	Diesel
Operational Life	6.56 yr	Generator Fuel Price	1.00 DA/L
Capital Cost	DA9.00M	Maintenance Cost	4,270 DA/yr
Fuel Consumption	15,046 L	Electrical Production	57,967 kWh/yr
Hours of Operation	122 hrs/yr	Marginal Generation Cost	0.242 DA/kWh
Fixed Generation Cost	125 DA/hr		

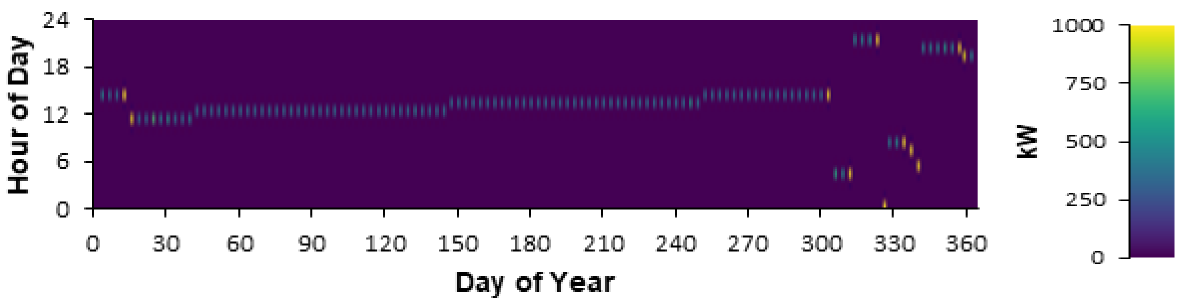


Figure III.30 The annual production of generator diesel

III.5.4.Storage: Generic 1kWh Li-Ion

The Generic storage system's nominal capacity is 2,750 kWh. The annual throughput is 138.054kWh/yr.

