PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA MINISTRY

OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

KASDI- MERBAH OUARGLA UNIVERSITY

Dissertation

PRESENTED TO OBTAIN A DIPLOMA OF

MASTER

FACULTY OF: Génie mécanique

Specialty : Renewable energies in mechanic

PRESENTED BY:

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Theme:

Modeling of a Micro grid Hybrid energy production System (PV/wind /Diesel generator)

Publicly supported on: /06/2020

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Academic year: 2020/2021

ACKNOWLEDGEMENTS

First of all, I thank God Almighty for giving us the courage, will and patience to complete this present work under better conditions, I would like to thank Mr. Mohamed Darnouni ***for his supervision, effort with us and his valuable guidance would like to express our gratitude to all the professors who helped us in teaching the lectures, and we would like to thank*** *Mr.* Omar Rawag***, the professor and head of the department,*** Mr. DJamel BenMenine, ***and all the members of the discussion committee who agreed to read. Thanks to the Renewable Energies Department, and last but not least we would like to express our sincere thanks to family, friends, classmates and anyone who contributed to this work by providing us with continuous support and encouragement throughout the years of study and during the work of this note.Thanks***

- ***Abdeslame Salhi***
- ***Mohamed Badrddine Aiad***

Dedications

I dedicate this humble work to my dear parents, may God protect them for me and my sisters, and all my family and everyone who is dear.

Mohamed Badrddine Aiad

Dedications

I dedicate this humble work to all my dear friends I have known in my academic career To my dear parents, may God preserve them for me, my brothers and sisters, all my family and all my loved ones.

Abdeslame Salhi

SUMMARY

summary

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H_{inv}: the efficiency of inverter and charge

η_B: efficiency of battery bank [%]

DOD_{max}: the maximum battery depth of discharge

$D_f(t)$: is the hourly fuel consumption of DG [L/h]

P_{Dg}: is the average power per hour of the DG [kW]

P_{Dgr}: is the DG rated power [kW]

E_L (t): is load demand at the time t

H_{inv}: the efficiency of inverter and charge

SOC (t): the states of charge of battery bank (Wh)

E_{Gen} (t): is the total energy generated by PV array

η_B: battery efficiency [0.65 to 0.85]

σ: self-discharge of the battery bank

DOD_{max}: the maximum battery depth of discharge

T_{cf}: the temperature correction factor and ηB is the battery efficiency

V_B: the battery bank voltage

E_L: the load in (Wh)

S_D: the battery autonomy or storage days

α_1: Power law exponent which varies with the elevation

C_B: battery bank capacity (Wh)

V_{href}: wind speed measured at the reference high H_0 and \alfa is the power law which varies

H: hub height

V_R: the rated wind speed

V_F: the cut-off wind speed.

P_R: the rated electrical power

V_c: the cut-in wind speed

P_{rated}: rated power

V_{cutin}: wind speed at hub height

P_W: Output of wind generator

V_{wind}: wind speed

P_{rated}: rated power

T_{cref}: reference temperature

T_a: ambient temperature (°C)

β_t: Temperature coefficient of effencicy [0.004 to 0.006]

Tc: Temperature PV

η_r: reference efficiency PV

η_{pc}: efficiency of power tracking the power conditioning efficiency

N: Number of modules

A_{pv}: Area of single module PV

P_{pv}: Output of the PV

G_t: global irradiance incident (W/m^2)

η_{pv}: Instantaneous PV

P_{pv}: Output of the PV

MW: Megawatt

NASA: National Aeronautics and Space Administration

(PV/WDG): Hybrid system renewable energy

M&O: Maintenance and operating

MPP: Maximum power point

MPPT: Maximum power point tracking

AC: Alternating current

DC: Direct current

WT: Wind Turbine

DTS: Driver Train System

PV: Photovoltaic

Wind: Turbine Wind

DG: diesel generator

NASA: National Aeronautics and Space Administration

KW: Kilo Watt

KWh: Kilo watt hour

HA: Horizontal axis

VA: Vertical axis

VAWT: Vertical axis wind turbine

HAWT: Horizontal axis wind turbine

CO_2: Carbon dioxide gas

CO: carbon monoxide

HOMER: Hybrid optimization model for electric renewable

HRES: Hybrid system renewable energy

LCE: Levelized cost energy

NPC: Net present cost

COE: Cost of energy

M&O: Maintenance and operating

Introduction

Permeable fossil energies are the only interface in the global demographic explosion and industrial development, (and they dominate global energy consumption. It is estimated that 80% of present-day energy use depends on fossil fuels.) [1]Electricity is the most widely used in the world and is essential to the requirements of modern life. They are produced in units and transmitted through electrical networks to the consumer. But for isolated areas, electric power is provided by diesel generator set, which is expensive to consume fuel and pollutes the environment in a large way, or it is transported over long distances through networks, and it poses risks due to weather fluctuations to which the wind and high temperatures in the summer are exposed, which may lead to its destruction. On the other hand, on the other hand we find high delivery cost and efficiency due to the far distance; in both cases we find damage in economic and environmental terms. It was necessary to confront the problem and find an appropriate solution to this obstacle, with the development of studies and research. Today,

Hybrid renewable energy systems (PV/W/D) have become popular as stand-alone power supply systems and electricity in remote areas due to developments in renewable energy technologies and increased prices for petroleum products. A typical hybrid energy system consists of two or more renewable energy sources used together to provide increased system efficiency as well as a greater balance in the power supply to isolated areas, and to provide increased efficiency of the system as well as a greater balance in the power supply for isolated areas and does not bear the expenses of losses from the transmission of electrical networks For far distances at the expense of the urban population. Usually hybrid power Solar, wind and hydro power systems use a system with these

Different sources are characterized by scale and stability. National Renewable Energy Laboratory (NREL) The Hybrid Renewable Energy Improvement Model (HOMER) program used to conduct the study. HOMER performs economic analysis of hybrid power systems. The input to HOMER will simulate hourly every possible thing. A combination of components has been introduced and the system is available. Results are based on total net present cost.

In these problems we start our work and scientific studies aimed at removing these problems and obstacles in order to facilitate and provide the full needs of these isolated areas, and from these areas we chose the BOUR AL AICHA area in Ouargla, located in the southeast. In Algeria, this research simulates a hybrid power system consisting of PV, a wind turbine generator, a diesel generator with a battery model and an energy management strategy that is designed and simulated, in a secluded house, and this makes it possible to provide a methodology for improvement and upgrading through technical

Tlili, I. (2014). ***Renewable energy in Saudi Arabia: current status and future potentials. Environment, Development and Sustainability***, and economic calculation through various potential variables For isolated sites in isolated areas .to study the mixed system. We divided our topic into three chapters as shown below :

- The first 1 chapter: It is devoted to generalizing and defining the importance of the hybrid system (photovoltaic turbines, wind and diesel generators) to get a comprehensive idea of the system components and the various tools.

- Chapter 2: Modeling all elements of a hybrid system and analyzing the dynamics of the behavior of the entire system in the face of climate change and system loads. Modeling and simulations are done using (HOMER) Software ®.

- Chapter Three 3: Chapter Three entitled discussion and analysis of modeling results, theoretical and experimental simulation, and economic technical improvement in the (BOUR AL AICHA) region of Ouargla.

CHAPTER I

Generality of hybrid system (PV/W/D)

I.1 Introduction

The demand for electricity in Algeria is increasing rapidly as a result of economic growth and demographic development, and the electricity generation capacity must be increased in the future. With this increasing growth in the value of consumption (the Algerian government realized the value of renewable energies to preserve fossil fuels) [1] and finding sustainable solutions to reduce climate change and greenhouse gas emissions. It has seen its success in many countries such as Canada, Russia, Japan and China (Algeria launched an ambitious program to develop renewable energies and enhance energy efficiency)[2] one of the most important of these programs. Hybrid system based on multiple sources of renewable energy (PV-W-D) and includes isolated areas and therefore we are looking to reduce the economic cost and fuel consumption as much as possible from the spent fuel

I.2 Diversity of renewable energies in Algeria

Renewable energies in Algeria are relatively the largest in North Africa. Promoting the market for renewable energies is one of the main axes of the country's energy policy. The goals announced by the authorities are for the local market to reach about 600 megawatts in 2015, bringing the percentage of electricity produced from renewable energies to 6% of the total electricity produced. Algeria is preparing for a new era of renewable energy as a result of the launch of a program to develop renewable energies. (The program represents the installation of nearly 10,000 megawatts of sustainable energy between 2011 and 2030, 7,500 megawatts for national electricity demand and 2,000 megawatts for export) [3]. However, the export of electricity is conditional on the guarantee of reliable partners, the guarantee of a long-term purchase contract and external investment. By 2030, according to the study, about 40% of electricity production for consumption will be from renewable energies. Solar thermal and photovoltaic energy dominate the potential of renewable energies, and this is an opportunity for Algeria. (When comparing renewable energy sources, the potential of wind energy, biomass and hydroelectric energy; and hydrogen is lower for thermal energy and photovoltaic energy) [4]. However, the program does not include the construction of about 60 solar photovoltaic and solar thermal power plants, wind farms and hybrid plants. Renewable energy production projects for the national market will be implemented in three phases:

- Pilot projects will be devoted to testing the various technologies available.
- Beginning of program deployment.
- Newsletter widely.

I.3 Definition of Hybrid Power Systems

There are many definitions of hybrid power systems. It is a multi-source power system that connects at least two renewable energy sources and one or more conventional energy sources (diesel) to what must be connected to the switching electric modes and that the renewable energies of the redundant storage system do not provide stable energy. Instead, their association with traditional sources makes it possible to obtain a permanent production of electricity (the performance and efficiency of the system depends in part on its design, optimization of component type and architecture) [5]. To better evaluate the performance of its economics in fuel consumption, cost per kilowatt hour, fault tracking and duration, maintenance, (etc.) the systems have been classified. It has been a successful experiment in many areas and isolated islands and we mention them: a home experiment in Manitoba, Canada, as well as in A rural island community in Iceland in 2004 has proven successful in terms of cost and environmental protection to reduce gases emission capacity from diesel generators.) [25] The leaching volume is divided according to the required loading capacity as shown in Table (1).

Table I- 1 Classification of multi-source systems by power range. [6]

Multi-source system power[kW]	Application
Low: <5	Autonomous systems: telecommunication stations,water pumping, other isolated application
Average: 10-250	Isolated micro networks: supplying an isolated village,rural areas, etc.
Large:> 500	Large isolated networks (e.g. island networks)

Large installations of isolated multi-source sites are categorized according to the degree of renewable energy availability determined by the percentage of energy generated from renewable energy

I.4 Presentation of the system and the basic elements (PV/W/D)

Hybrid energy systems rely mainly on traditional energy sources (diesel) and renewable energy (solar, hydro, tidal, wind, geothermal, etc.) consisting of a diesel generator, wind farm, photovoltaic field and storage system Transformers, loads, and supervision system for conventional hybrid systems contain Two buses: DC bus for sources, DC loads and batteries and AC bus for AC generators) as shown in Figure (1)

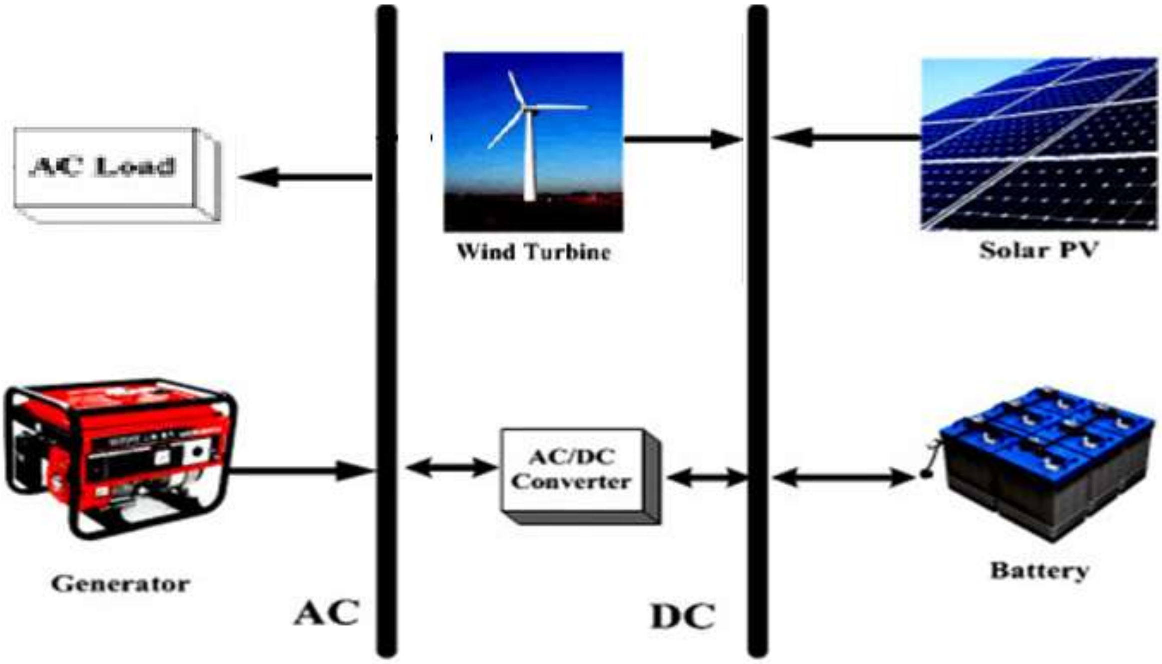


Figure I- 1 Scheme of a solar PV, wind and diesel hybrid system.[7]

I.5.The history of photovoltaic

The first photovoltaic cells were produced in the late 1950s, and were used to provide electrical power for satellites. In the 1970s, the manufacturing and performance of photovoltaic modules lowered costs and opened up a number of opportunities to power many applications, such as battery charging for navigation aids, telecommunications, and many other low-energy needs. In the 1980s, it became a power source for electronic devices, including calculators, watches, radios, and many other applications. After the energy crises of the 1970s, great efforts began in the development of photovoltaic power systems for residential, commercial, and utility-related applications. In the same period, the uses of photovoltaic systems to operate rural health clinics, cooling, water pumping and telecommunications increased significantly and became a large part of the global market for photovoltaic products. Today, industry production of PV modules is growing at a rate of approximately 25 percent annually. and major programs in the United States, Japan, and Europe are accelerating the implementation of PV systems on buildings and interconnection with utility grids. see [8],

I.5.1 Photovoltaic installation

Electricity Photovoltaic power generation through the conversion of solar energy to radiant direct current electric current using the effect of photovoltaic conductors . Photovoltaic power generation uses solar panels comprising a number of cells containing a conductive material. (When the light is reflected on the solar cells, it generates electrical energy) [9]. When the light stops, the electricity stops, there is no energy stored inside the cell, the momentary converter, which cannot supply energy electrically if the energy is received in the form of radiation...

The photovoltaic system consists of

- Photovoltaic Module
- regulator
- Inverter.

I.5.2 Crystalline Silicon Photovoltaic cells

Silicon cells are manufactured in two layers the first is made of silicon doped with phosphorous that has an electron on the outside orbital. , the extra electron is transferred to crystal lattice; Because these negatively charged electrons are Freedom of movement, so this material is known as n-type silicon. P-type silicon gets its positively charged particles Small amounts of boron, which contains An electron from silicon in its outer shell. Over there there are not enough electrons to form all the covalent bonds , so the electrons move around to try to fill this deficiency, which is called perforation. The holes act as if they are free, positively charged particles. at type p and n The materials are put together, forming a pn junction like It is shown in Figure (2). Electrons and holes attract each other, Assembly by interface, leave type p and n- Write the areas with negative and positive charges, thus Create the required electric field. When the light is on crystalline silicon, the electrons It is released to the crystal lattice. But not all photons – like They are called light energy packets - they are created according to equality. See [10].

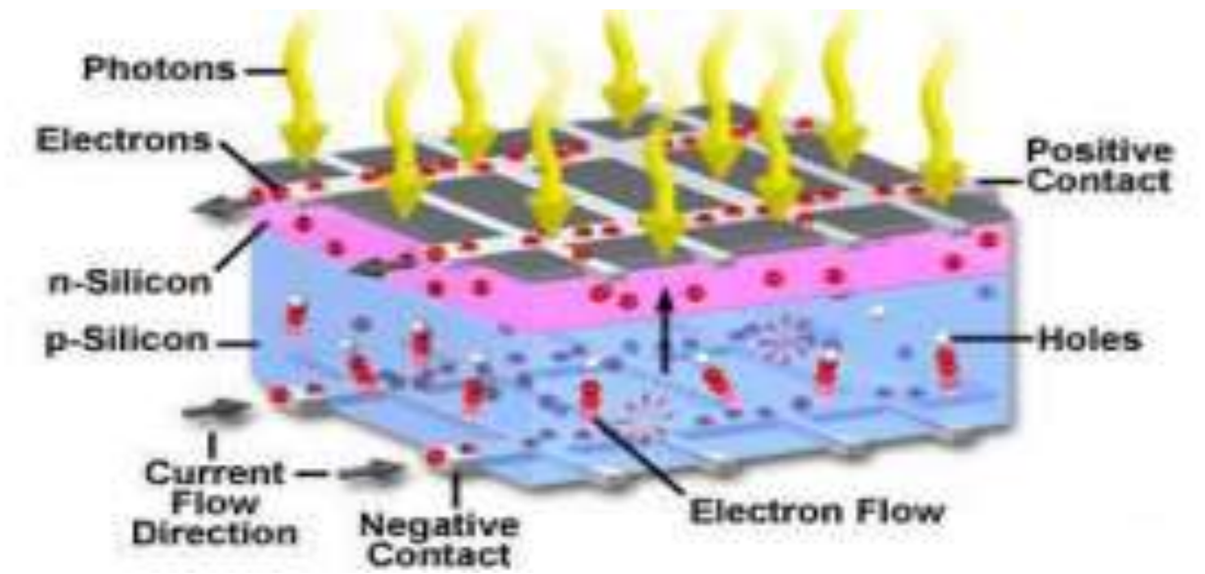


Figure I- 2The photovoltaic effect in a solar cell [14]

There are three types of solar panels available widely for use in PV systems[11], each type of panels has advantages and disadvantages. The main differences between these types of panels are their cost and efficiency, which is the most widely used in the relatively high world of production

Figure I- 3types of solar panels

- *Monocrystalline:* panels have the highest efficiency to date and perform better than other types of panels in low light conditions. It has the highest initial cost; however, saving energy over time may make the cost worthwhile.
- *Polycrystalline silicon* solar panels have a blue color that is less efficient than monocrystalline solar panels and less efficient at operating temperature due to the larger temperature coefficient than monocrystalline solar panels. Due to the lower power conversion efficiency, more panels are required to generate the specific power.
- *Thin-film solar panels* are less efficient than monocrystalline solar panels; Polycrystalline and has a shorter life. And lower cost due to simple manufacturing methods compared to crystalline solar panels. Thin-film solar panels can also be made flexible, more brittle and will crack if they are bent: see [11].