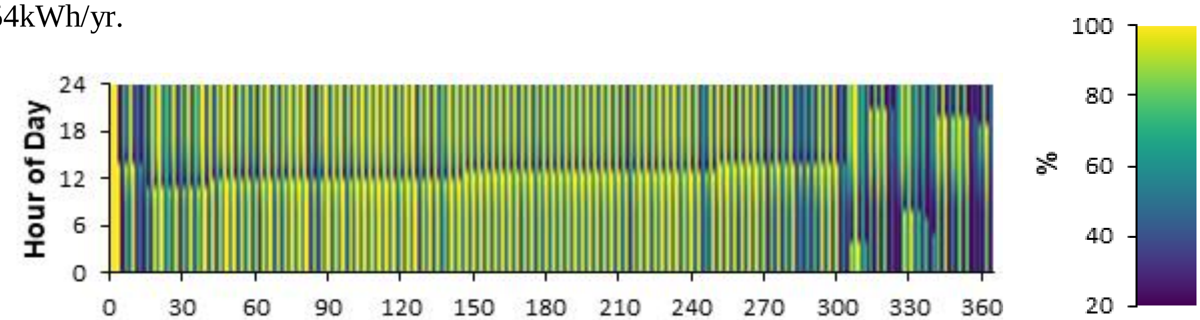


Figure III.31 The annual production of battery

Canadian solar max power cs6u-330p power output is represented by figureIII.32

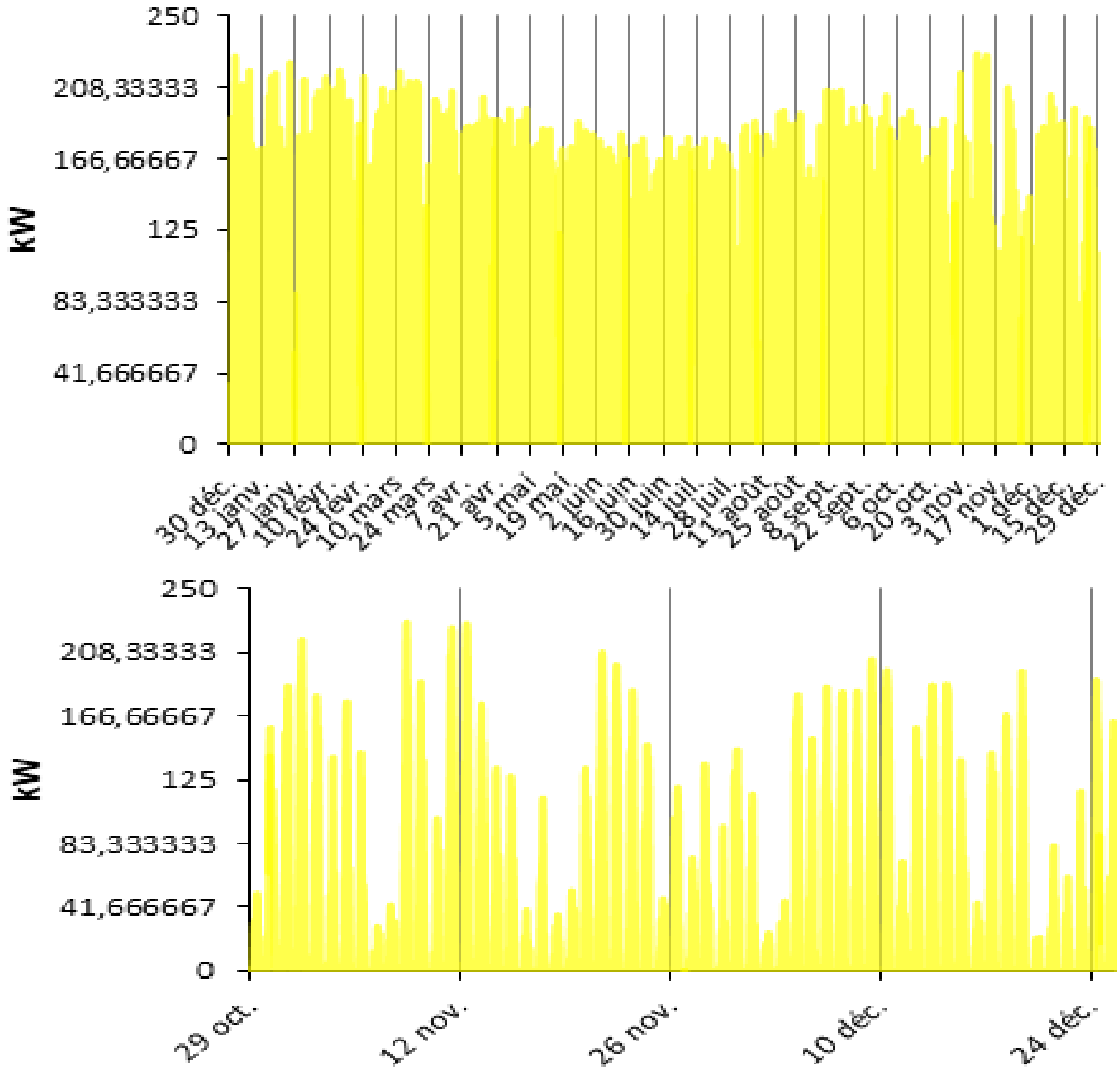
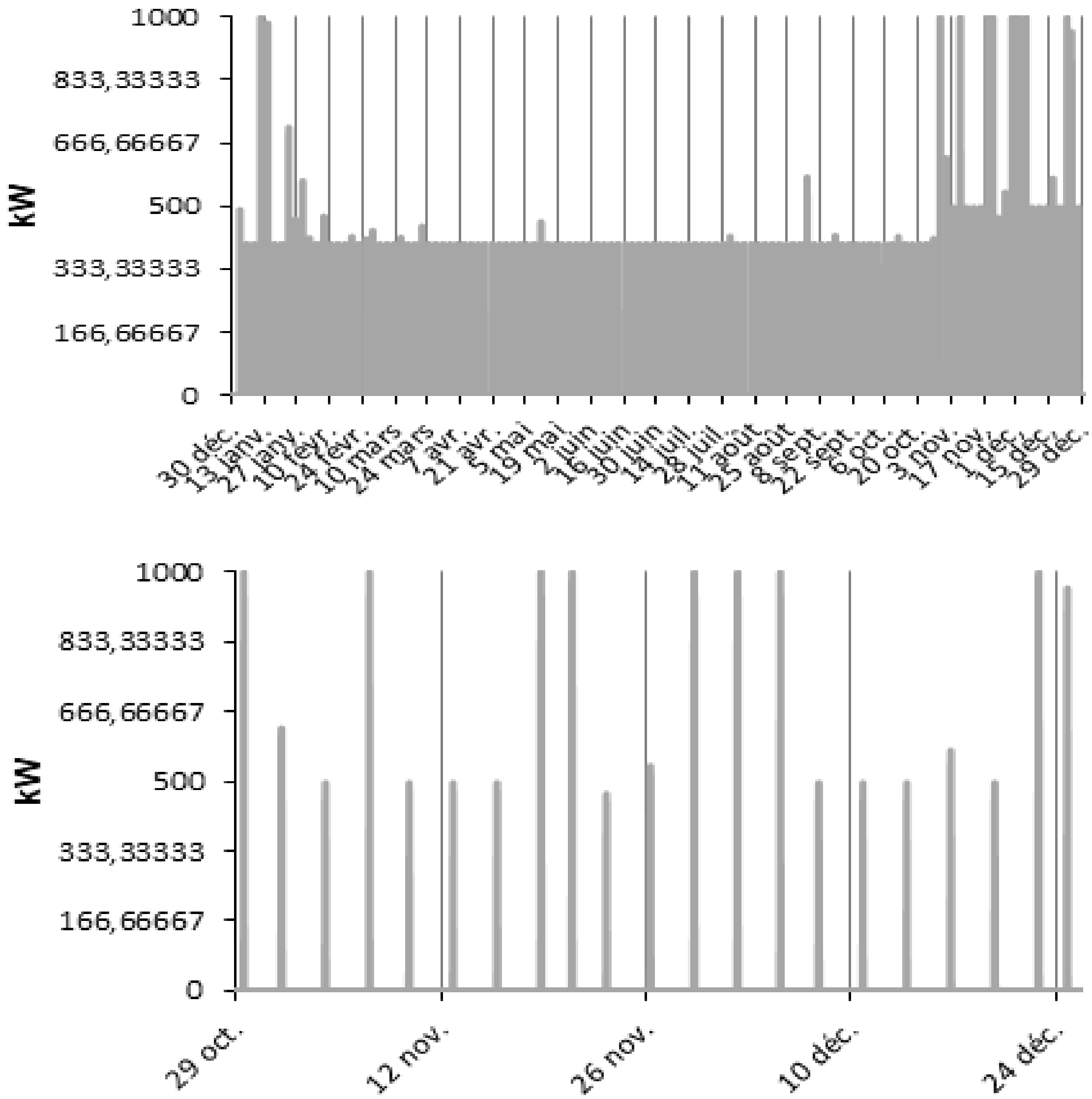


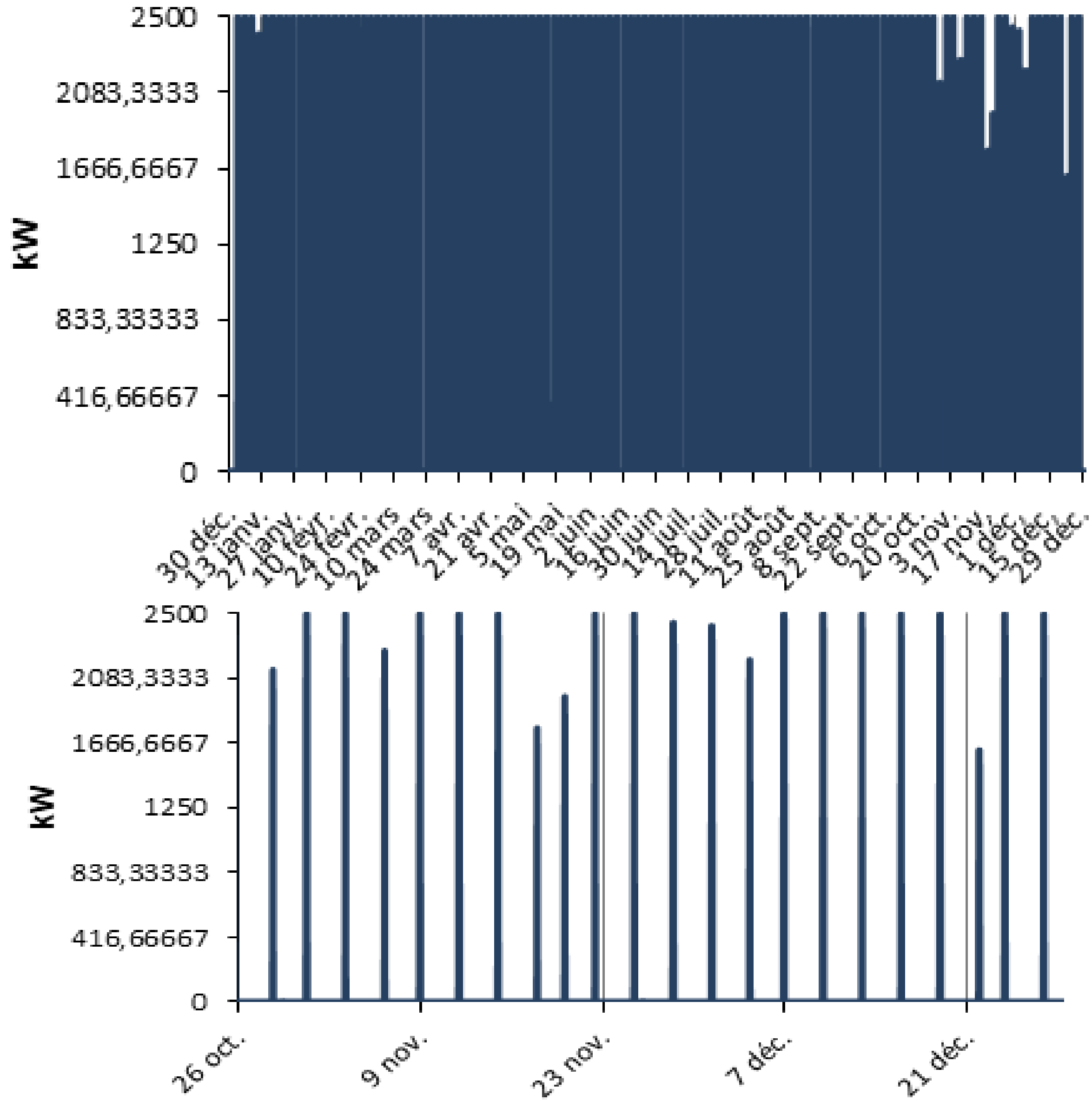
Figure III.32:Canadian Solar max power CS6U-330P power output

MTU 18v2000 ds1250 power output is represented by figureIII.33



FigureIII.33MTU 18V2000 DS1250 power output

Total electrical load servedis represented by figure III.34



FigureIII.34 Total electrical load served

Total production of energy relative circleis represented by figure III.35

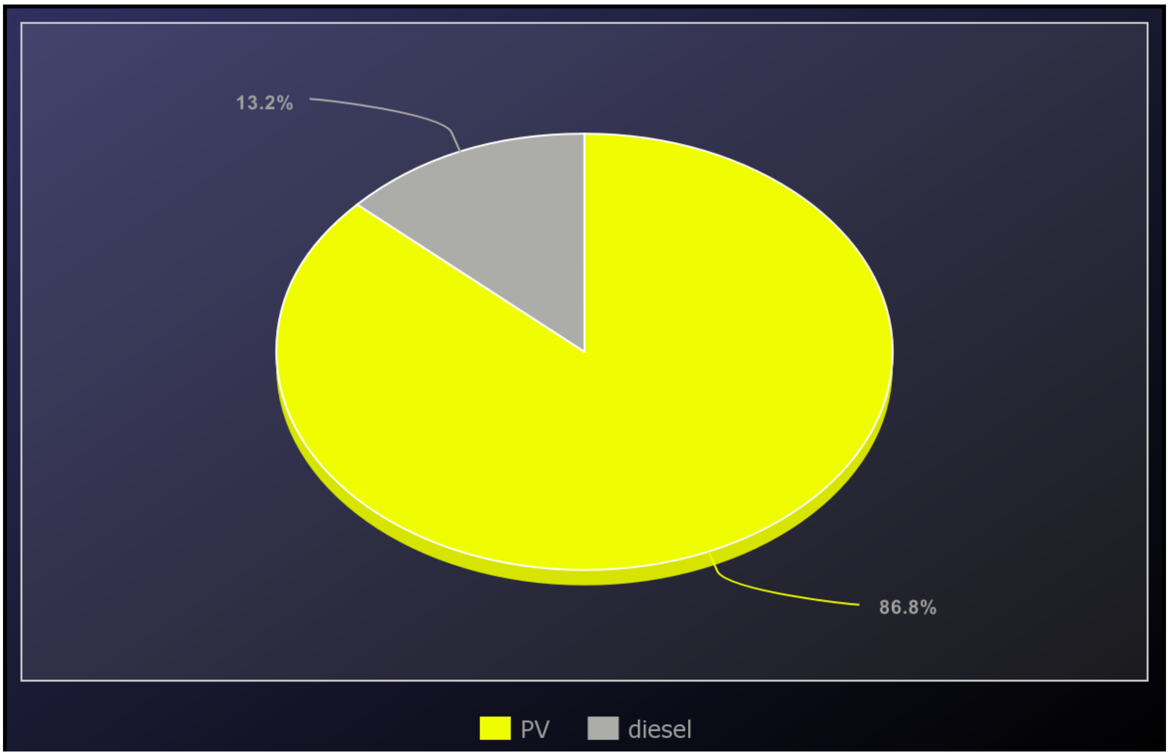


Figure III.35 Total production of energy

III.5.5.Result:

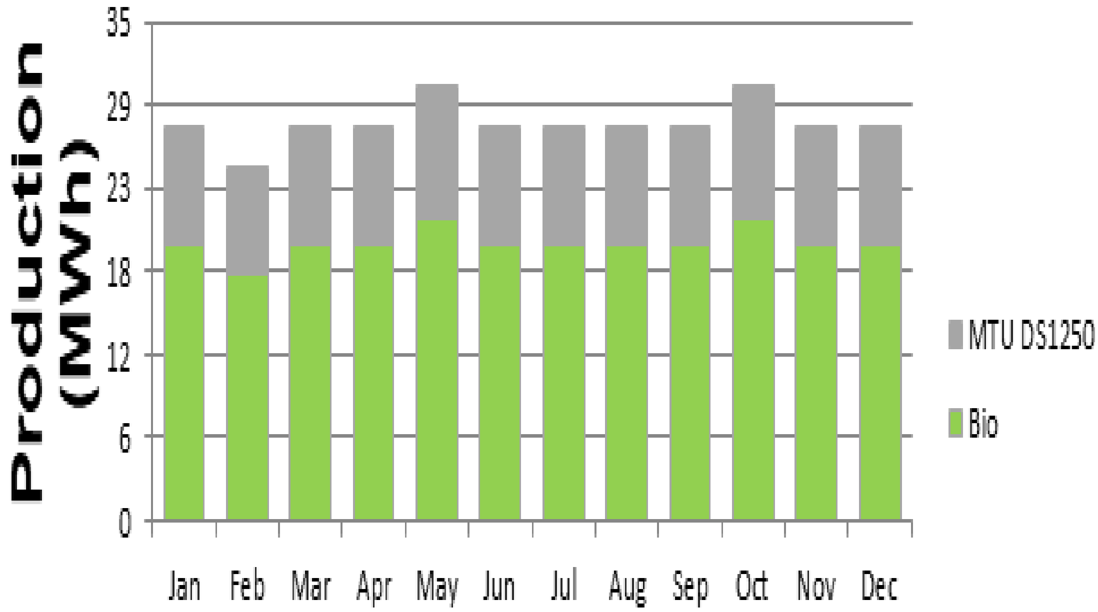
- 87% green energy.
- Pvare best production energy.381.81kW.
- Good production 439.77kW.
- Mean productions of generator diesel.
- Medium emission.
- Medium cost.
- Storage 138..054kWh/yr.
- Consumption 301,722kWh/yr

III.6.Fourth scenario:

simulation of a hybrid system Biomass + Generator diesel

III.6.1 Current system:

Total production of energy histograms represented by figureIII.36



FigureIII.36 Total production of energy histogram

III.6.2.Generator: Generic 500kW Biogas Genset (Biogas)

Power output from the Generic generator system, rated at 500 kW using Biogas as fuel, is 233,962 kWh/yr.

Generator Fuel	Biogas
Generator Fuel Price	1.00 DA/kg
Maintenance Cost	14,520 DA/yr
Electrical Production	233,962 kWh/yr
Marginal Generation Cost	0 DA/kWh

Capacity	500 kW
Operational Life	41.3 yr
Capital Cost	DA1.50M
Fuel Consumption	492 tons/yr
Hours of Operation	484 hrs/yr
Fixed Generation Cost	61.3 DA/hr

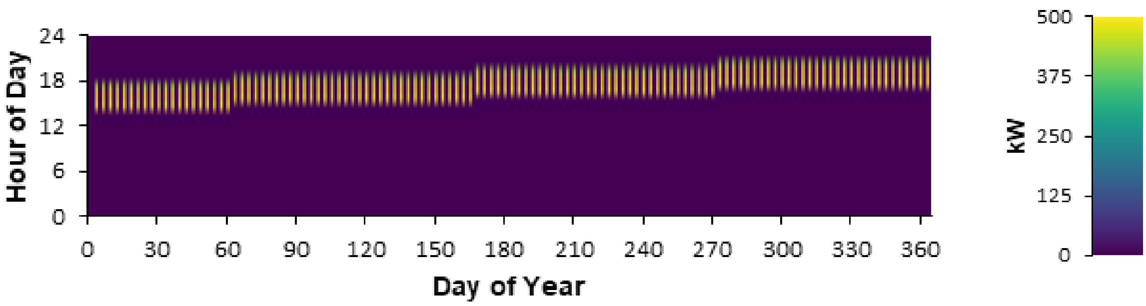


Figure III.37 the annual production of generator diesel

III.6.3. Generator: MTU 18V2000 DS1250 (Diesel)

Power output from the MTU generator system, rated at 1,000 kW using Diesel as fuel, is 101,121 kWh/yr.