I.5.3 photovoltaic system model

The model was developed using the basic circuit equations of Photovoltaic solar cells and the effects of solar energy irradiation and temperature changes. And the photovoltaic cell Represented by a current source connected in parallel with A diode, because it generates current when it is lit and It works as a diode when it is not. Equivalent Circuit Model Also includes a shunt and a series internal resistance that can be Represented by the resistors Rs and Rsh, the .figure (4) [13]

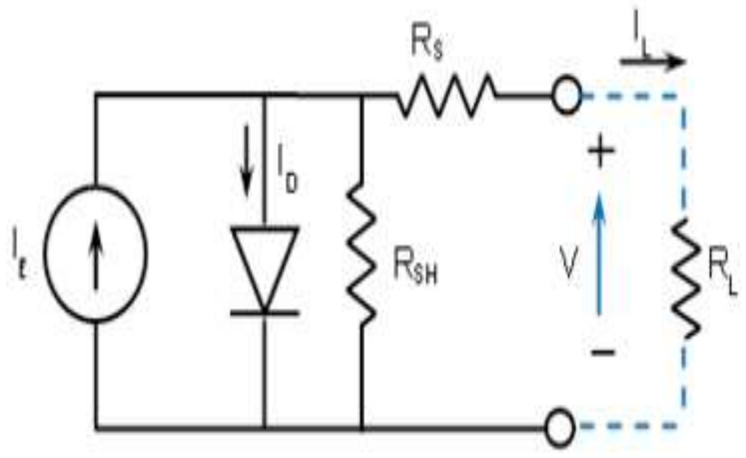


Figure I- 4The equivalent PV cell circuit model

Physical structure such as solar cell structure A The diode in which the p–n junction is exposed and when exposed to sunlight. Semiconductor theory is captured in the following (Equations) [14]:

$$\mathbf{I} = \mathbf{I}_{\mathrm{ph,cell}} - \mathbf{I}_{\mathrm{D}} \tag{1}$$

$$I_D = I_{o,\,cell} * \exp\left[\left(\frac{qV}{AkT_c}\right) - 1\right] \tag{2}$$

I: Cell output current, A

$I_{ph,cell}$: , is the photocurrent produced by the incident light and a function of the radiation level and

the crossover temperature, A

$\mathbf{I}_D$: The diode current modeled

$I_{o,\,cell}$: leakage current, A

q : Electron charge (1.602 × 10-19 C).

K : Boltzmann constant (1.38 x 10 -23 J/o k)

V : Cell output voltage,

V : Cell operating temperature, o k A : The diode ideality factor

Equation (1, 2) can be adjusted to extract the current voltage The characteristics of the photovoltaic cell used in solar energy Panel increments some parameters as follows in the equations:

$$\mathbf{I} = \mathbf{I}_{ph} - \mathbf{I}_o * \exp\left[\left(\frac{(\mathbf{V}+\mathbf{IR}_s)}{\mathbf{AV}_t}\right) - \mathbf{1}\right] - \left[\frac{\mathbf{V}+\mathbf{IR}_s}{\mathbf{R}_{sh}}\right] \tag{3}$$

$$\mathbf{V}_t = \frac{\mathbf{N}_S\mathbf{KT}_C}{\mathbf{q}} \tag{4}$$

Where:

I: Photocurrent, The photovoltaic current, A

$\mathbf{I_{ph}}$: Reverse saturation current, A

$\mathbf{R_s}$: Series resistance of the cell, Ω

$\mathbf{R_{sh}}$: Shunt resistance of the cell, Ω

$\mathbf{V_t}$: Thermal voltage, V

$\mathbf{N_s}$: Number of series cells

During operation, the efficiency of the solar cells is reduced by dissipating energy via the internal resistance. This parasitic resistance can be modeled as parallel shunt resistance (RSH) and series resistance (RS). For an ideal cell, RSH would be infinite and would not provide an alternate path for current flow, while RS would be zero, resulting in no voltage drop and power loss before the load. Decreasing RSH and increasing Rs will reduce fill factor (FF) and PMAX : see[12]

I.5.4 Performance evaluation

To maximize energy point tracking, MPPT is explained by studying an example of a monocrystalline solar cell produced by Q-CELLS. Simulations performed using cell parameters .Obtained from the datasheet 12 Figure (6.5) depicts the I-V characteristic and power versus voltage curve of a solar cell. Indicates that solar PV can only give maximum power at one point . Aim to extract the maximum power from the cell, the operating voltage or current should be identical to the maximum power point (MPP), i.e. Vm and Im, respectively, under a Due to the temperature and insulation [13]

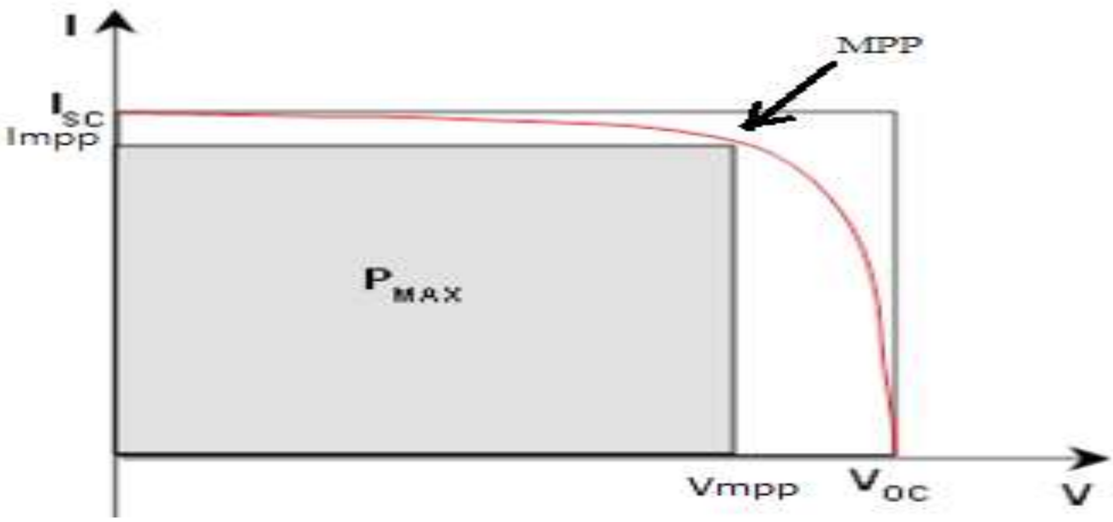


Figure I- 5characteristics of different levels of insolation [12]

The characteristics of solar cells are greatly affected

- insolation,
- Temperature
- Partial shading requirement

The effects of these environmental factors are explained as follows.

1) **The effect of insolation on solar photovoltaic energy**

Changes in characteristics and for a difference in insulation in the short circuit Figure (6) the electrical current (Isc) of the solar cell is the function of insolation and decreases proportionally [13]

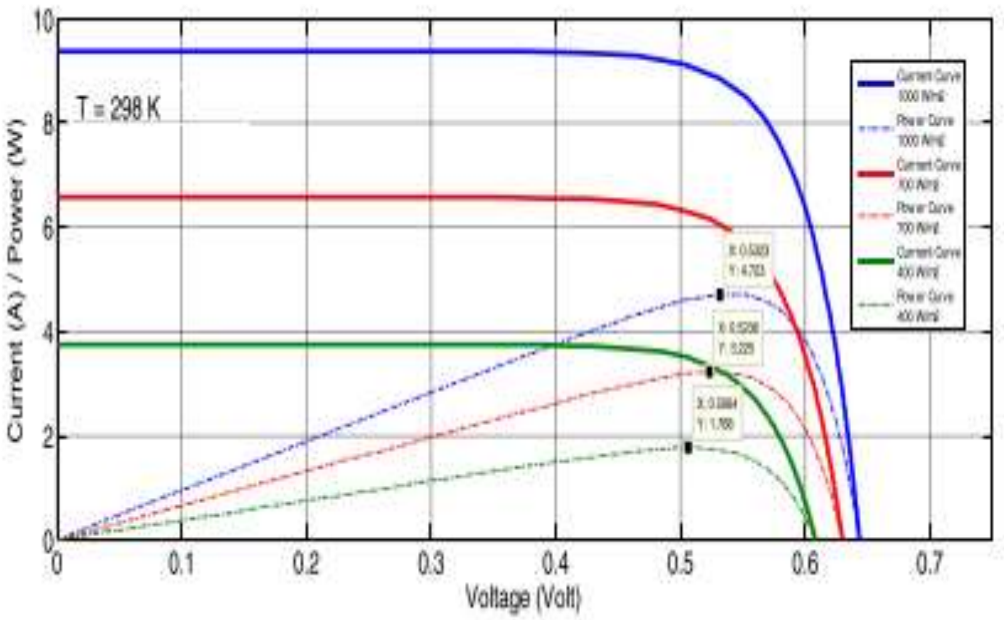


Figure I- 6Solar I-Vand P-V characteristic with different insolation

2) **The effect of temperature on solar photovoltaic**

A second factor that shows a very important influence is temperature on property Solar cells. With the increase of the latter, the open circuit voltage increases proportionally and the short circuit current decreases logarithmically. Figure (7) reflects this characteristic of solar cells.

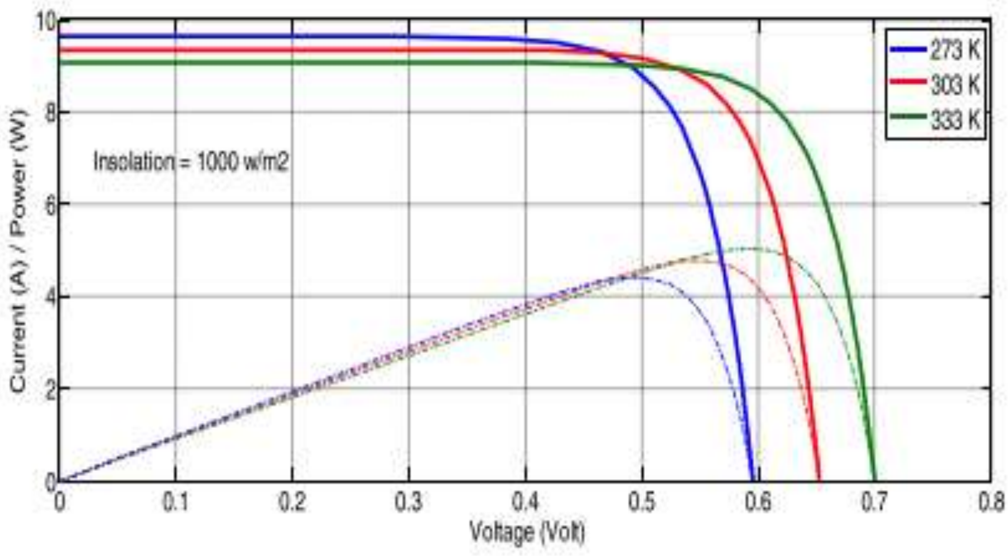


Figure I- 7 Solar cell characteristic with different working temperatures

3) **The effect of shading on solar photovoltaic**

In contrast to temperature and insolation, partial shading also shows a significant effect on cell property. With terminal voltage V1 and V2, total power P, and total voltage V. In partial shading condition, the power coming out of the matrix is less due to shade (500 W/m2) .cell stream It controls the current of the other panel as they are connected in series. In bypass diode Mitte- gation strategy, each solar PV is connected with the bypass diode as shown in Figure (8)

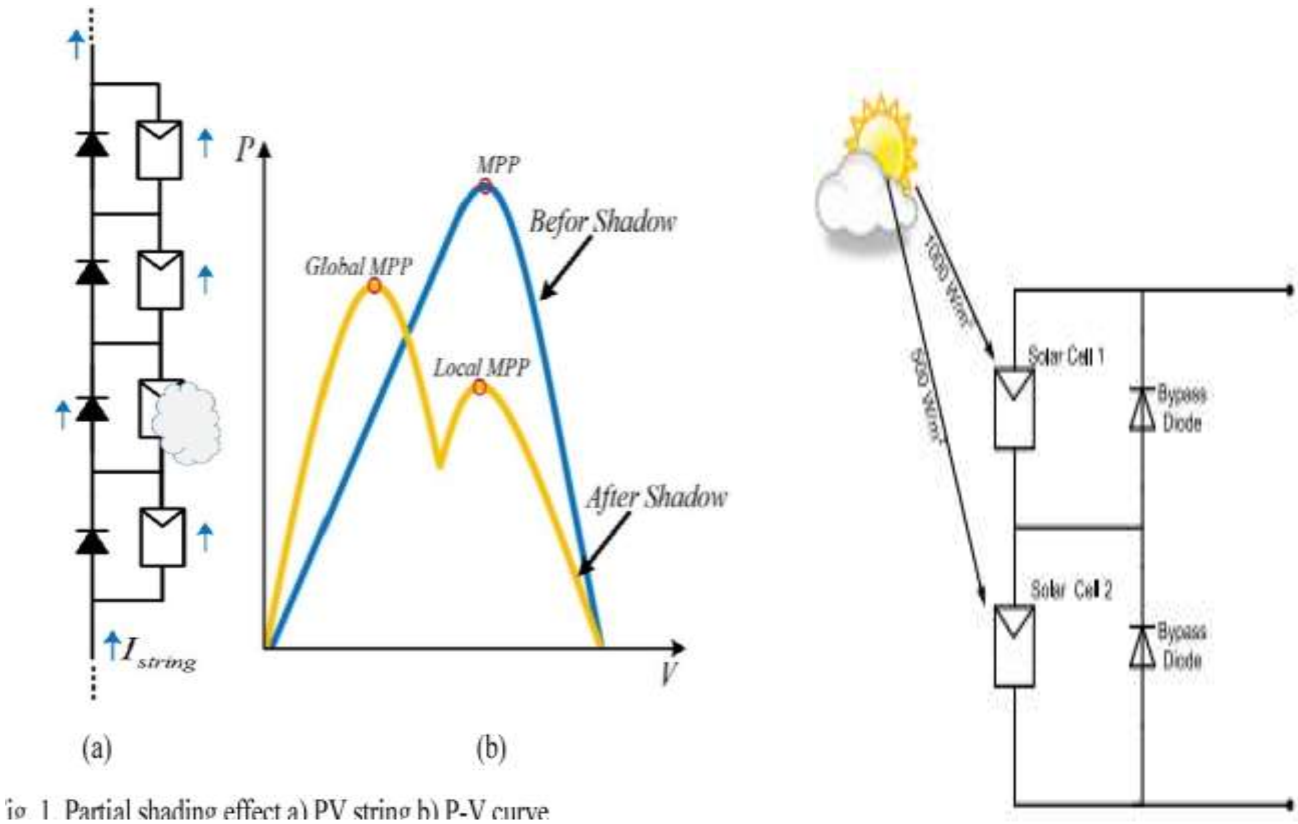


Figure I- 8 Operation of Solar PV under partial shading condition

4) **MPPT operating principle**

After knowing the influence of environmental factors such as insolation and temperature as wel And shading on the characteristic of solar cells, the operation strategy of MPPT . is explained To track maximum power with change in insolation Figure (9). The solar cell gives a characteristic of three different insolation of linear impedance Load type, resulting in different maximum power points which are A0 , B0 and C0 .Since the load is linear, the operating points and terminal voltages corresponding to The cell is A, B, and C. The energy provided by the solar cell With respect to points A, B and C is less than the available energy. The power point tracking maximum operating strategy invokes the concept of file retention Terminal voltage corresponding to the maximum power point, see [13]

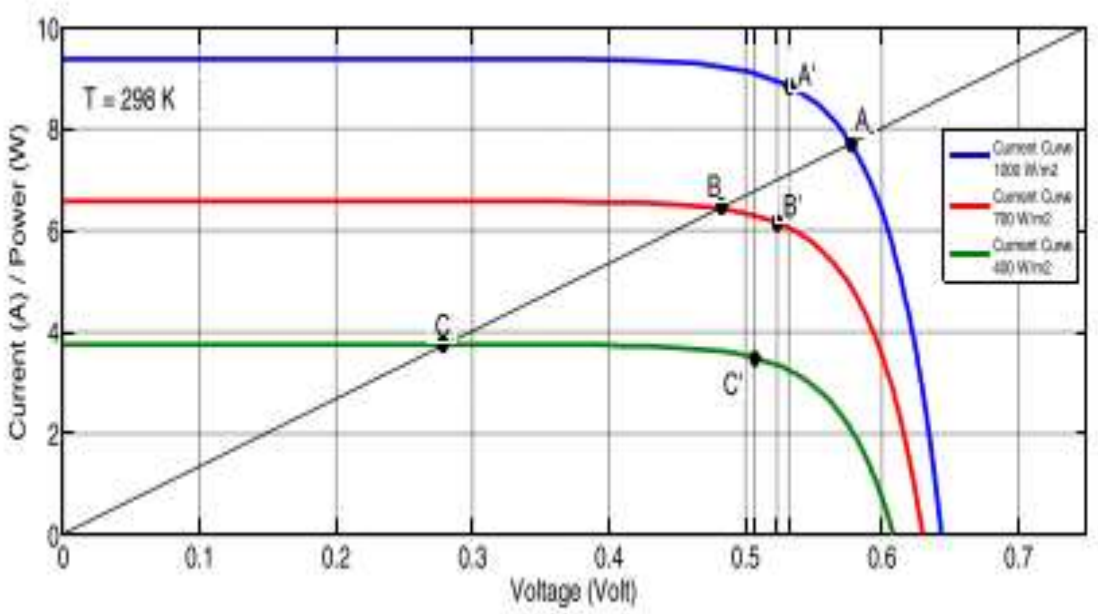


Figure I- 9 Maximum power point for different insolatio

I.5.5 Solar Array Model

Solar photovoltaic panels consist of individual cells connected together that are multiple solar panels electrically conductive together to form a much larger PV installation (PV system) called an array, the higher the total surface area of the array, the more solar electricity it will produce. The PV system uses an array as the main source To generate electrical power supply. The amount of solar energy produced by a single photovoltaic panel is insufficient for general use. Most manufacturers produce standard PV panels with an output voltage of 12V or 24V. By connecting several PV panels in series (for higher voltage requirements) and in parallel (for higher current requirements), the PV array will produce the required power output …[15].

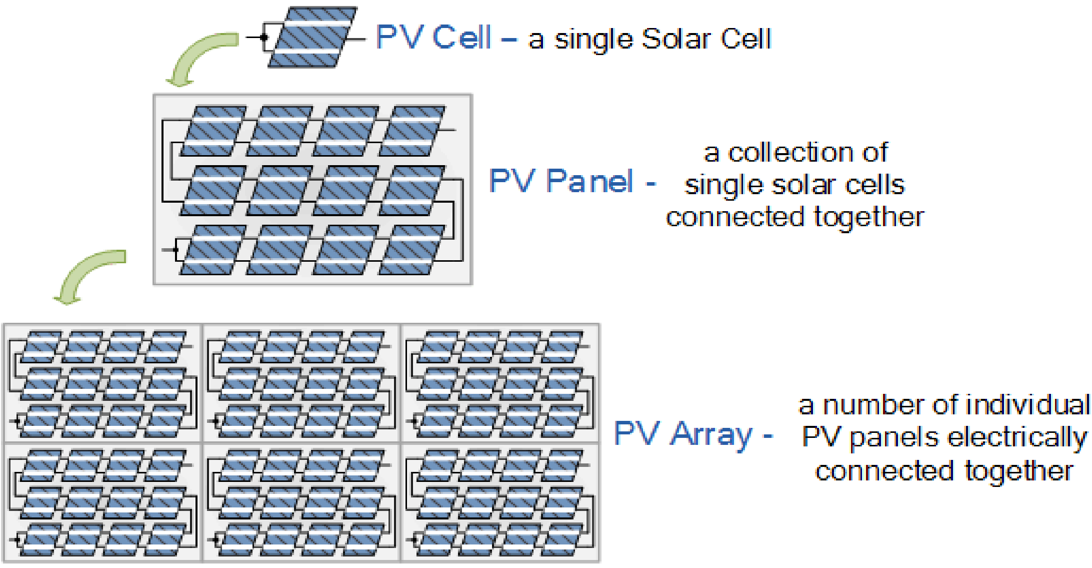


Figure I- 10 Photovoltaic array modules

The total unit voltage increases, when the cells Connected in series as shown in Figure (11) (Vout = V1 + V2 + V3 +…).

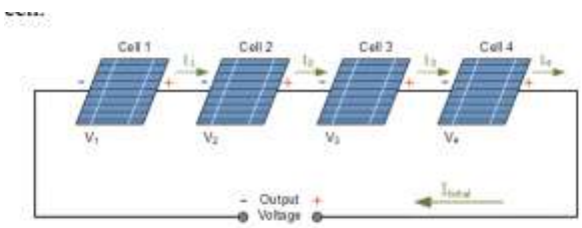


Figure I- 11 Connecting PV cells in series

The current of photovoltaic cells increases when the cells connected in parallel, as shown in Figure (12) The current generated by the module (Iout = I1 + I2 + I3 + ...)…..[14]

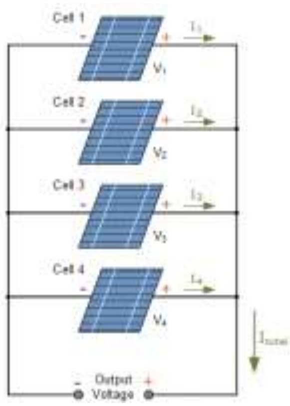


Figure I- 12 Connecting PV cells in parallel

I.6 Power and electrical control topology

I.6 .1 Converter control

The Converter is used to charge storage batteries and convert direct current to DC, and consists mainly of PV arrays, batteries, loads, and various types of power conversion devices, among which PV arrays and batteries are connected to the Boost and DC-DC bus [16], respectively, and the loads have a resistive load and a load constant power. For the two loads, one is a direct parallel connection to the DC bus, and the other is connected to the DC bus and performs an AC/DC conversion, in hybrid systems, it is also used to charge batteries from an AC source. The converter has two modes; Back and Post. , which is equivalent to a static power load with a buck converter. Because the DC micro-grid PV can operate in the on-grid and off-grid working mode, this paper mainly takes the stabilization of the DC PV network vector voltage at off-grid functions. These devices are relatively simple, not expensive, efficient and basic in the system.

I.6.2 Inverter control

The inverter converts the DC current into AC currents and the active and reactive powers are controlled separately with the help of the voltage controlled PWM inverter. The inverter operates separately from the electrical distribution network and requires batteries. Which provides a constant voltage source at the DC input of the inverter? Active power control by shift angle between MG and inverter voltage using a (PI controller the reactive power can be controlled using pointer modulation, it is kept at 1 permanently because there is no need for additional voltage regulation,) [17] MG voltage is kept constant only with DG. There are types of inverter

- Square Wave Transformers
- Modified since wave inverter
- Since the inverter wave (sine wave)

The type of inverter used depends on the load it will serve. The designer must choose the transformer according to the type of load and power requirements

I.6.3 MPPT control

Further control the PV group to extract maximum benefit. Possible to power over MPPT . In this work, Mini P & O MPPT the instrument is selected to select the PV current reference according to MPP which depends mainly on solar radiation see …[17]

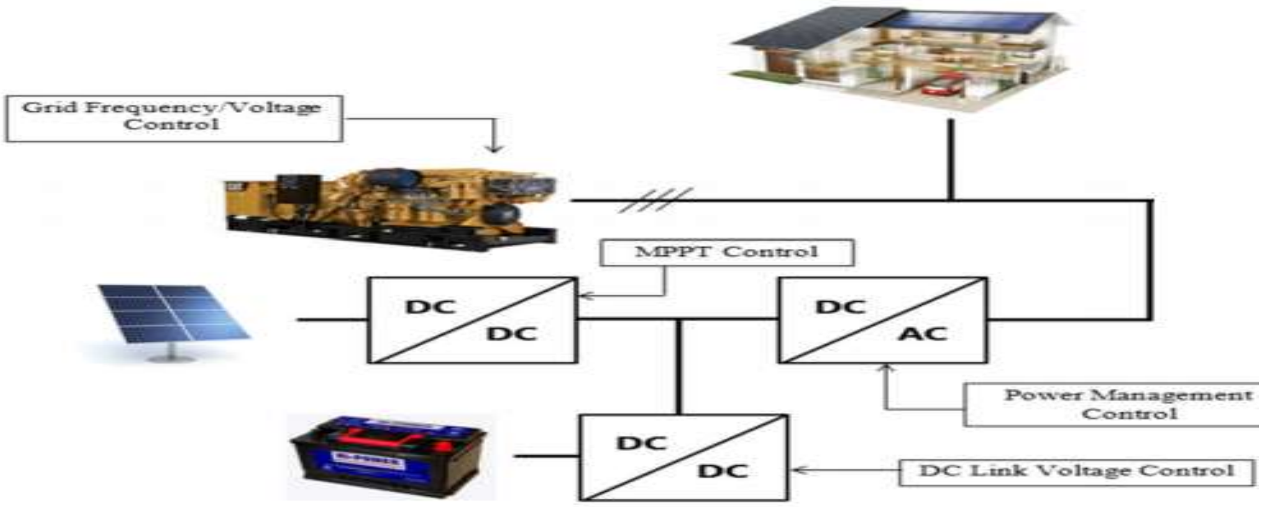


Figure I- 13 Configuration of the PV-W-D system with AC / DC mix bus [17]

I.7. History of wind turbines

Wind energy has been used to drive boats along the Nile since 5000 BC and simple water pumps and (wind-powered windmills have been used By the eleventh century, new ways of using wind energy had spread all over the world. And widespread to Europe) .The Dutch developed large wind pumps to drain the lakes and swamps in the delta of the Rhine. Eventually, immigrants from Europe took wind energy technology to the Western Hemisphere. (The number of wind pumps and wind turbines declined with the expansion of rural electrification programs in the 1930) s. Small wind turbines are becoming more and more popular again, especially for supplying electricity in remote and rural areas…. [18].

I.7.1 installation wind power

Wind turbines are a system that converts the kinetic energy of the wind into energy mechanical Figur

(14), it is used to produce this conversion it takes place in two stages:

a) At the level of the turbine (rotor) extracts the kinetic energy of the wind And to convert it into mechanical energy using profiles Aerodynamics. The airflow creates a thrust around the profile that drives the rotor he pull constitutes a parasitic force.

b) At the generator level, it receives mechanical energy and converts it into energy electric power and transferred to the electrical network…see [18].

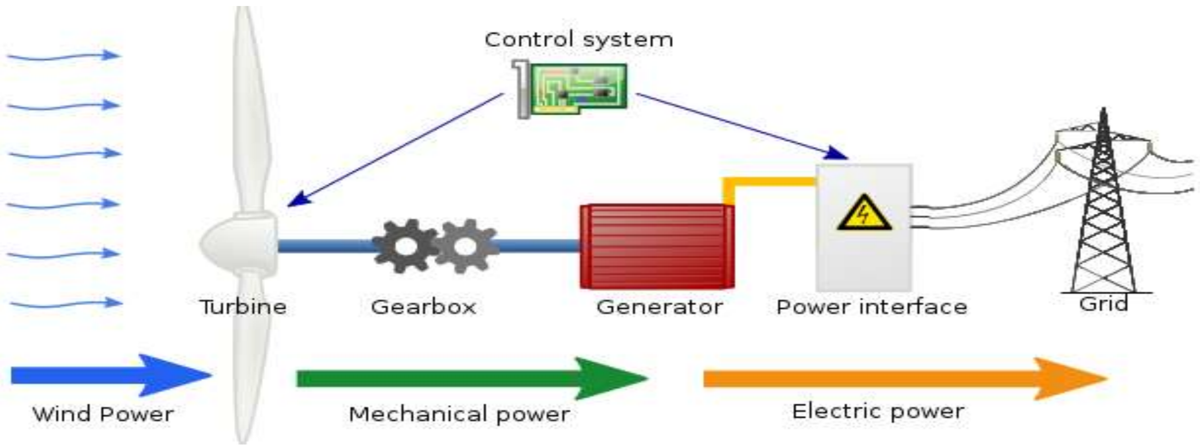


Figure I- 14 Principle of energy conversion of a wind turbine

I.7.2 types of wind turbines

Wind turbines are divided into two main types' *Horizontal axis* wind turbine and (HAWT) *vertical axis* wind turbines (VAWT)

I.7.2.1 Horizontal axis wind turbine (HAWT)

Horizontal axis turbines (15) are (more commonly used than vertical axis turbines because they are less expensive and subject to less mechanical stress) [18].. Consists of several generating feathers the torque of the motor that drives the rotation . Number of blades between 1 and 3, three-blade rotor It is the most widely used because it is a compromise between power factor, cost and Wind sensor rotation speed. Horizontal axis turbines are usually placed against the wind by a mechanism Directional control or natural dynamic equilibrium phenomenon is guaranteed By the rudder in the case of wind turbines. The larger the rotor diameter, the higher the recoverable force

Figure I- 15 Horizontal axis wind turbines (HAWT)

I.7.2.2 vertical axis wind turbines (VAWT)

Vertical axis wind turbines have (existed for centuries and are the first structures used to produce Electric energy. but it is not as common as horizontal structures).[18] The main reason for this is that they do not benefit from Higher wind speeds at higher altitudes above the ground as well as the horizontal axis For turbines this type is based on the fact that the profile is placed in the direction of the air flow Subject to varying directional forces and intensity according to the direction of this profile . Figure (16)

Figure I- 16 Vertical axis wind turbine (VAWT)

I.7.3 The main components of wind turbines

The main components of wind turbines are Figure (17) and shown in the following list:

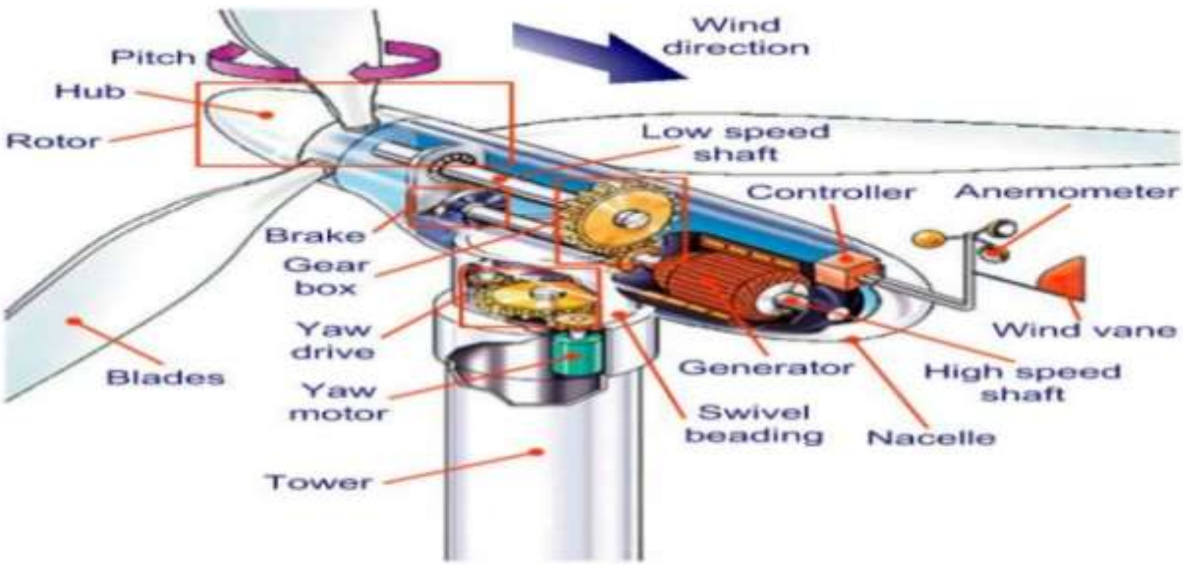


Figure I- 17 Different elements of wind Turbine …[19]

a) ROTOR

b) BLADE Main part which convert free flowing wind energy to useful energy. – Uses Lift & Drag principle as shown in the picture.

c) HUB- In simple designs, the blades are attached directly to the axle. - In other, more complex designs, it is attached to the tilt mechanism, which adjusts its angle of attack according to the wind speed. The axle is fixed to the rotating shaft that drives the generator

d) NACELLE

e) LOW SPEED SHAFT – The shaft from hub to the Gear box – Speed is typically between 40rpm to 400rpm – Generators typically rotate at 1200rpm to 1800rpm.

f) BRAKE

g) The yaw brake - in order to hold the yaw bearing against rotation, it is necessary to use a method of braking. One of the simplest ways to accomplish this task is to apply a small constant torque to the yaw motors. However, this process greatly reduces the reliability of electric yaw motors, so the solution is to use a hydraulic actuated brake.

h) GEAR BOX •Gearbox increases the speed of the shaft. Meets the requirement of the generator.

i) High Speed Shaft - Gearbox is followed by the high speed shaft Connects to generator Braking Mechanism A mechanical drum brake or disk brake is used to stop turbine in emergency situation. This brake is also used to hold the turbine at rest for maintenance

j) Generator - A wind power generator converts wind energy (mechanical energy) into electrical energy. Wind turbines typically generate electricity through asynchronous machines that are connected directly to the power grid. The generator is connected at one end to the wind turbines that provide mechanical power. The generator is connected to the electrical network. The generator needs a cooling system to make sure there is no overheating.

k) Controller - The controller starts the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts down the machine at about 55 miles per hour. - Do not operate turbines at wind speeds greater than 55 miles per hour because they may be damaged by high winds

l) Anemometer- works according to the intensity of wind speed data

m) Yaw System

n) The yaw system of wind turbines is the component responsible for the orientation of the wind turbine rotor towards the wind. It is the means of rotatable connection between nacelle and

o) Tower :Tower the nacelle is mounted on a roller bearing and the azimuth rotation is achieved via a Plurality of powerful electric drives .Yaw system consists of .Yaw bearing .Yaw drives Yaw brake

p) Typically,: 2 types of towers exist Floating towers and. Land-based towers. Floating towers can be seen in offshore wind farms where the towers are float on water. Land based Towers can be seen in the onshore wind farm where the towers are situated on the land.

q) Foundation : Transfers the vertical and horizontal loads to the ground

For HAWTs, make better use of more expensive active ingredients. In the lower level of the tower there will be step-up transformers to connect to the network…. see wibesit [19]

I.7.4 Power and Efficiency

The efficiency of a wind turbine is called the power coefficient, or Cp, and in practice, the power factor is calculated as the ratio of the actual energy extracted. , you can adjust it by controlling the angle of attack, by the wind turbine manufacturer. Note that the (maximum power factor that you can achieve with any turbine is .59%,) [21].or what is known as the (Betz limit). The usable power of the wind can be (calculated using the main equation for the usable power being blade) length and wind speed

$$P_{\text{wind turbine}} = 1/2\rho CpAV3 \quad (5)$$

Where p = density of air (1.2929 kg/m^3) This section explains what affects wind energy and the efficiency of this process. This graph (18) indicates that the wind is present on both sides of the turbine, that proper balance between rotational speed and wind speed is necessary to regulate performance. The balance between rotational velocity and wind velocity, referred to as the terminal velocity ratio, is calculated

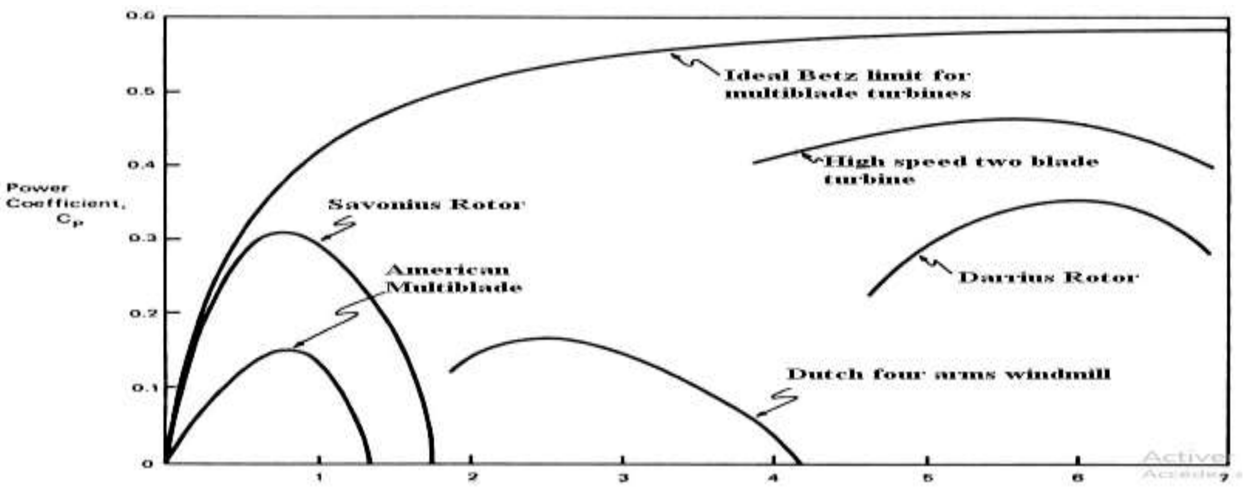


Figure I- 18 power coefficient …[20]

I.7.5The Power Curve

It is important to understand the relationship between power and wind speed to determine what type of control is required. The power curve determines how much power you can extract from the incoming wind. Figure (19) contains the ideal wind power curve.

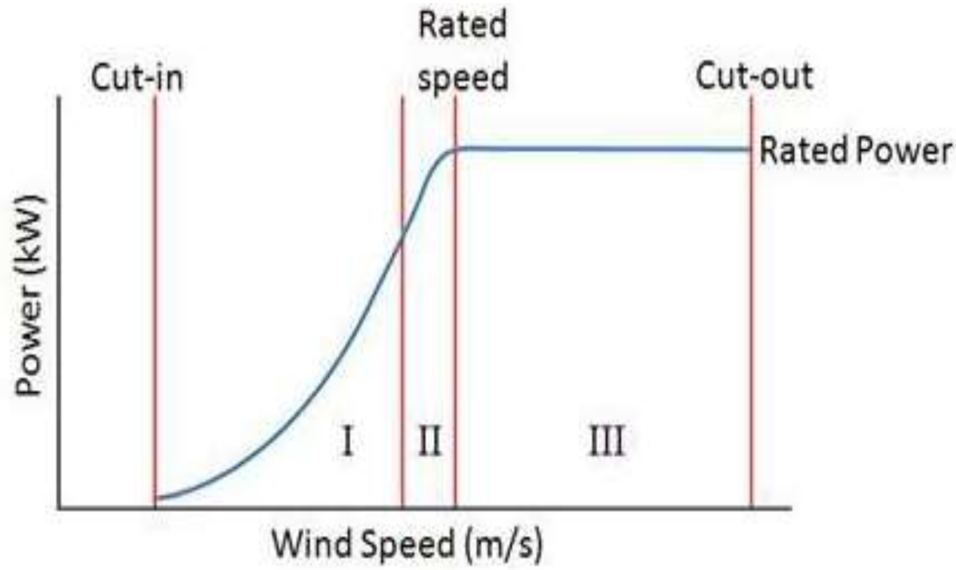


Figure I- 19 ideal wind power curve

The ***cut-in*** and ***cut-out*** speeds are the operating limits of the turbine. This range, ensures that the available power is above the minimum which is a point provided by the manufacturer, to indicate power and cost into account. The estimated wind speed is chosen because speeds above this point are scarce. It is assumed that a turbine design that extracts the bulk of the power above the rated wind speed is not cost-effective. Figure 4 shows the power curve divided into three regions since the first region consists of low wind speeds and is less than the rated power of the turbines; the turbine is operated at the highest efficiency to extract all the energy. That is, the turbine controls with optimization in mind. The third zone consists of high wind speeds and rated turbine power. The turbine is controlled with constraints on generated power in mind when operating in this area. Finally, the second region is a transitional region primarily concerned with keeping torque and noise low.

I.7.6 Control Strategies

Incline speed control strategies use the generator to manage turbine functions across the power curve: fixed-speed *fixed-pitch, fixed-speed variable-pitch, variable-speed fixed-pitch,* and *variable-speed* variable-pitch.. Figure 8 shows the power curves for the various control strategies described below, with the variable speed variable, VS-VP, as the ideal curve.