Capacity	1,000 kW
Operational Life	6.61 yr
Capital Cost	DA9.00M
Fuel Consumption	25,463 L
Hours of Operation	121 hrs/yr
Fixed Generation Cost	125 DA/hr

Generator Fuel	Diesel
Generator Fuel Price	1.00 DA/L
Maintenance Cost	4,235 DA/yr
Electrical Production	101,121 kWh/yr
Marginal Generation Cost	0.242 DA/kWh

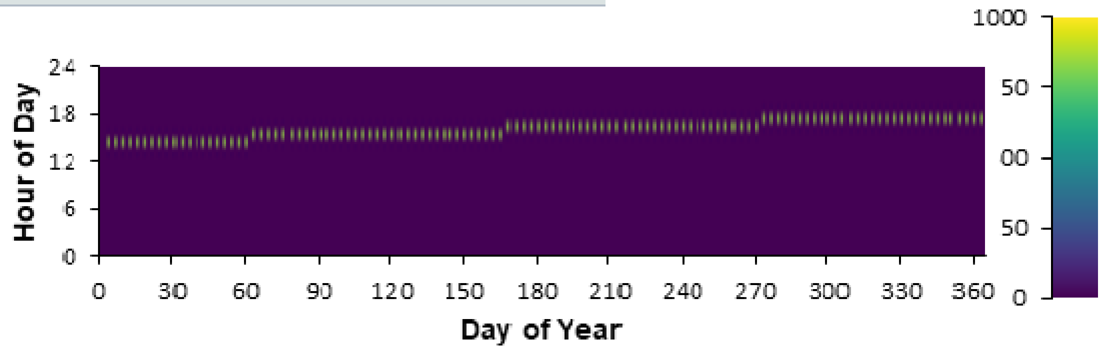


Figure III.38 The annual production of generator diesel

III.6.4. Storage: Generic 1kWh Li-Ion:

The Generic storage system's nominal capacity is 1,598 kWh. The annual through put 32.583kWh/yr

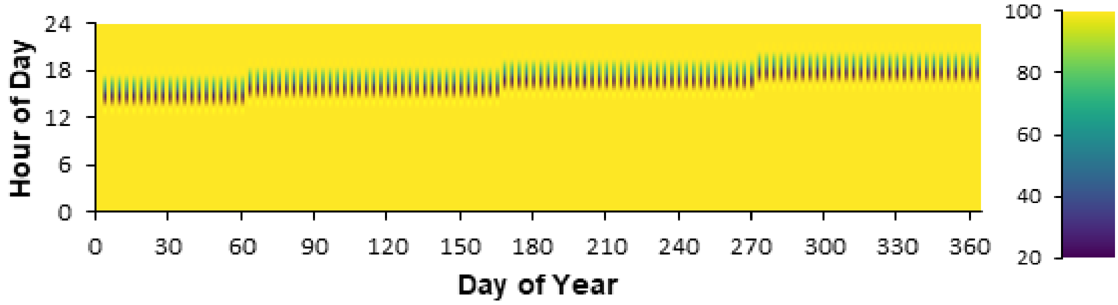
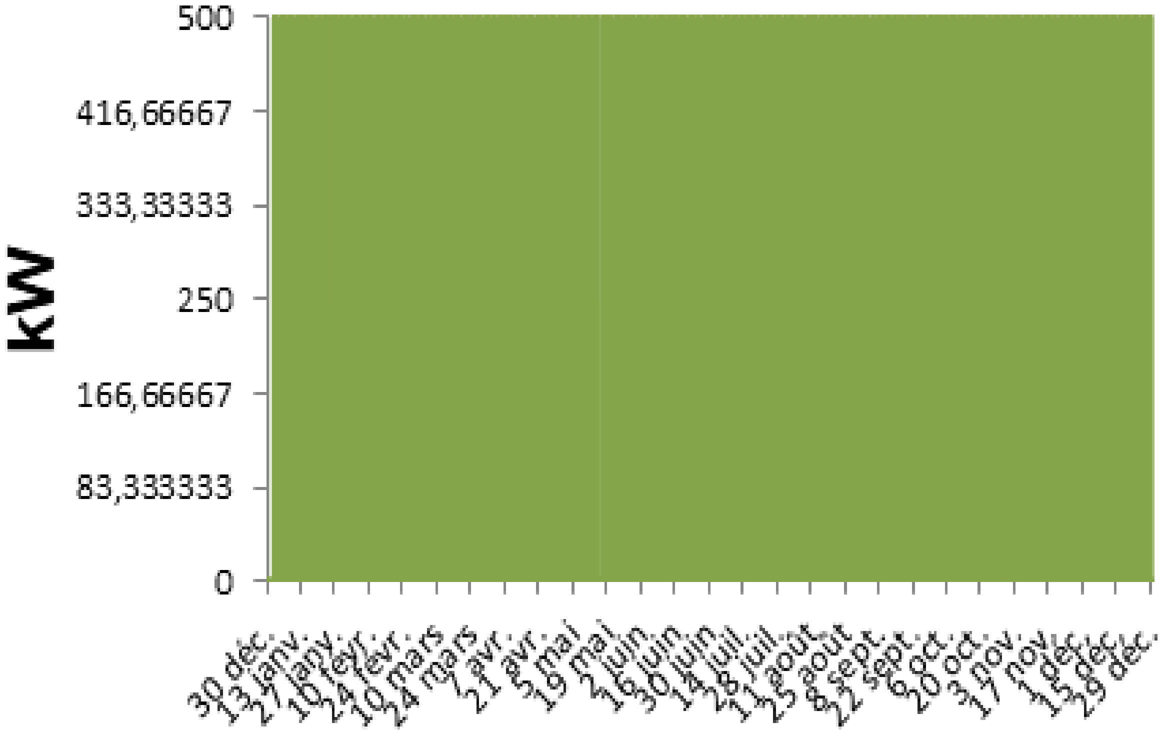
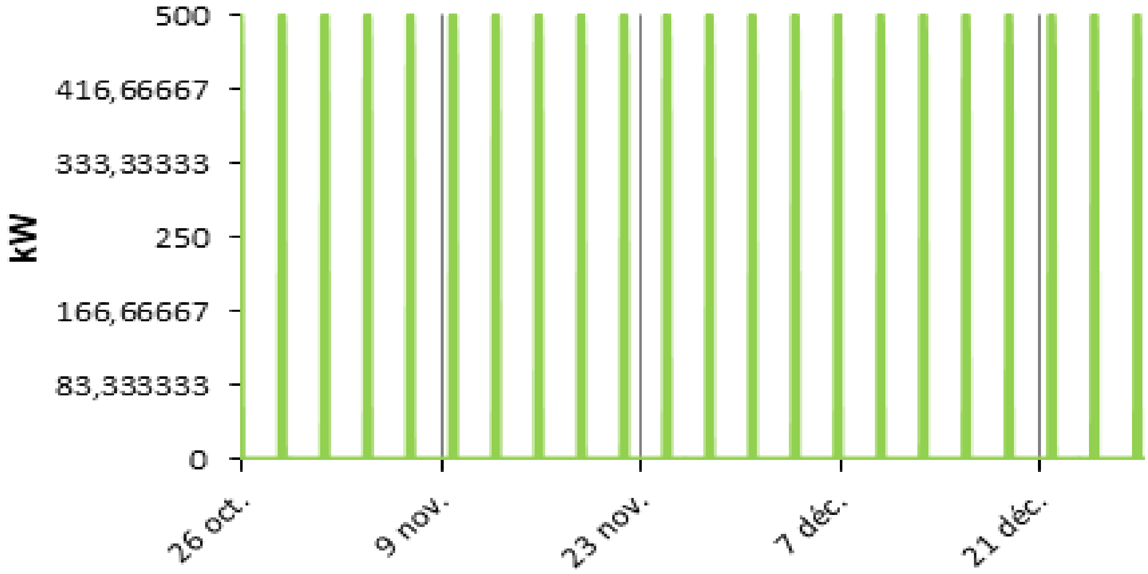


Figure III.39 The annual production of battery

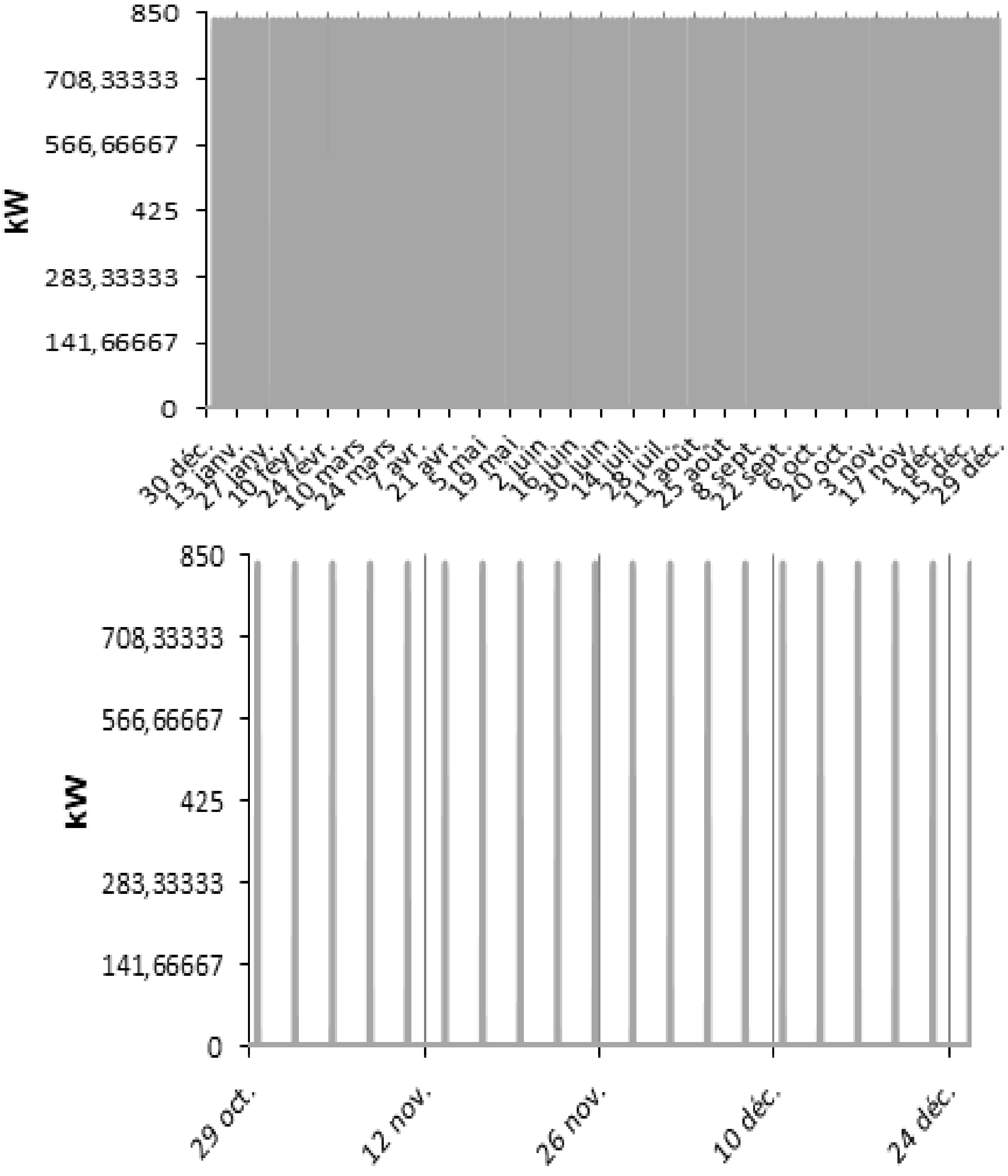
Generic 500kW Biogas Genset Power Output Is represented by FigureIII.40