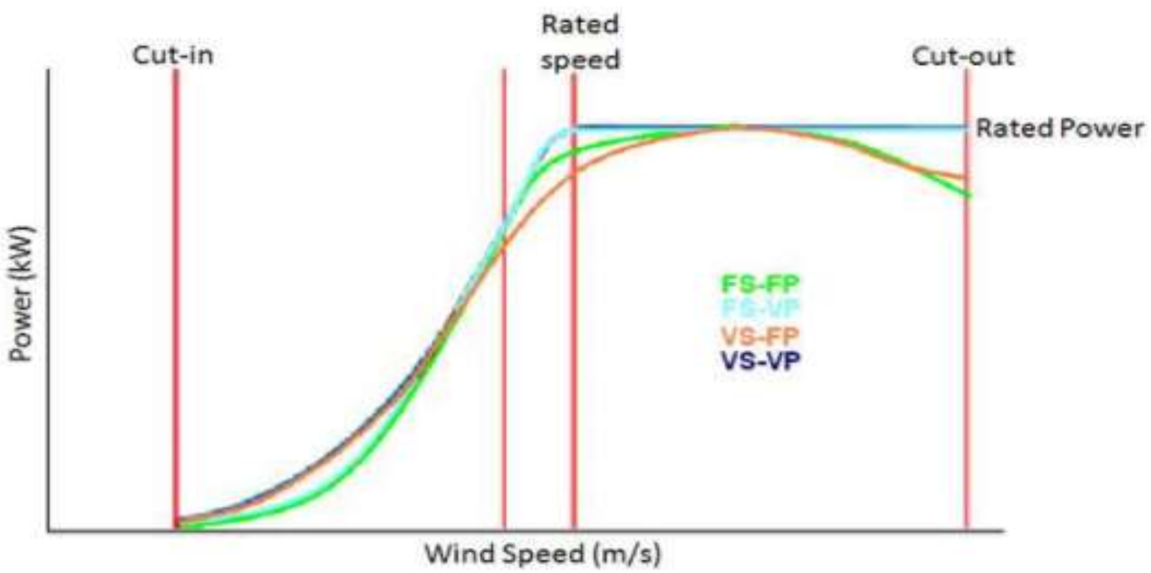


Figure I- 20 Different Control Strategies (Variable-speed variable-pitch, VS-VP, is the ideal curve.

a. **Fixed step with fixed speed (FS-FP)**:

Is associated with the turbine generator directly to the power grid, causing the lock speed of the generator frequency power line and repair speed of rotation Figure (20) shows the power curve to run FS-FP

b. **Fixed-speed variable-pitch (FS-VP)**

Configuration operates at a constant angle of inclination below the rated wind speed and constantly adjusts the angle above the rated wind speed. All feather pitch control methods can be used in this configuration to reduce power. . Figure 8 shows the power curve for FS-VP using feather or stall control.

c. **Variable-speed fixed-pitch (VS-FP)**

The configuration continually adjusts the speed through the power electronics. . Constant distance is highly dependent on blade design to reduce power through negative stall. Figure (20) shows the power curve of the VS-FP. Energy efficiency is maximized at lower wind speeds, and you can only achieve the rated turbine power at one wind speed.

d. Variable-speed variable-pitch (VS-VP)

Configuration is the derivation of VS-FP and FS-VP. When operating at less than the rated wind speed, the variable speed and constant tilt are used to increase power capture and increase power quality. VS-VP is the only control strategy that theoretically achieves the ideal power curve shown in Figure (20).

I.8 Storage system

There are types of batteries (electrochemical batteries) which are devices for storing electrical energy in chemical form. Electrochemical storage is widely used in stationary applications. This technology has an experience of more than fifty years particularly in automotive applications. Its low cost and Excellent recycling rate makes it the main player in storage in electrical systems. It is used in hybrid System to store excess energy for later use and has a great role in providing us with energy stability when it is not a source of energy production, it is among the types that we have see .. [22]

I.8.1Differences and advantages of batteries

- **Lead – Acid**

It is the most safe, reliable and inexpensive type that can be designed to obtain high energy

- **Nickel-Metal Hydride**

It has reasonable energy and specific strength. It is safe and has a longer life cycle than lead acid

- **Nickel- Cadmium**

Its energy is of high quality and good life cycle compared to lead acid

- **Lithium Ion**

It is characterized by high specific energy and specific strength, and good energy efficiency at high temperatures Need improvement in Calendar and life cycle

- **Lithium Polymer**

It is safe, has energy, high quality capacity, good cycle, and life-correction. The cost is high and the specific strength is reasonable compared to others see wibset [22]

I.8.2Key Features of batteries

I. Voltage

It is the electromotive force of the collector, and depends on the load current and the internal resistance of the cell. These factors depend on the kinetics of the electrode and therefore vary with temperature, state of charge, and cell age The battery consists of basic elements with a nominal voltage of 2V (actually between 1:9V and 2:1 volts depending on the load condition) [23].

II. charging

is the minimum voltage required to effectively recharge the compound; it's a Expressed in volts

III. Capacity The theoretical capacity of a battery is the amount of electricity involved in an electrochemical reaction. Q is denoted and given by: ….

$$Q = \frac{nF}{M_r} \tag{6}$$

Where: M_r = Molecular Mass. This gives the capacity in units of Ampere-hours per gram (Ah/g).

In practice, the full capacity of the battery can never be achieved, as there is a significant weight contribution from non-reactive components such as binders, conductive molecules, separators, electrolytes, complexes and current substrates as well as encapsulation. Typical values range from 0.26 Ah/g for Pb to 26.59 Ah/g for H2.

IV. Energy density

The energy density is the energy that can be derived peer unit volume of the weight of the cell.

V. life time

The battery cycle life of a rechargeable battery is defined as the number of charge/recharge cycles a secondary battery (can perform before its capacity drops to 80% of its original capacity). This is usually (between 500 and 1200 cycles). Battery life is the time the battery can be stored inactive before its capacity drops to 80%. The decrease in amplitude with time is caused by the depletion of the active substances through undesirable reactions within …. [23]

I.9 Diesel generator

The main and traditional source of electric power in isolated areas is the diesel generator In our study, diesel generators are the source of energy for DC, but not mainly. It consists of a diesel engine that drives an electric generator. It runs on a range of fuels (gasoline, propane and diesel). The gap of the outage in the current and has the feature of saving energy without the need for batteries

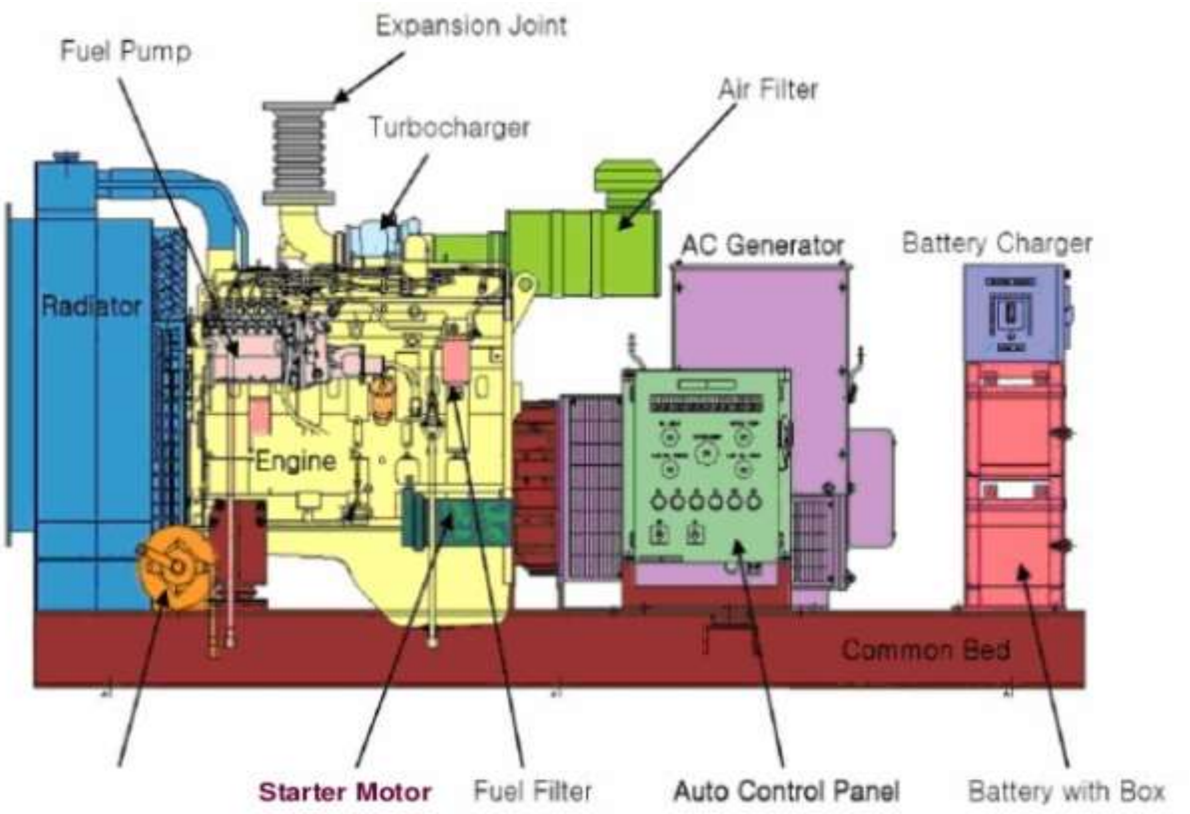


Figure I- 1 Diesel generator configuration[24]

It produces frequency generator voltages by law:

$$\omega_{sync} = \frac{\omega_e}{p} \tag{7}$$

Where $\omega sync$ is the angular velocity (synchronous velocity) of the diesel generator shaft, $\omega e = 2\pi f$

Is the pulse current of the stator of the group synchronous generator,

I.10 Conclusion

In this chapter we have presented a detailed conceptual description to design of a multi-source (PV/W/D) system. In this context we have mentioned all the components and technology of the system. Wind turbines, PV generators, diesel and storage batteries. In addition to common problems and strategies for introducing control and modeling into the hybrid system

note

We must take into account the difference in load and renewable energy resources to ensure the success of the system

Chapter II

Modeling of hybrid system (PV /WIND/ DG) with HOMER® software

II.1 Introduction

The world continues to face challenges in providing reliable and cost-effective services, which is one of the main challenges facing us in this century with the advent of hybrid power systems. The greatest interest has emerged due to the success of these systems in overcoming deficiencies and the intermittent nature of renewable energy. In the production and exploitation of electrical energy, and it has proven its success with distinction in the areas isolated from the main network. We need to trace the work of this system and follow it to a means of controlling and modeling the elements of this system. This is what we will address in our study. We take the BOUR AL AICHA region in the Wilayat of Ouargla , which is an isolated region with a changing energy climate. In terms of solar energy, wind speed and temperature. The optimum size matching design is very important for solar wind generation systems with battery banks. For efficient and economical use of energy resources (wind and solar)

II.2 System modeling

In Chapter 1, we realized the importance of combining the following technologies, namely solar (PV), wind turbines, batteries and a diesel standby generator (DG). In a single integrated hybrid system, the performance of the components of the system is modeled through a deterministic or probabilistic approach through the methodology shown in Fig (1). …

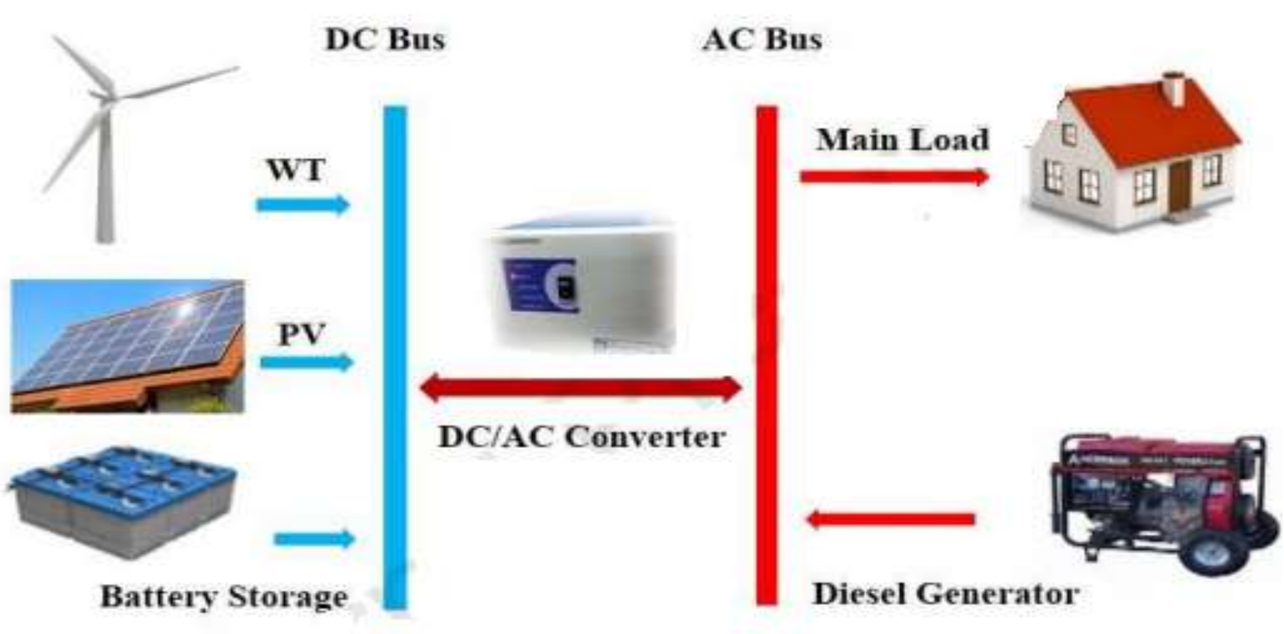


Figure II- 1 Configuration of system hybrid

The contact (AC) for the traditional diesel generator , the village, the grid and the system (PV). The batteries and the wind energy (DC) and the batteries play the role of helping the system on demand to cover the load requirements and when the energy from renewable energy sources is less than the load demand. The load will be provided by diesel generators directly, whether and herein lies the strength and success of the system to ensure stability on demand see [1]:

II.3 Hybrid PV/wind/Diesel System model

II.3.1 PV generator model

In this section the simple PV model used is described. Which can be motivated by the aggregation of power generation from several PV systems that is made in the appended papers? If no losses are assumed, the DC output from a PV array can be modeled [.Gives the hourly output power of the photovoltaic generator with an area of Apv (m2) In the sun Radiation on an inclined plane unit G_t (W/m2), by; equation [1]:

$$P_{pv} = \eta_{pv.} A_{pv} \cdot G_t \tag{1}$$

where: $\eta_{pv.}$ is the efficiency of the PV module under standard test conditions (STC), . The conversion efficiency of the solar cell is affected by the temperature of the cell, which in turn depends on the incident solar radiation and the ambient temperature and is given by equation [3]

$$\eta_{pv} = \eta_r \cdot \eta_{pc} \cdot \left(1 - \beta\left(T_c - T_{cref}\right)\right) \qquad (.2)$$

Where :

η_r ; is the reference unit efficiency, ηpc is the energy conditioning efficiency equal to 1 if a perfect maximum power tracker (MPPT) is used. β is the generator efficiency temperature coefficient, It should be constant and for silicon cells the range is between (0.004-0.006) each (°C), T_{cref} is the reference cell temperature (°C) and Tc is the cell temperature (°C) and can be calculated on As follows [4]:

$$T_c = T_a + \left(\frac{NOCT-20}{800}\right) G_\beta \qquad (.3)$$

NOCT is the normal operating cell temperature (C). Ta , NOCT = 20 C and G_β ,NOCT = 800 W/m2 , for a wind speed of 1 m/s. 4[4]

II.3.2Wind turbine system model

There are a large number of models available for estimating the power of wind turbines, such as the linear model, the Whipple parameter [5] model, and the quadratic model. It is important to choose a model that is very suitable for simulating wind turbine power. In this study, the power output of the wind generator is in the form of a quadratic equation given as follows;

$$P_{wg}(V) = \begin{cases} P_r \frac{V^2 - V_{cin}^2}{V_{mt}^2 - V_{din}^2} & V_{cin} < V < V_{rat} \\ P_r & V_{rat} \leqslant V < V_{cou} \\ 0 & V \leqslant V_{cin} \text{ and } V \geqslant V_{cou} \end{cases} \quad (4)$$

Where;

P_r is the rated power; V_{cin} is the cut-off wind speed; V_{rat} is the rated wind speed and V_{cou} is the maximum Wind speed. In this study, the adjustment of the wind's altitude profile is taken into account using an energy law which is Described (5) as a useful tool for modeling the vertical wind velocity profile. The equation used is given as follows [4];

$$V = V_{ref} \left(\frac{H}{H_{ref}} \right)^{\alpha} \quad (5)$$

Where; V is the wind speed (m/s) measured at the hub height H (m); V_{ref} is the wind speed (m/s) measured at the reference height H_{ref} (m) and a is the wind speed power law coefficient. A typical value of 1/7 for low rough . Well-exposed roofs, elevations, and sites [4] are used in this study

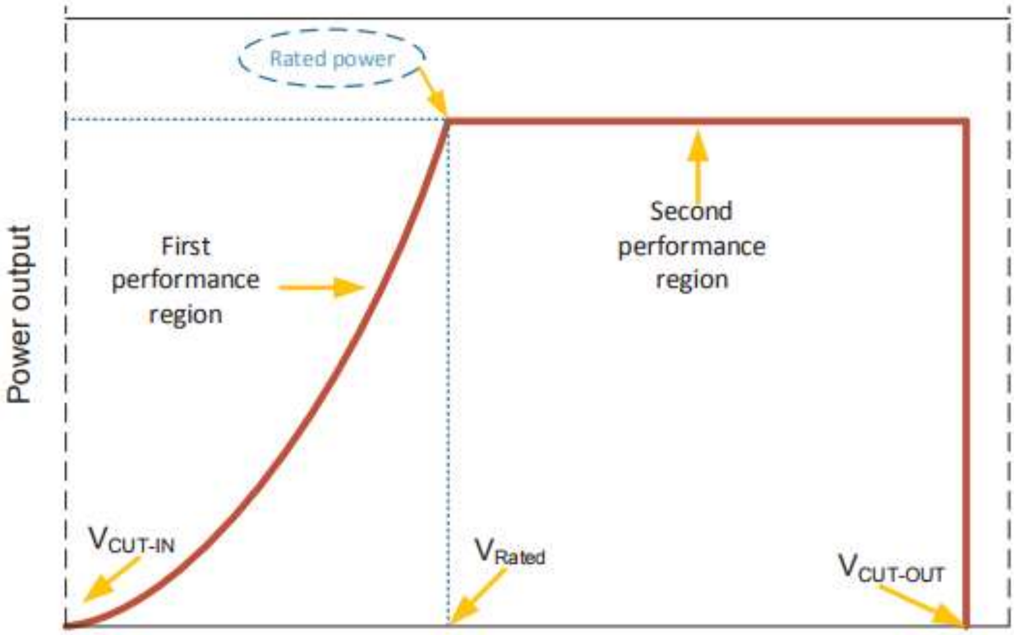


Figure II- 2 typical WT power-wind speed characteristics. [6]

II.3.3 Battery Bank Model

The battery bank is stored to meet the load demand during the period of unavailability and interruption Renewable energy sources, called the days of autonomy. It ranges from 2 to 3 days.Battery efficiency depends on factors such as depth of discharge, energy density and temperature Correction, rated battery capacity and battery life. (The total capacity of the battery bank is determined Which will be used to counter the pregnancy according to the following law) [3]

$$C_B = \frac{E_L \cdot S_D}{V_B (DOD)_{\max} T_{\mathrm{cf}} \cdot \eta_B} \quad (7)$$

Where;

EL is the load in Wh; $E_L \cdot S_D$ is battery autonomy or storage time; V_B is a file Battery bank voltage; $(DOD)_{\max}$ is the maximum depth of discharge of the battery; T_{cf} is a file The temperature Correction factor and η_B is the battery efficiency. The charge status of the battery can be calculated based on the production of photovoltaic energy, wind energy and load energy requirements, Through the following equations:

- ***Battery charging,***

$$\mathrm{SOC}(t) = \mathrm{SOC}(t-1) \times (1-\sigma) + \left(E_{\mathrm{gen}}(t) - E_L(t)/\eta_{\mathrm{inv}}\right) \times \eta_B \quad (8)$$

- ***Battery discharging,***

$$\mathrm{SOC}(t) = \mathrm{SOC}(t-1) \times (1-\sigma) + \left(E_L(t)/\eta_{\mathrm{inv}} - E_{\mathrm{gen}}(t)\right) \quad (9)$$

Where SOC (t) and SOC (t − 1) are the states of charge of battery bank (Wh) at the time (t) and (t – 1) , respectively; σ is hourly self-discharge rate; $E_{\mathrm{gen}}(t)$is the total energy generated from PV array and wind generators after the power loss of the control unit; $E_L(t)$ is the load demand at time (t); η_{inv} and B is the efficiency of the inverter and and charging the battery bank [7], respectively. at any time (t), the charged quantity of the battery bank is subject to the following two restrictions:

$$\mathrm{SOC}_{\min} \leq \mathrm{SOC(t)} \leq \mathrm{SOC}_{\max} \quad (10)$$

The maximum charge quantity of the battery bank $\mathrm{SOC}_{\max}$represents the nominal value CB battery bank capacity, represents the lowest charge amount of the battery bank $\mathrm{SOC}_{\min}$ is determined by the maximum DOD discharge depth: $\mathrm{SOC}_{\min}$ = (1 - DOD) as the corresponding figure(3). According to manufacturers' specifications, Battery life can be extended to the maximum if the mod takes the value 30–50%. In this search, the mod takes a value of 50% see [3].