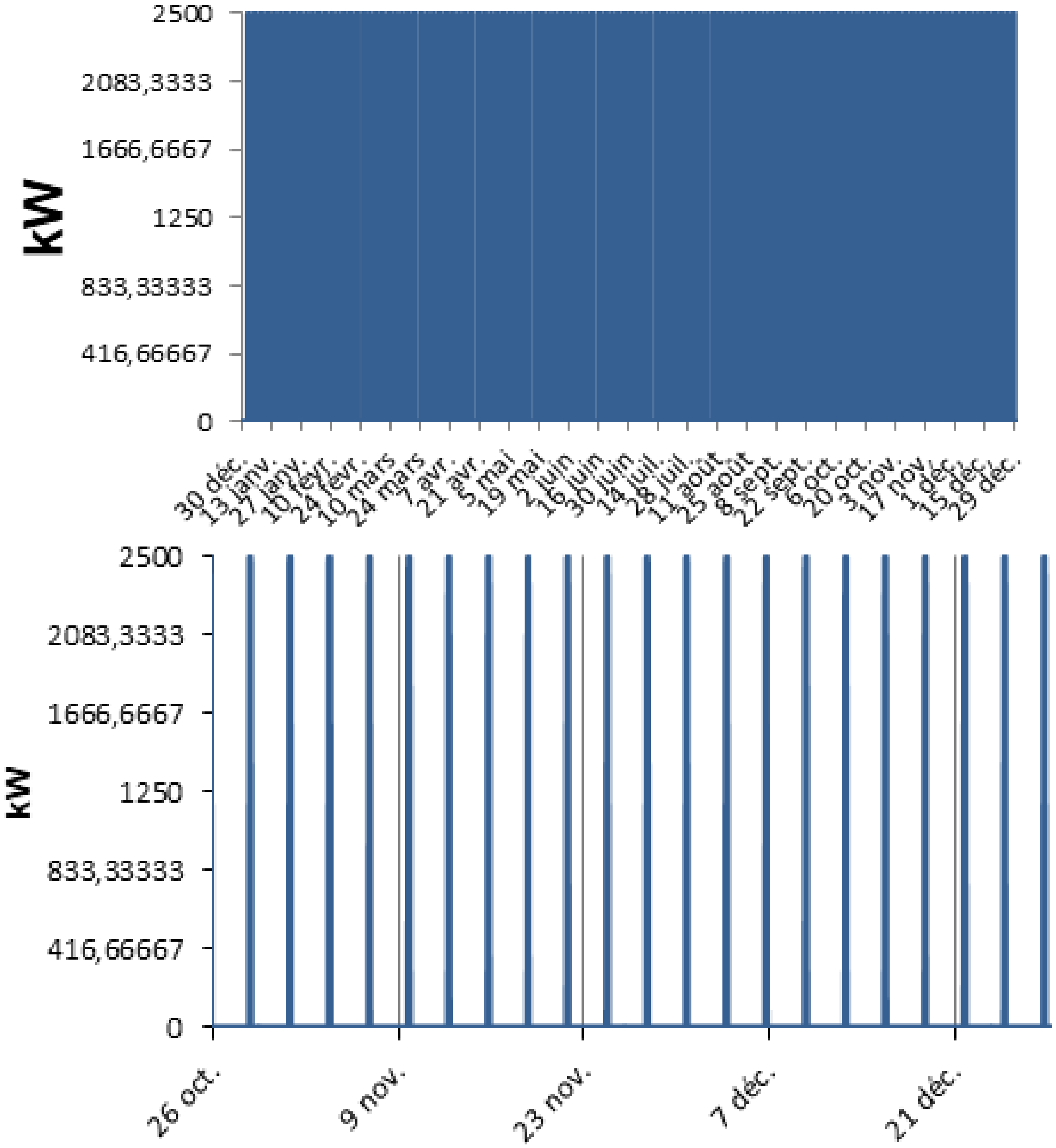
FigureIII.40 Generic 500kW Biogas Genset Power

MTU 18V2000 DS1250 Power Output Is represented by FigureIII.41



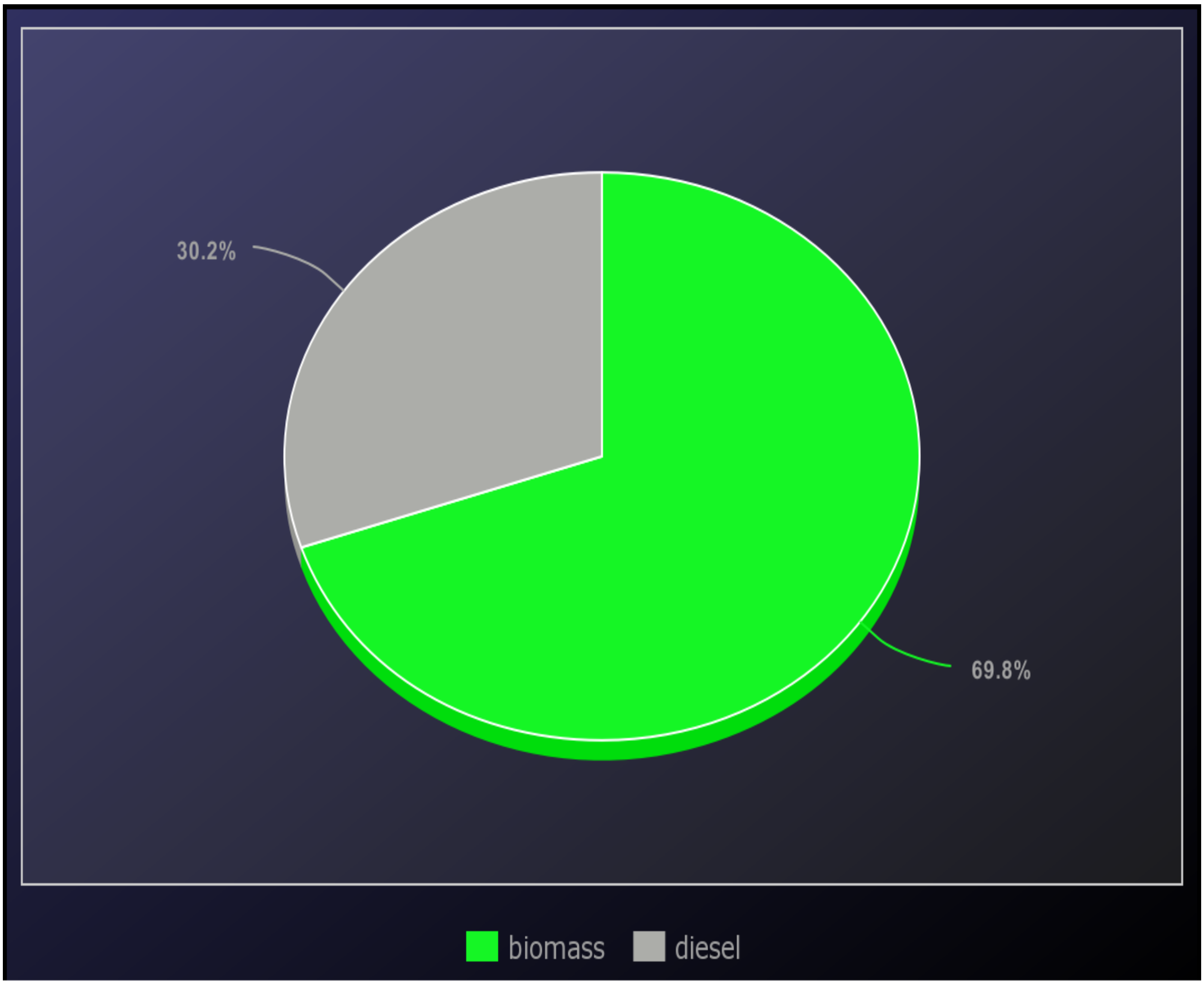
FigureIII.41 MTU 18V2000 DS1250 Power Output