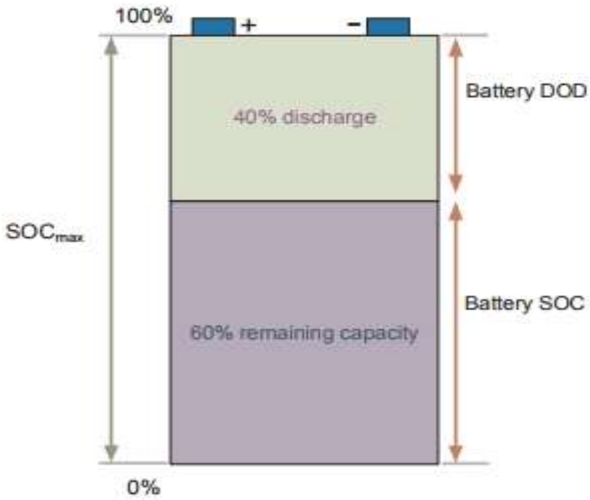


Figure II- 3 A fundamental concept of BT SOC and DOD …[6

II.3.4 Converter

The inverter converts electrical energy from DC to AC; the efficiency of the inverter is determined by the following : equations [8]

$$\eta_{\text{Lnv}} = \frac{P}{P+P_0+KP^2} \tag{11}$$

where: η_{Lnv} is the inverter efficiency And K, Po and P are determined by the following equations : .[6]

$$P = \frac{P_{\text{out}}}{P_n}, \tag{12}$$

$$K = \frac{1}{\eta 100} - P_0 - 1 \tag{13}$$

$$P_o = 1 - 99(1/\eta 10 - 1/m100 - 9)^2 \tag{14}$$

η10 and 100 denote the efficiency of the inverter at 10% and 100% re- pectroscopically.[6]

II.3.5 Diesel Generator Model

DG is the traditional source of energy that is used as a backup power supply in the system Models are made based on fuel consumption and efficiency - expressed using the following formulas. See [9]

$$F_{(t)} = 0.246P_{DG}(t) + 0.08415P_{(r)} \tag{15}$$

Where

, P_{DG},; the generated power (kW), $F_{(t)}$;the fuel consumption (L/hour), $P_{(r)}$;the rated power (kW) of the DG[11]. Its efficiency is calculated by;

$$\eta_{\text{loverall}} = \eta_{\text{brake}}\ \text{thermal}\ \times \eta_{\text{generator}} \qquad (16)$$

Where;

η_{loverall} the overall efficiency,

η_{brake} thermal the brake thermal efficiency of the DG,

$\eta_{\text{generator}}$ The respect- tively.[6]

II.4 Site and data description

Ouargla region is one of the places with the highest rates of solar energy,(where the annual sunshine period reaches 3900 hours. The energy received is 2.65 kilowatt hours / square meter / year in the desert) [10], as shown in the figure (4.) It is characterized by moderate wind speeds that reach in the range of (2 to 6 m/s) as shown in the figure (5). Where we see the availability of a suitable climate for the hybrid system to be exploited in isolated areas

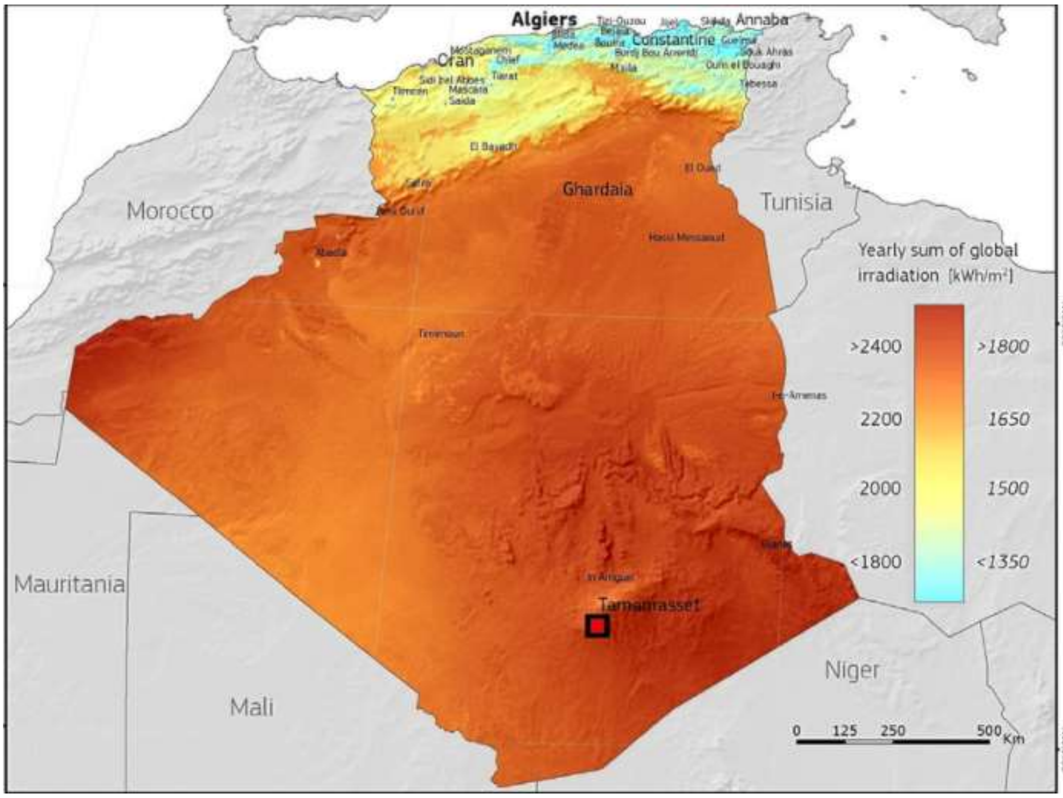


Figure II- 4 Algeria solar radiation Kw/m2/h [11]

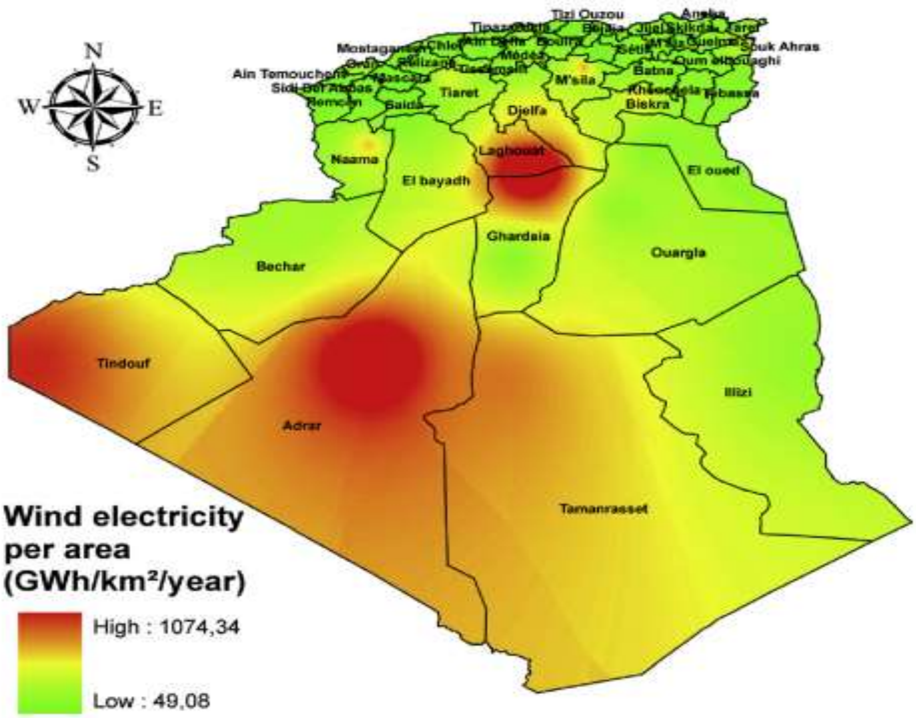


Figure II- 5 Algeria wind energy potential (m/s) …[10]

In our study, we will shed light on an isolated area, which is the oasis of BOUR AL AICHA (Ouargla) as a source of wind and solar energy in (32°1.1' N, 5°19.9'E)

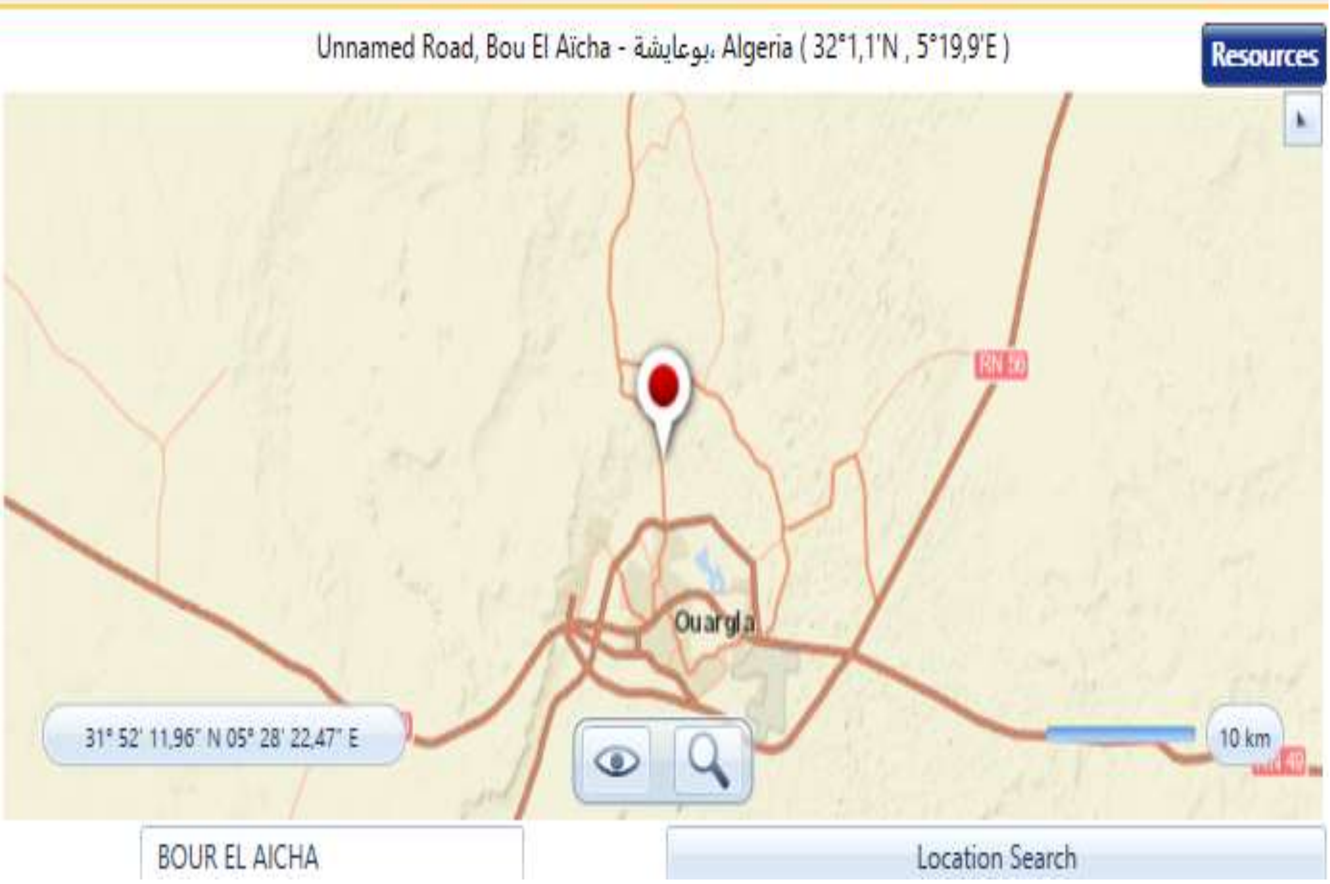


Figure II- 6 Location of Bour El Aisha (Ouargla) by satellite

II.5 Load Profile

Power generation system that has load, characteristics، and efficiency and reliability requirements for power transmission .The load factor of the project is important in the design process. The team is strategically distributed. Figure (7) shows the average daily download rate of the system for 24 hours and consists of: PV / WT / DG and battery storage system in a mixed system. The simulation was studied using real weather data (solar radiation and wind speed) in the BOUR AL AICHA region of ouargla . The house requires electricity to operate many household appliances such as (LCD TV, washing machine, mobile phone charging, etc.) Table 1 shows that the total demand for this house is about 31 000 watt-hours per day.

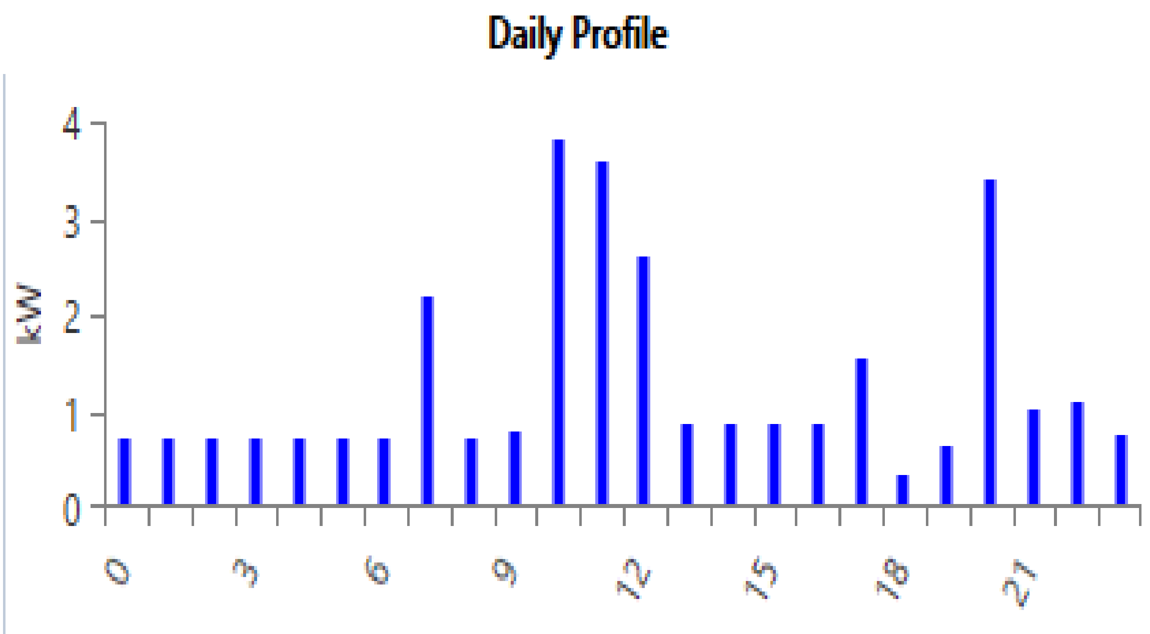


Figure II- 7 Daily load profile of the house

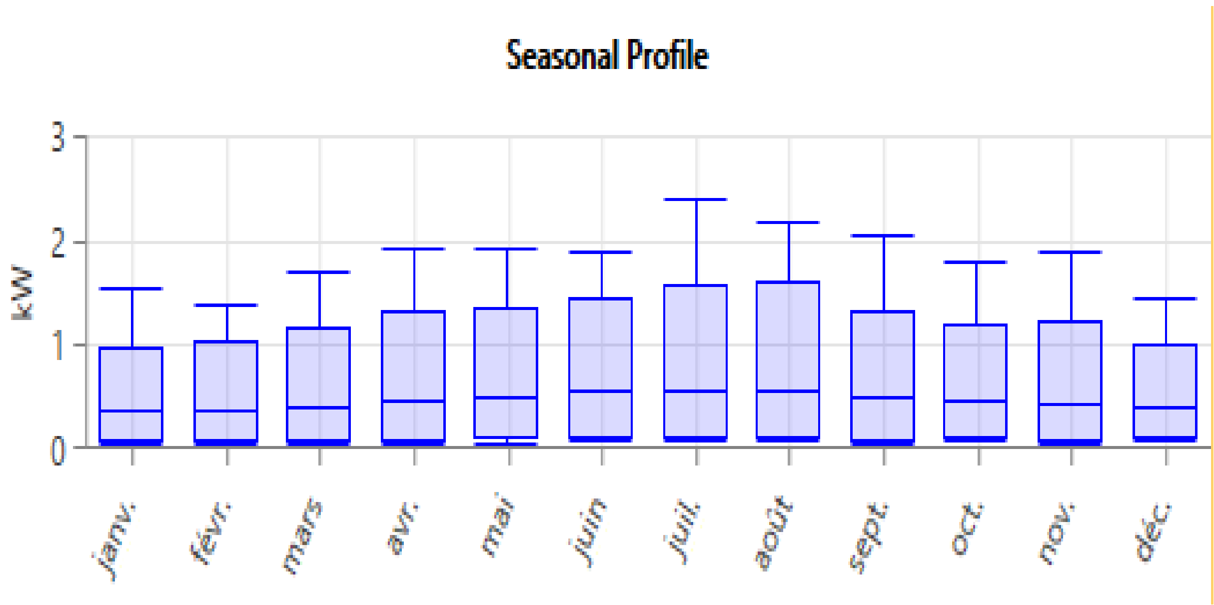


Figure II- 8 Seasonal profile electric load

Table II- 1 Details of consumption daily profile

Time	Refrigeration	Washing machine	Electric Oven	TV LCD	Economic lighting	Mobile phone charger	smoothing iron	Computer	Air conditioner	Water Pomp	(wh/day)
00:00	200				12	5			500		717
01:00	200				12	5			500		717
02:00	200				12	5			500		717
03:00	200				12				500		723
04:00	200				12				500		712
05:00	200				12				500		712
06:00	200								500		700
07:00	200		2000								2200
08:00	350									370	720
09:00	350							80		370	800
10:00	350	3000						80		370	3800
11:00	350	3000		250							3600
12:00	350		2000	250		5					2605
13:00	350					5			500		856
14:00	350								500		856
15:00	350								500		856
16:00	350								500		856
17:00	350						1100	80			1530
18:00	350										350
19:00	350			250	60						660
20:00	200		2000	250	60				500	370	3380
21:00	200			250	60				500		1010
22:00	200			250	60	5		80	500		1095
23:00	200				60	5			500		765
									Total load AC (Wh/day)		**30940.00**

II. 6 Electrical structure of the hybrid system

The components of the hybrid system were selected according to the quality and cost chosen in this study (PV, wind and diesel turbines. Generator with storage batteries), and the system was simulated using the HOMER program. From the load and demand results obtained from one of the Table (1) houses for 24 hours outside the network,

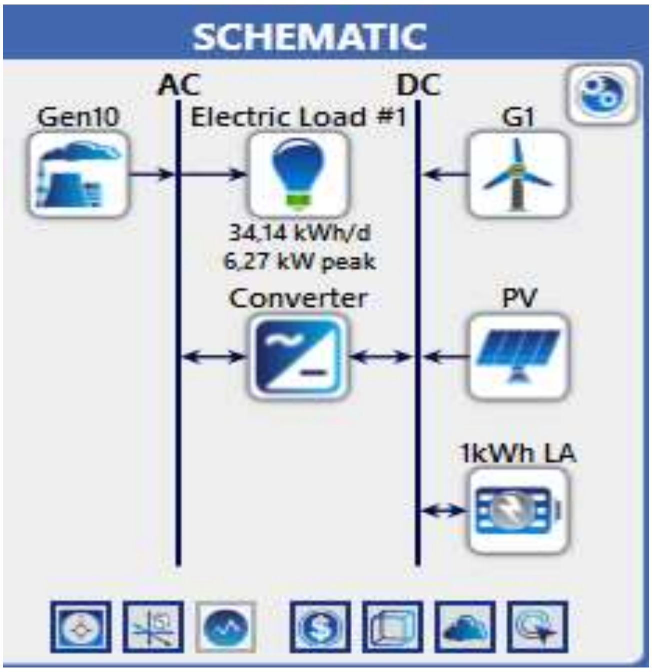


Figure II- 9 Schematic of system hybrid

II.7 Materials and Methods

In this study, selection and sizing / dimensioning of the hybrid power components system was implemented using NREL's HOMER program. HOMER) . is a multi-purpose hybrid system design software that facilitates the design of electric power systems for standalone applications. Input information to be provided to HOMER includes: electrical loads (1 year of load data), regeneration-capable resources (such as 1 year of solar radiation data), details Component technical costs, limitations, controls, type of dispatch strategy, etc. HOMER is a simplified optimization model / code,

Which performs hundreds or thousands of simulations every hour over and over (to ensure the best position- Clear matching of supply and demand) for optimal system design Life cycle uses The cost of arranging these systems. Provides a robust user interface and accurate scaling with Detailed system analysis The software performs automatic sensitivity analyzes showing- Hybrid system design sensitivity to key parameters, such as resource available .City or component costs. Any home needs electricity for lighting, cooling, washing machine and many necessary electrical appliances. The simulations depend on the specific research area and some specific sensitivity .Optimum configuration of the renewable energy system. We have average monthly local data regarding the see . [13].
Taken solar radiation (6 kW/m2/ day) and the wind speed taken from (2.5 m/s to 7 miss). It gives us when entering any component of the system its market price record and power generation statistics. We provide the basic input data for the improvement process. Input parameter for each component selected within the categories: PV, wind turbine, diesel generator, battery, inverter

II.8 Using HOMER to simulate renewable energy sources and sustainable design

A HOMER program that can be used to simulate renewable energy and hybrid energy systems to provide cost-effective solutions for fuel use, strength and environmental requirements, and size and design optimized for specific loads. Students can obtain useful solutions for renewable energy systems and learn about current renewable energy industry practices. The HOMER software package used here can simulate, analyze, and model renewable or hybrid energy systems which can include generation and cogeneration systems for solar/PV, batteries, wind turbines, small turbines, hydropower and fuel cells among other inputs.[15]

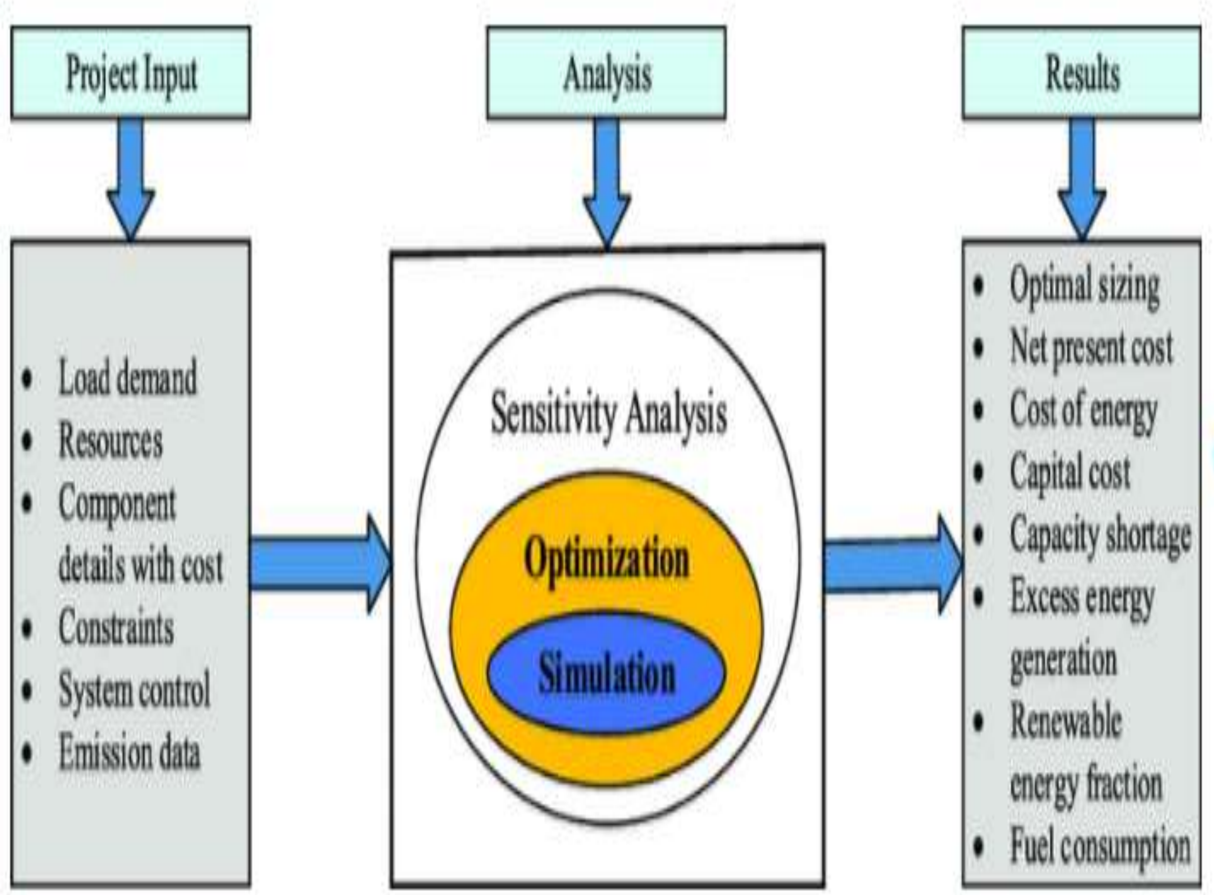


Figure II- 10 HOMER software package architecture.[14]

Simulation software packages are popular tools for improving and evaluating the performance of hybrid energy or renewable energy systems, and HOMER is one of the most used. With these tools, the optimal configuration can be found by comparing the performance and power production cost of different configurations. HOMER was originally (developed at the National Renewable Energy Laboratory (NREL) and upgraded and distributed by HOMER Energy, LCC in the United States and is used by designers as a teaching aid for our renewable energy course) [16] . It can be used to design, analyze and model configurations of small and hybrid power systems with different power sources for economy and expansion to determine the optimal combination of them to meet load demand and user requirements.

Figure. (10) (11) Shows the basic structure of this software package .Shows the result of calculating the number of cases of different renewable energy sources under atmospheric conditions, load requirements, capacity ranges, fuel costs, and carbon emissions constraints to determine the optimal system. (An important role is played by the software package HOMER is involved in the design and analysis) [16] of hybrid power systems for both standalone and on-grid applications. Enter information that is submitted to HOMER and includes: Electrical loads (one year of load data), by performing energy balance calculations for each of the 8760 hours per year. , HOMER compares the hourly electricity demand to the energy the system can supply at that hour, it computes the power flows to and from each component of the system HOMER performs the energy balance, system cost, component technical details, costs, constraints, controls, type of transmission strategy, etc. Designs An ideal power system to serve the desired loads and perform many simulations and ensure the best possible match between supply and demand for optimal system design (NPC) Homer includes many models of power components, and protects m appropriate options. Consider the cost and availability of energy resources. Network connectivity is also in the HOMER design process. It requires preliminary information including energy, economic and technical resources and inputs such as component type, capital, replacement, operating and maintenance costs, efficiency, service life, etc.

II.8.1 Interfaces of HOMER Pro

HOMER is easy to use and contains a menu at the top as well as icons that can be used without going into menus. The HOMER interface contains three important elements as shown in (Fig. II.12), in addition to it contains a map to define the region, define and load resources for the studied region.

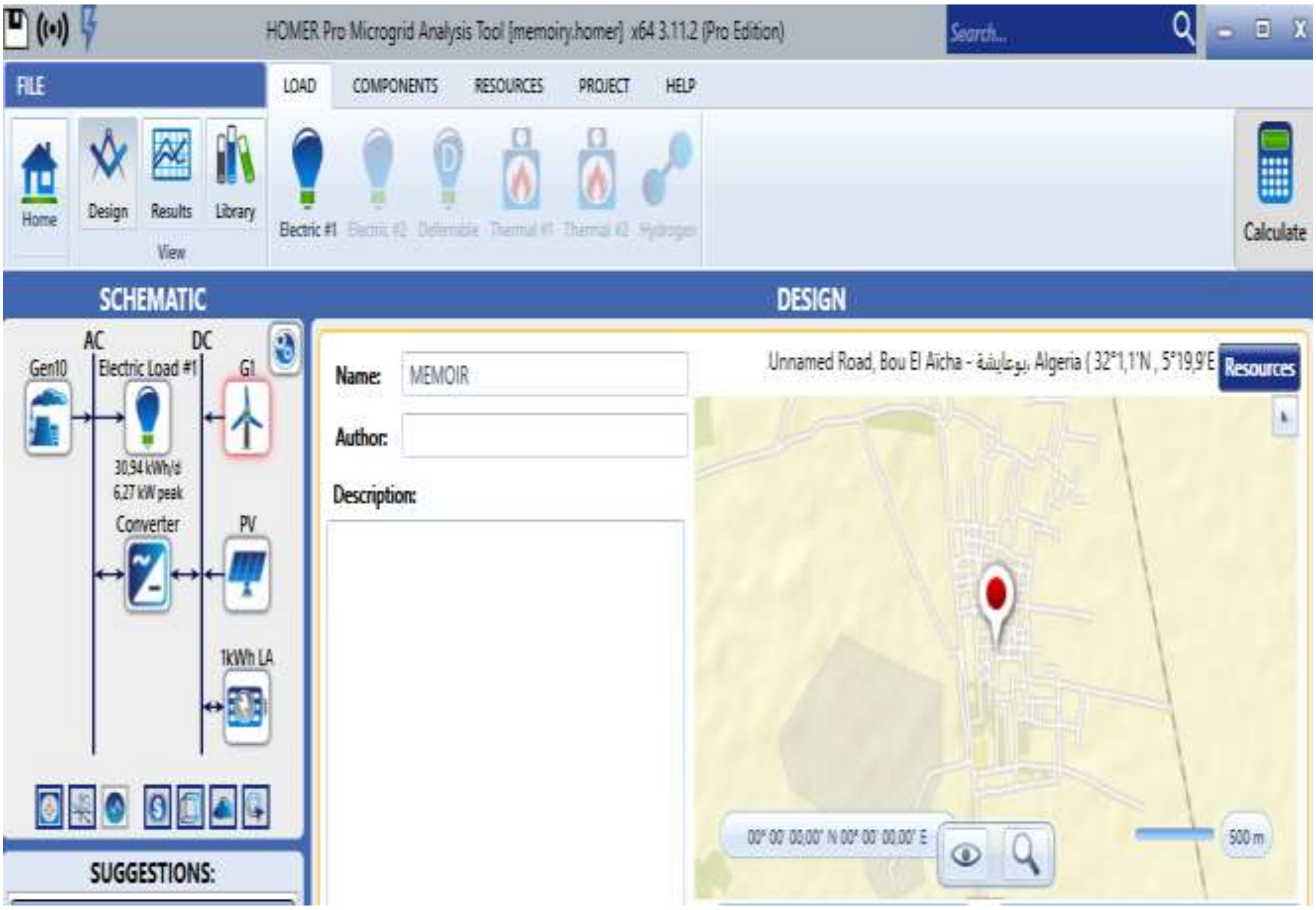


Figure II- 11 Interface Homer Pro

II.8.2 Starting Project Information

In this tape we find a set of tasks, download components, project resources, and instructions.

Figure II- 12 HOMER components

II.9 Data on Solar radiation, wind speed and temperature by Homer® software

HOMER has a special database through which a good estimate of the daily, monthly and annual resources is obtained in the studied sites and in the locations close to those sites.. Wind resources are more complex than solar energy resources due to their inconsistency and diversity. Wind speed and direction data from at least one year of measurements are required in order to obtain a good estimate of wind resources. Figure (14) (15) (16) shows the flow of solar energy, wind resources, temperature and utilization by a hybrid system consisting of wind turbines, photovoltaic panel, storage unit and inverter . .see [15]

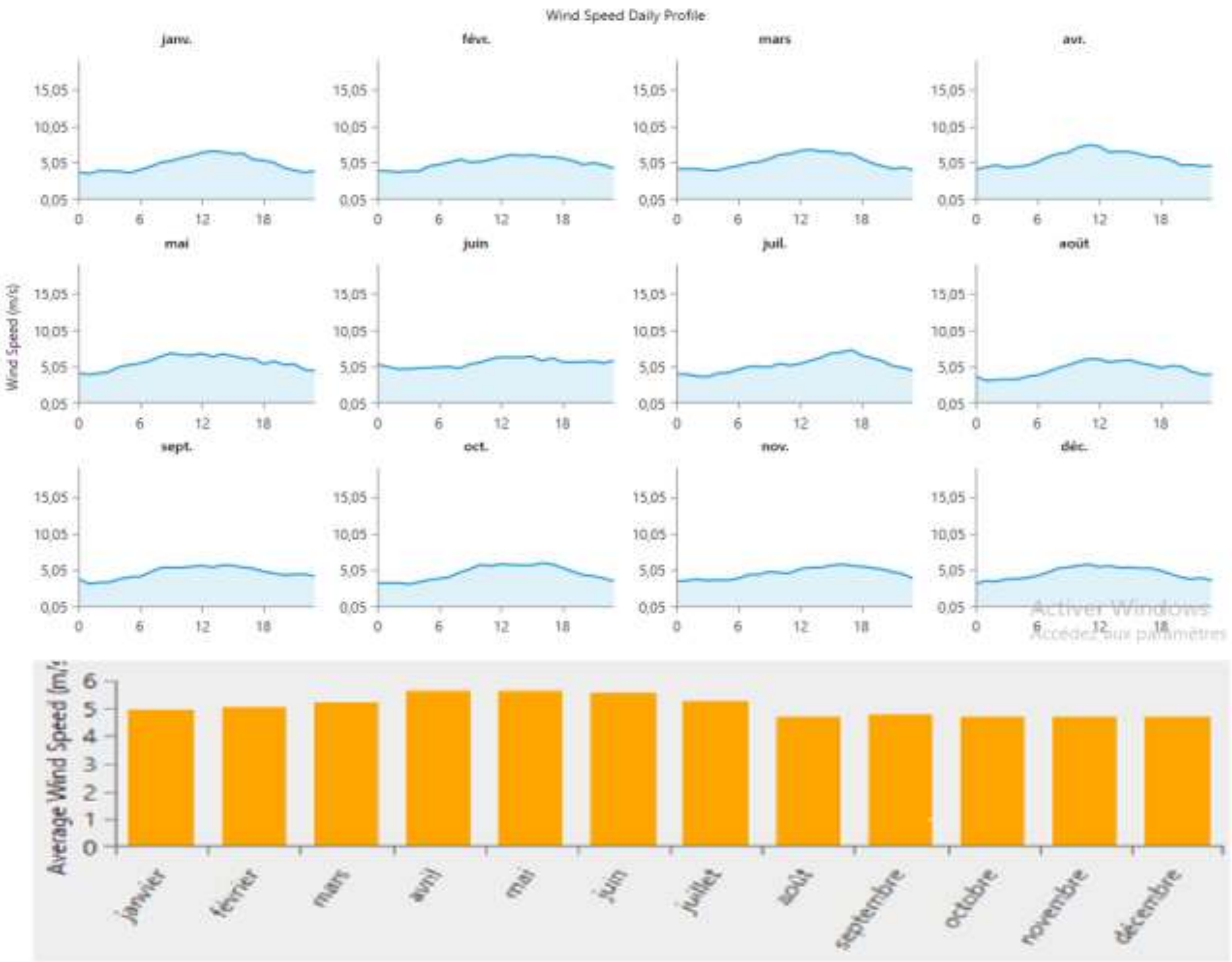


Figure II- 13 Monthly Average Solar radiation

Table II- 2 Monthly Average wind speed DATA

Month	Janvier	Février	Mars	Avril	Mai	Juin	juillet	aout	September	octobre	Novembre	Décembre
Average (m/s)	4,92	5,06	5,23	5,61	5,63	5,57	5,28	4,70	4,76	4,68	4,71	4,68

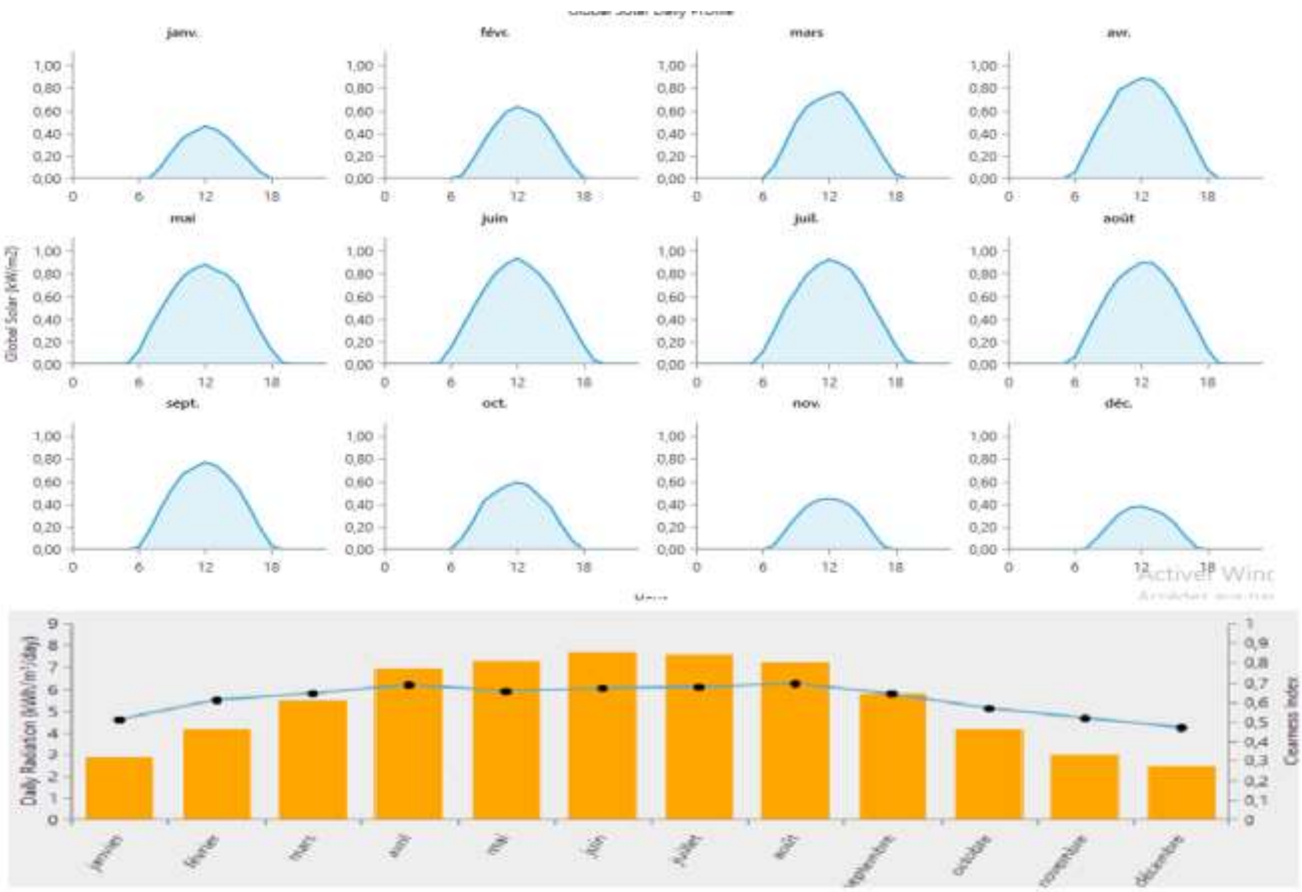


Figure II- 14 Typical annual profile of solar radiation

------------Daily Radiation -------- Clearness index

Table II- 3 Monthly Average Solar Global Horizontal Irradiance (GHI) DATA

Month	Janvier	Février	Mars	Avril	mai	Juin	Juillet	Aout	september	Octobre	novembre	décembre
Clearness Index	0,509	0,608	0,641	0,686	0,653	0,668	0,674	0,692	0,640	0,567	0,517	0,469
Daily Radiation (KWh/m^2/day)	2,840	4,170	5,480	6,940	7,260	7,660	7,590	7,230	5,800	4,160	3,030	2,430