Electrical load servedis represented by figureIII.42



FigureIII.42 Total electrical load served

Total production of energy relative circleis represented by figureIII.43



FigureIII.43 Total production of energy relative circle

III.6.5.Result:

- 69% green energy.
- Medium production 335.083kW.
- Good productions of generator diesel.
- A lot of emission.
- A lot of cost.
- Very low Stocking 32.583kWh/yr.
- Consumption 302,500kWh/yr

III.7.Conclusion:

This chapter presents a new optimal methodology of a hybrid system (PV/biogas generator/diesel generator) in order to electrify the southwest region of Algeria prefecture Naama. Our project is to produce electricity and minimize the total annual cost of the system. The study presented in this chapter has demonstrated the effectiveness of renewable energy (biomass / PV)

Moreover, in this study, a hybridization of four scenario According to the simulation the most efficient Pv/generator biogas /generator diesel, the cost very low because the generator diesel is in resting state and the emission very low with a large storage .consequently Pv/biomass , 100% clean energy good storage zero emission . Let's remember Pv/ diesel generator, medium emission medium cost with big storage. On last place inefficient hybridization is generator biogas/ diesel generator big emission and cost but very low storage

Greeting.

General conclusion

General conclusion

In this dissertation entitled: " Study and Sizing of Hybrid Renewable Energy System (PV / Biomass / Diesel Generator) for Supply Electrical Energy to the Naama site ", we have addressed the issue of the insertion of renewable production in electrical networks, in order to supply the city of Naama with electricity.

The work of this dissertation focused on a technical-economic study aimed at minimizing fuel consumption (natural gas, diesel) and toxic emissions from a multi-source power plant, and maximizing photovoltaic and biomass production.

Moreover, in this study, a hybridization of fourth scenario According to the simulation the most efficient Pv/generator biogas /generator diesel, the cost very low because the generator diesel is in resting state and the emission very low with a large storage.consequently Pv/biomass , 100% clean energy good storage zero emission . Let's remember Pv/ diesel generator, medium emission medium cost with big storage. On last place inefficient hybridization is generator biogas/ diesel generator big emission and cost but very low storage.

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Abstract

In this note, we will address two important issues in the development of electricity grids. The first is devoted to the technical part through which the flow of energy (resulting from the hybridization of renewable energies (solar and biomass energy extracted from the exploitation of waste)) is improved through the use of the simulation program Homer pro. The second is related to the economic side, where the incorporation of renewable energy resources and their involvement in the electricity generation process reduces fuel bills and thus reduces the production price. On the one hand, on the other hand, we wish to establish a model of the electricity distribution network for sustainable development (a real study on an Algerian website in the state of Naama) based on a comprehensive and exemplary technical study.

Résumé

Dans la présente note, nous aborderons deux questions importantes pour le développement des réseaux électriques, la première consacrée à la partie technique par laquelle le flux d'énergie est amélioré (résultant de l'hybridation des énergies renouvelables (énergie solaire et énergie de biomasse issue de l'exploitation des déchets)) à l'aide du logiciel de simulation Homer pro, et la seconde à l'économie par laquelle l'intégration des sources d'énergie renouvelables et leur participation à la production d'électricité réduisent les coûts du carburant et donc le prix de production, d'une part, et par conséquent, la réduction des émissions de gaz à effet de serre, et nous aimerions donc créer un modèle de réseau de distribution d'électricité pour le développement durable (une étude réelle sur un site algérien dans l'état de Naama).

ملخص :

سنتطرق في هذه المذكرة لمسألتين من المسائل المهمة في تطوير الشبكات الكهربائية ,المسألة الأولى مكرسة للجزء التقني الذي يتم من خلاله تحسين تدفق الطاقة (الناتجة من تهجين الطاقات المتجددة (الطاقة الشمسية و طاقة الكتلة الحيوية المستخرجة من استغلال النفايات)) وذلك باستخدام برنامج المحاكاة Homer pro، وأما المسألة الثانية فهي متعلقة بالجانب الإقتصادي ,حيث يؤدي إدماج موارد الطاقة المتجددة و إشراكها في عملية توليد الكهرباء إلى التقليل من فواتير الوقود وبالتالي تخفيض سعر الإنتاج هذا من جهة، و من جهة أخرى التخفيف من إنبعاث غازات الاحتباس الحراري وبالتالي فإننا نرغب في إنشاء نموذج لشبكة توزيع الكهرباء من أجل التنمية المستدامة (دراسة حقيقية على موقع جزائري بولاية النعامة) والتي تستند الى دراسة تقنية شاملة ومثالية.