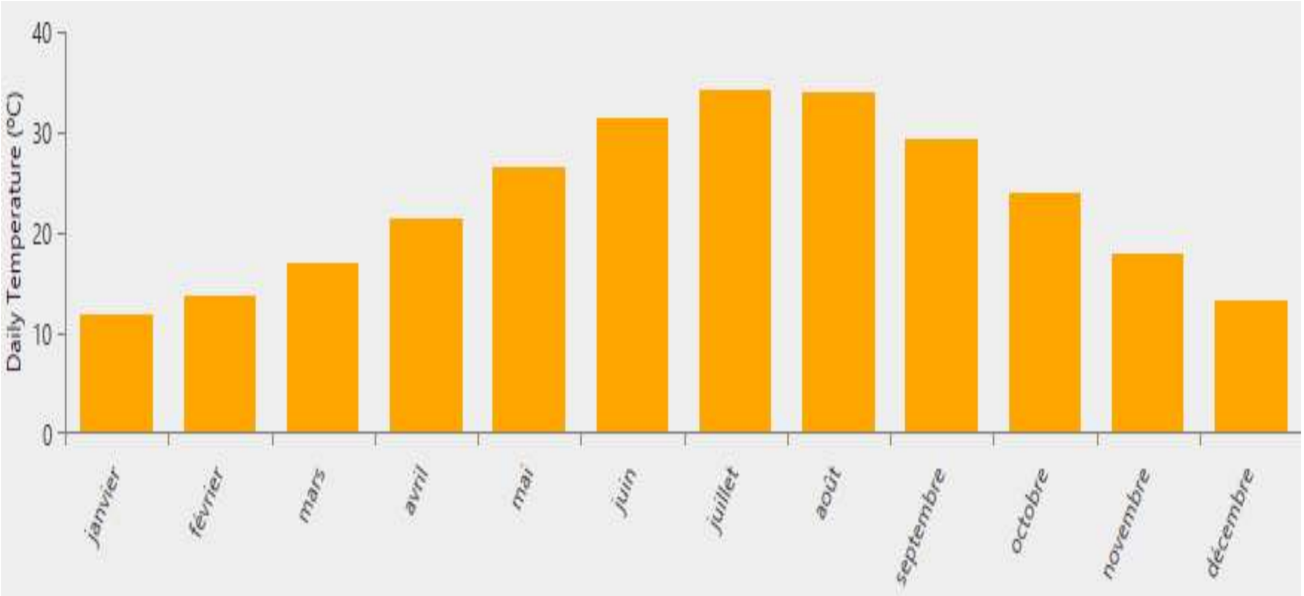


Figure II- 15 Average daily temperature

Table II- 4 Daily Temperature (c °)

Month	Janvier	Février	Mars	Avril	Mai	Juin	juillet	aout	September	Octobre	Novembre	Décembre
Daily Temperature (c°)	11,8	13,65	17,09	21,33	26,5	31,44	34,08	33,93	29,34	23,84	17,82	13,29

The program includes a (library containing solar and wind resources around the world, obtained through NASA data) [17.] . After entering the corresponding longitude and latitude, the area is determined, the solar resource, wind resource and temperature are established, which are the important factors to determine the correct function of the system , and the base load used to simulate the study condition is determined by HOMER Pro. Estimated monthly file download program for 25 years. Taking into account a random difference of 10% day by day

II.10 Conclusion

In this chapter, we define and model the components of the system. We determine the optimum volume of the autonomous system (PV/wind/GD) with a storage battery. And we presented an explanation and definition of the HOMER program, which is an important tool that can really help students of technology and engineering in the field of designing optimal systems for hybrid and conventional systems and analyzing renewable energy resources and sources and explained how to use it after entering the equipment, prices and meteorological data (sun, wind and temperature) to access to the objectives to be ach

Chapter III

Results and discussion

Technical-economic

III.1 Introduction

In this chapter we will discuss the results obtained using this hybrid system, (PV / Hybrid system for wind / diesel generator with storage batteries) and from these results we will choose the best suitable result to provide the necessary consumption for a separate house in Ouargla in an isolated area in BOUR AL AICHA , we calculated these Results by HOMER® Micro-Network Simulator; will select the best available models with the lowest possible cost, energy savings and reliability based on the components the designer chooses. In the process, HOMER® will calculate the energy balance based on the system configuration consisting of several component numbers and sizes. We select the best possible system configuration that is suitable to meet the demand for electricity based on cost, quality and reliability at the lowest possible cost for the selected group and calculates the operation and maintenance cost, expected maintenance intervals, lead time, resale of the system and possible cost recovery.

III.2 Hybrid system (PV/ wind turbine/ DG) with batteries storage

III.2.1. Results and discussions

The components of the hybrid system were selected according to the quality and cost chosen in this study (photovoltaic, wind turbines and diesel. Generator with storage batteries), and the system was simulated using the HOMER program, and the structure of the designed system and the amount of electrical outputs

TableIII- 1 The optimal system architecture

Component	Name	Size	Unit
Generator	Generic 10kW FixedCapacity Genset	10,0	kW
PV	Generic flat plate PV	/	kW
Storage	Generic 1kWh Lead Acid	36	Strings
Wind turbine	Generic 1 kW	1	ea.
System converter	System Converter	6,16	Kw

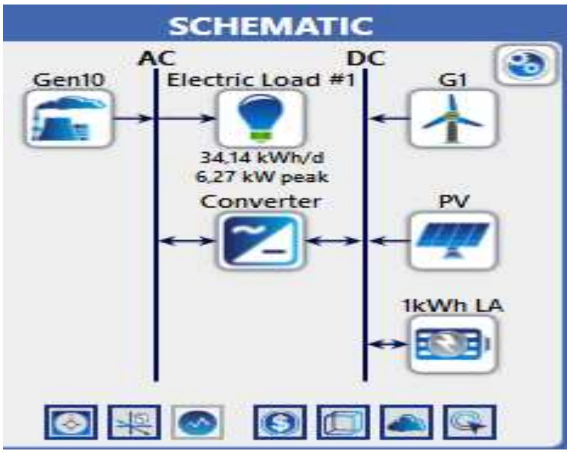


Figure III- 1 electrical assembly of the hybrid system

The following table represents the best results obtained after the simulation

Export... Export All... **Sensitivity Cases** Compare Economics Column Choices...

Left Click on a sensitivity case to see its Optimization Results.

Architecture						Cost				System			Gen10			
PV (kW)	G1	Gen10 (kW)	1kWh LA	Converter (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fuel (DA/
8,40		10,0	36	5,94	LF	0,529 DA	77 236 DA	2 991 DA	38 571 DA	86,3	720	578	1 546	720	173	720

Export... **Optimization Results** Categorized Overall

Left Double Click on a particular system to see its detailed Simulation Results.

Architecture						Cost				System			Gen10			
PV (kW)	G1	Gen10 (kW)	1kWh LA	Converter (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fu (D
8,40		10,0	36	5,94	LF	0,529 DA	77 236 DA	2 991 DA	38 571 DA	86,3	720	578	1 546	720	173	72
7,88	1	10,0	36	6,16	LF	0,568 DA	82 896 DA	2 982 DA	44 344 DA	87,2	673	541	1 444	673	162	67
		10,0	31	6,26	CC	0,854 DA	124 693 DA	8 394 DA	16 179 DA	0	4 797	1 929	13 537	4 797	579	47
	1	10,0	32	5,99	CC	0,867 DA	126 505 DA	7 976 DA	23 396 DA	0	4 481	1 802	12 643	4 481	541	44
24,8			96	7,29	CC	0,900 DA	131 351 DA	2 968 DA	92 988 DA	100	0					
24,8	1		92	7,26	CC	0,943 DA	137 584 DA	3 002 DA	98 779 DA	100	0					

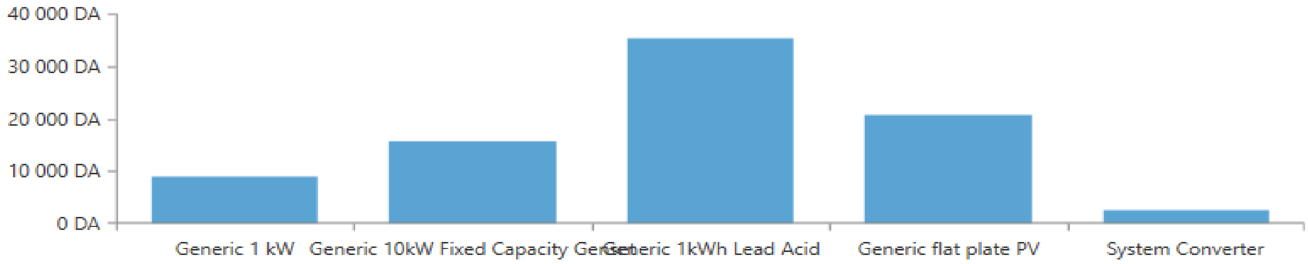
Figure III- 2 table of all calculation results the hybrid system

The program is technically designed to obtain the best results for technical and economic analysis, efficiency in system outputs, and system operation after operating the system Approximately 67,774 candidate suggestions were evaluated for you considering different system designs (i.e. use of diesel generators, batteries, etc.) to calculate the option with the lowest NPC at Project start. Of the total number of simulated suggestions, 5396 . were found Maybe; feasible is considered a proposal capable of achieving goals, 1,378 suggestions were removed due to limitations, lack of power sources, lack of transformers etc. We note the best result used in the order of net total net current cost (NPC) equal to (82 896.00DA) and in the order of results and rated values from best option to least. We note in the figure that the best result is in the first line, and we will take in our study the result in the second line because it matches our study with a suitable hybrid system (PV, wind turbine, DG and battery)

PV (kW)	G1	Gen10 (kW)	1kWh LA	Converter (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fu (D
8,40		10,0	36	5,94	LF	0,529 DA	77 236 DA	2 991 DA	38 571 DA	86,3	720	578	1 546	720	173	72
7,88	1	10,0	36	6,16	LF	0,568 DA	82 896 DA	2 982 DA	44 344 DA	87,2	673	541	1 444	673	162	67

Figure III- 3 optimal results for the hybrid system (BOUR AL AICHA)

III.2.1.1 Discussion of the economic aspect



Component	Capital (DA)	Replacement (DA)	O&M (DA)	Fuel (DA)	Salvage (DA)	Total (DA)
Generic 1 kW	7 000,00 DA	2 231,65 DA	904,93 DA	0,00 DA	-1 257,68 DA	8 878,90 DA
Generic 10kW Fixed Capacity Genset	5 000,00 DA	0,00 DA	2 098,14 DA	8 694,56 DA	-117,78 DA	15 674,91 DA
Generic 1kWh Lead Acid	10 800,00 DA	20 891,14 DA	4 653,91 DA	0,00 DA	-1 202,66 DA	35 142,39 DA
Generic flat plate PV	19 695,05 DA	0,00 DA	1 018,43 DA	0,00 DA	0,00 DA	20 713,49 DA
System Converter	1 849,36 DA	784,63 DA	0,00 DA	0,00 DA	-147,68 DA	2 486,31 DA
System	44 344,41 DA	23 907,43 DA	8 675,40 DA	8 694,56 DA	-2 725,80 DA	82 896,00 DA

Figure III- 4 Cost summary

After selecting the optimal solution and the most interesting candidate is the design of the second after meeting the constraints and reliability variables are the most important issues in responsible for technology services, where economic cost plays an important role in the selection and evaluation of this project. The results obtained from the sensitivity analysis of the hybrid system through shown in Figure 4, which shows the variance in the initial cost of the system (initial capital) (44344,41DA), it seems that the cost of solar panels took the largest value from the initial cost, with a percentage of up to 44%, followed by The cost of the batteries is 24%, then the diesel generator and the turbine, about 16% and 12%, and the lowest cost, and finally the inverter 4%. After that, the system calculated the costs of operation, maintenance, replacement and selling materials. Over 25 years of work on all project costs, the total network cost (NPC) amounted to (82896.00 DZD)

TableIII- 2 Net Present Costs (25years)

Name	Capital	Operating	Replacement	Salvage	Resource	Total
Generic 1 kW	7 000.00 DA	904,93.00 DA	2 232.00 DA	- 1 258,00 DA	0,00 DA	8 879,DA
Generic 10kW Fixed Capacity Genset	5 000.00 DA	2 098.00 DA	0,00 DA	-117,78.00 DA	8 695.00 DA	15 675.00 DA
Generic 1kWh LeadAcid	10 800.00 DA	4 654.0 DA	20 891 DA	-1 203 DA	0,00 DA	35 142.00 DA
Generic flatplate PV	19 695.00 DA	1 018.00 DA	0,00 DA	0,00 DA	0,00 DA	20 713.00 DA
System Converter	1 849.00 DA	0,00 DA	784,63 DA	-147,68 DA	0,00 DA	2 486.00 DA
System	44 344.41 DA	8 675.00 DA	23 907.00 DA	-2 726.00 DA	8 695.00 DA	82 896.00 DA

We note in this table (2) that the total cost of the project during 25 years was (82896.00 DA) and on the basis of (capital) from (44344.41 DA) and then we move to operation and maintenance at a cost of (8675.00DA)) and replacement by (23907.00 m) and after salvage from to recover Some profits (-2 726.00 DZD)

TableIII- 3 Annualized Costs

Name	Capital	Operatin	Replacemen	Salvage	Resource	Total
Generic 1 Kw	541,48 00 DA	70,00.00 DA	172,63.00 DA	-97,29.00 DA	0,00 DA	686,82.00 DA
Generic 10kW Fixed Capacity Genset	386,77.00 DA	162,30.00 DA	0,00 DA	-9,11.00 DA	672,56.00 DA	1 213.00 DA
Generic 1kWh LeadAcid	835,43.00 DA	360,00 DA	1 616 DA	-93,03 DA	0,00 DA	2 718.00DA
Generic flat plate PV	1 523.00 DA	78,78 DA	0,00 DA	0,00 DA	0,00 DA	1 602.00 DA
System Converte r	143,06.00 DA	0,00 DA	60,69 DA	-11,42 DA	0,00 DA	192,33.00 DA
System	3 430.00 DA	671,08.00 DA	1 849.00 DA	-210,85.00 DA	672,56.00 DA	6 412.00DA

Through the(3) table, we see the total estimated energy cost of the unit over 25 years of work in all project costs: (capital, replacement, operation and maintenance, and salvage) With a flat cost energy (0,568DA / kWh). As (the capital was the largest cost of energy production is solar panels and Batteries) the operating stage we notice an increase in the cost of batteries and generator in the remaining stages and a decrease in the cost of renewable energy sources No need for maintenance

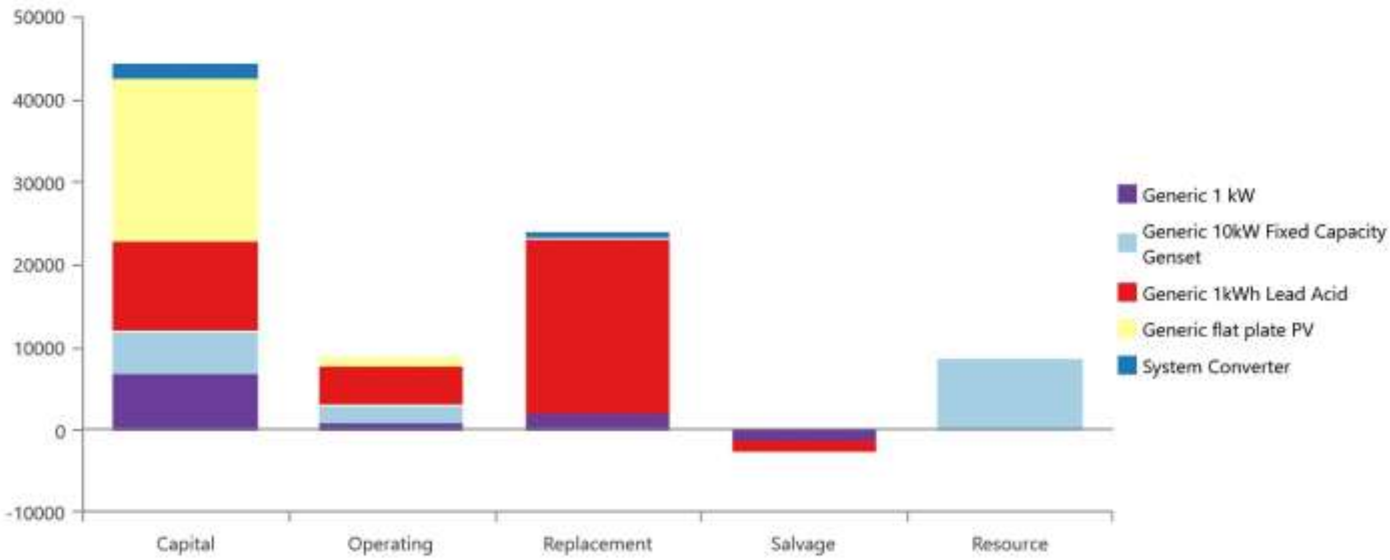


Figure III- 5 cost summary for the hybrid system during 25 years

In Figure (5) a graph that confirms and explains the data of Table (3), where it is shown that the capital cost of the project (44344.41 DA) we note the cost of photovoltaic cells and batteries, which is the dominant parameter in the initial capital cost sector, estimated at 45% of The total amount of the system over 25 years, followed by batteries at a rate of about 23% and 11% for a wind farm, 15% for a diesel engine. After the first five years, we note that batteries are the largest share of the cost for fuel consumption and need for maintenance. After ten years, we note the cost control for batteries as well, which is the shelf life of the date its expiry date and the need to replace it. After 20 years, we note the recovery of some profits from reselling the parts of the system. After 25, we note the full cost of the generator and its fuel consumption

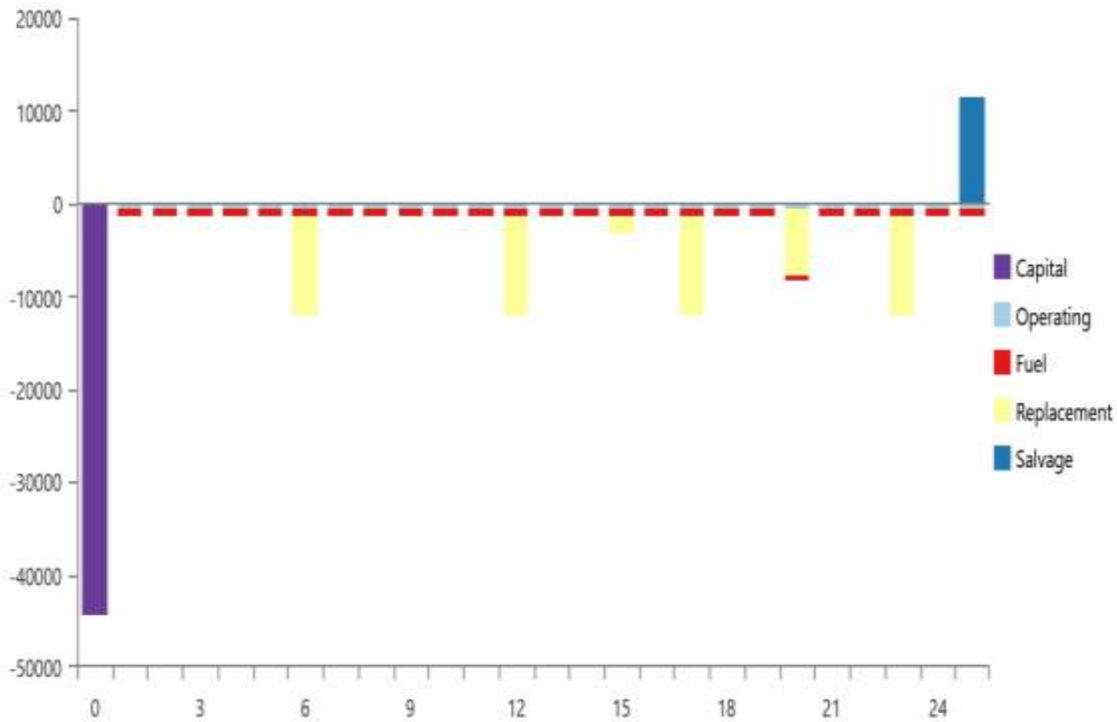


Figure III- 6 summary of operations and replacements throughout the operating life of the

The figure (6) represents the graphs of the project cost stages for each year of the project's duration of 25 years. We note that it is divided into four stages

- ✓ The cost of capital in the first year (44344.41DA)
- ✓ Low Fuel cost every year
- ✓ The cost of replacing and operating batteries per 6 years (batteries)
- ✓ Cost of profit after 25 year

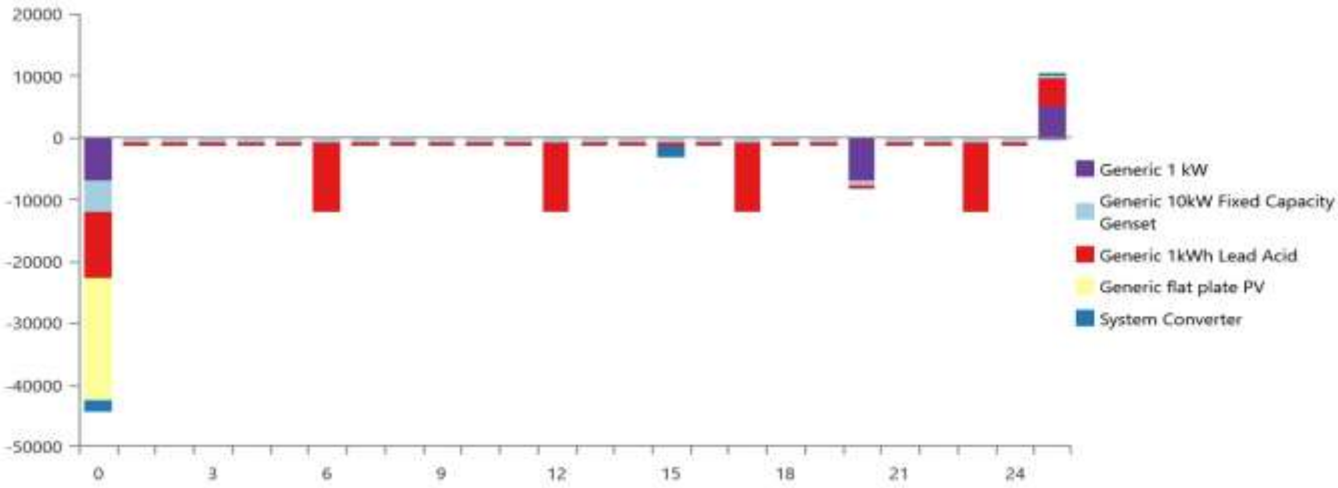


Figure III- 7 Summary of replacement devices

The figure (7) represents the graphs of the cost stages of the systems for each year of the project's duration of 25 years. In the first year, the capital cost of the project was the largest, and we notice changes in a very small percentage for each year and a significant cost for each year. These changes can be divided into stages.

- Change the batteries every 6 years
- Transformer change after 15 years
- Wind turbine change after 20 years
- Light diesel maintenance every year

At the end of the project, wind turbines, batteries, and transformer gained benefit from this Project (salvage)

III.2.1.2Electrical output of the system

We have Table III. 4: detailing for us the electrical results obtained from (PV, wind turbine, DG, with battery bank) and they are shown as follow

TableIII- 4 Production, consumption and quantity of PV-wind-DG system

Production Summary		
Component	**Production (kWh/yr)**	**Percent**
Generic flat plate PV	13 419	85,8
Generic 10kW Fixed CapacityGenset	1 444	9,23
Generic 1 kW	777	4,97
Total	15 640	100
Consumption Summary		
Component	**Consumption (kWh/yr)**	**Percent**
AC Primary Load		100
DC Primary Load	0	0
Total	11292	100
Excess and Unmet		
Quantity	**Value**	**Units**
Excess Electricity	2 636	kWh/yr
Unmet Electric Load	0	kWh/yr
Capacity Shortage	0	kWh/yr

Thetable (4) shows that the amount of energy produced, consumed and stored from the hybrid system, where the produced energy was estimated to be about (15,640 kWh / year) divided as follows:

- Photovoltaic energy produced the largest amount (13 419 kWh / year), at 85,8%
- Wind turbine production (777 kWh / year) by 4,97%
- Diesel generator producing (1 444 kWh / year) at a rate of 9,23%
- The house that consumes (11292kWh / year).
- The remaining quantity (2636 kWh / year) is used for other services

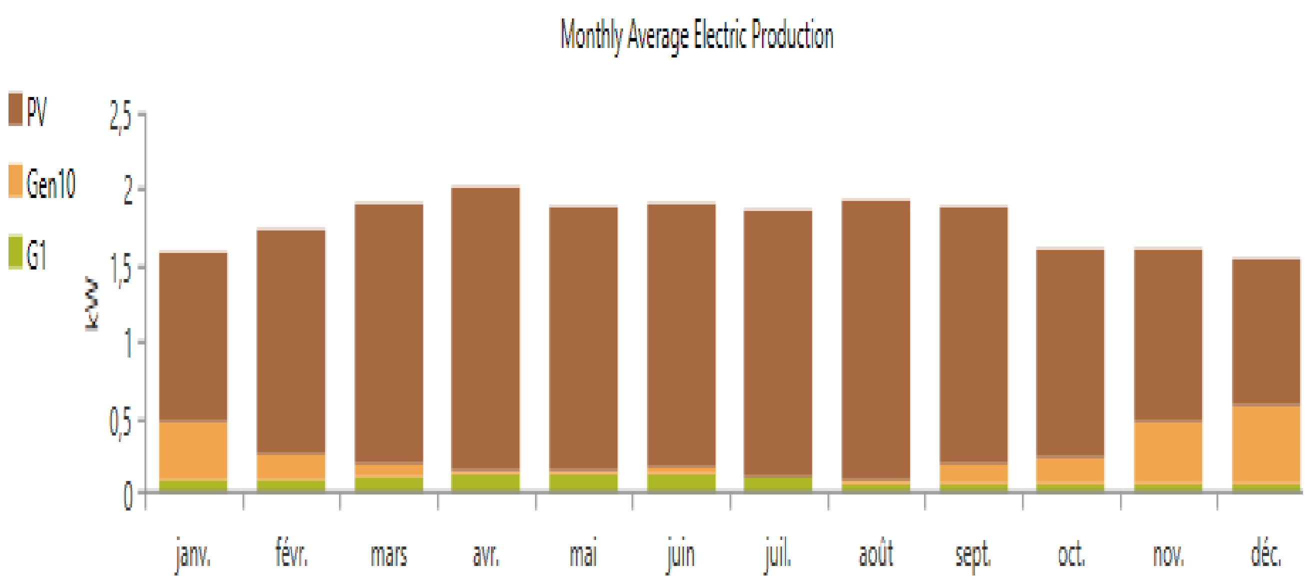


Figure III- 8 Total monthly energy produced by the hybrid system for one year

The figure (8) shows the value of the energy produced per month during one year. We note the increase in the electrical output numbers for each of (wind turbines and photovoltaic cells).
and diesel generators) during the months of the year, as the largest value of production in the month of April is about (2 kw/h) due to the high source of solar and wind energy in the summer period, and the lowest value in December (1.5 kw/h) and this decrease is due to the change In solar radiation during the winter period in the BOUR AL AICHA region.

III.2.2 General Flat Panel (PV)

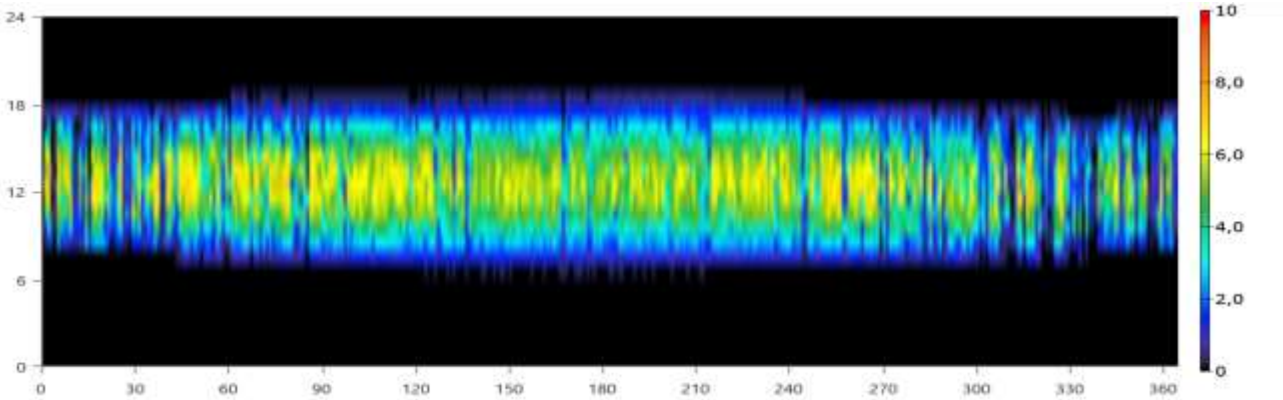


Figure III- 9 Total daily energy produced by the PV during one year

TableIII- 5 Generic flat plate PV Electrical Summary

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	8,07	kW
Hours of Operation	4 374	hrs/yr
Levelized Cost	0,119	DA/kWh

TableIII- 6 Generic flat plate PV Statistics

Quantity	Value	Units
Rated Capacity	7,88	kW
Mean Output	1,53	kW
Mean Output	36,8	kWh/d
Capacity Factor	19,4	%
Total Production	13 419	kWh/yr

Figure (9) and Table (5) (6) show the different periods of electrical energy production for solar energy, as they change throughout the year. In winter and autumn, energy production begins after sunrise. Between (8:00 a.m. / 16:30 p.m.) and in the spring and summer, the electric power production begins. After sunrise, between (6:00 a.m. / 6:00pm) Where the total production of electrical energy for solar panels throughout the year is (13 419 kWh/yr) .

We notice a difference in the amount of energy produced within 24 hours, where low electrical energy at the beginning of sunrise around 7:00 to 9:30 with different values (0.20 kilowatts) up to 2,50 kilowatts and then production increases from 9:30 until the hour 15:00 to reach the maximum value of 6 KW and from 15:00 until sunset Production is gradually decreasing

III.2.3 Wind Turbine (Common 1KW)

- Generic 1 kW Output (kW)

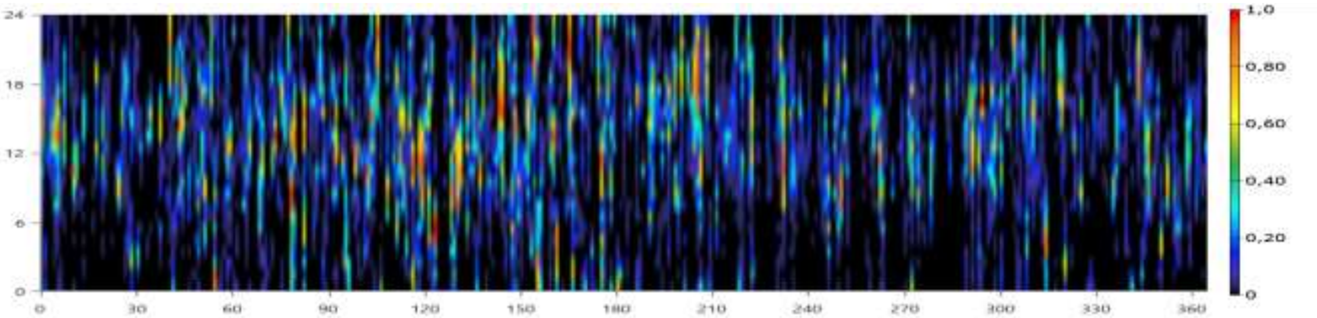


Figure III- 10 Total daily energy produced by the WT during one year

TableIII- 7 Generic 1 kW Electrical Summary

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	1,00	kW
Wind Penetration	6,88	%
Hours of Operation	6 083	hrs/yr
Levelized Cost	0,884	DA/kWh

TableIII- 8 Generic 1 kW Statistics

Quantity	Value	Units
Total Rated Capacity	1,00	kW
Mean Output	0,0887	kW
Capacity Factor	8,87	%
Total Production	777	kWh/yr

Figure (10) and the table (7) (8) represent the results of the electrical energy of the wind, and through an analysis of the data, we can see that there is no stability and random results throughout the year, and a small amount of electrical energy produced by wind turbines in winter can be observed less than in summer .Where production ranges from (0 to 1 kWh). While we record the largest production capacity file in the months of April, May and June (about 1 kilowatt in the operating period amounted to (6083 hours / year) and the total energy value (777 .kWh/yr).

III.2.4 Storage Batteries (1Kwh Lead Acid)

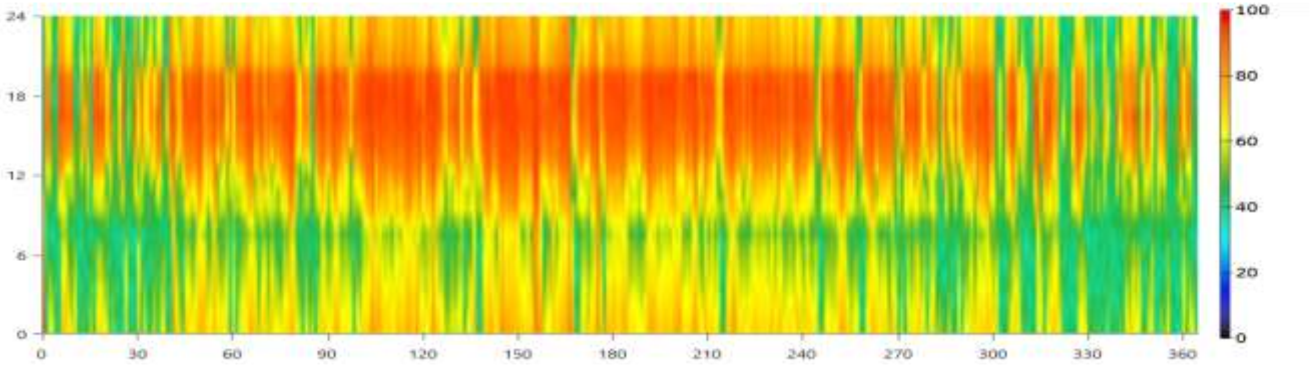


Figure III- 11 State of charge through a year

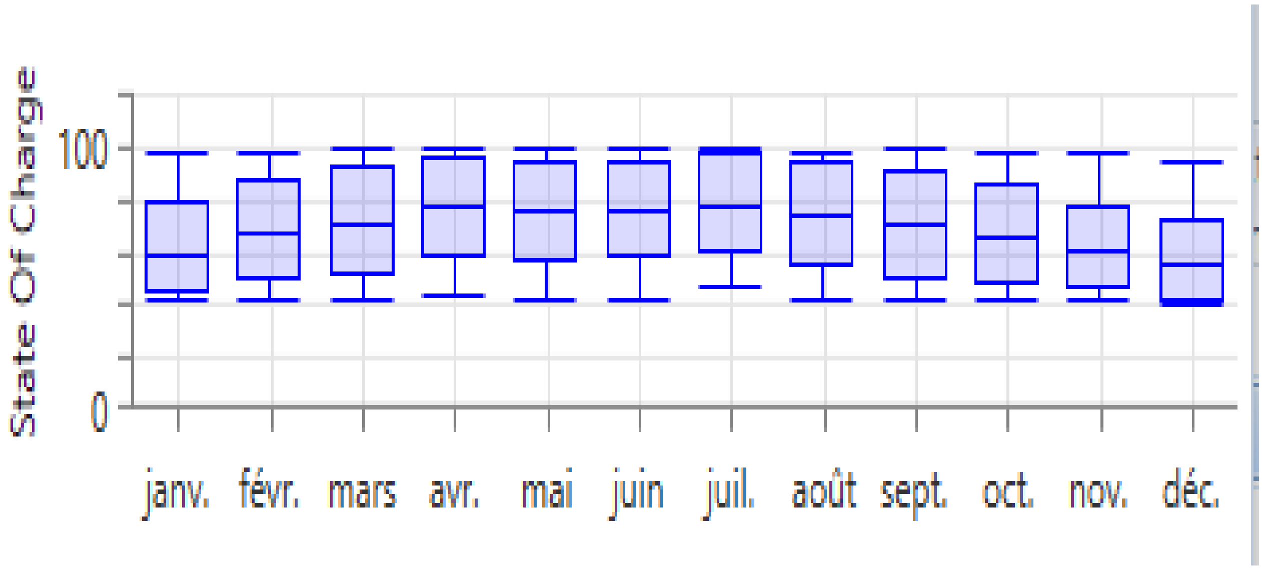


Figure III- 12 Charging battery through a year

As we explained earlier, batteries play an essential role in the system when there is a shortage of renewable energy due to (weather conditions). It is used as the primary component of consuming stored energy on the one hand .On the other hand, to store excess energy, and for various reasons. Therefore, batteries are considered the most important element in ensuring the continuity of demand. We note from

Figures (11) and (12) that charging is at its highest levels in summer and spring, and this is a result of the increase in sources of renewable energies in this period. Batteries are used permanently throughout the year throughout the day and it is at its peak between Period (12:00 / 18:00) at a load level between 30 and 100%.

TableIII- 9 Generic 1kWh Lead Acid Properties

Quantity	Value	Units
Average Energy Cost	0	DA/kWh
Energy In	5 819	kWh/yr
Energy Out	4 673	kWh/yr
Storage Depletion	19,8	kWh/yr
Losses	1 166	kWh/yr
Annual Throughput	5 224	kWh/yr

TableIII- 10 Generic 1kWh Lead Acid Result Data

Quantity	Value	Units
Autonomy	16,8	Hr
Storage Wear Cost	0,419	DA/kWh
Nominal Capacity	36,0	kWh
Usable Nominal Capacity	21,6	kWh
Lifetime Throughput	28 800	kWh
Expected Life	5,51	Yr

TableIII- 11 Generic 1kWh Lead Acid Statistics

Quantity	Value	Units
Batteries	36,0	qty.
String Size	1,00	Batteries
Strings in Parallel	36,0	Strings
Bus Voltage	12,0	V

Through the table (9) (10) (11) shows us the characteristics of the batteries used and the energy value . Stored, discharged and lost during the year, as the stored value reached to(5819 kWh/yr) and discharged to (4673 kWh / year). The results show us the necessity and importance of batteries in the system

III.2.5 Diesel Generator

- Generic 10KW Fixed Capacity Genset Output (KW)

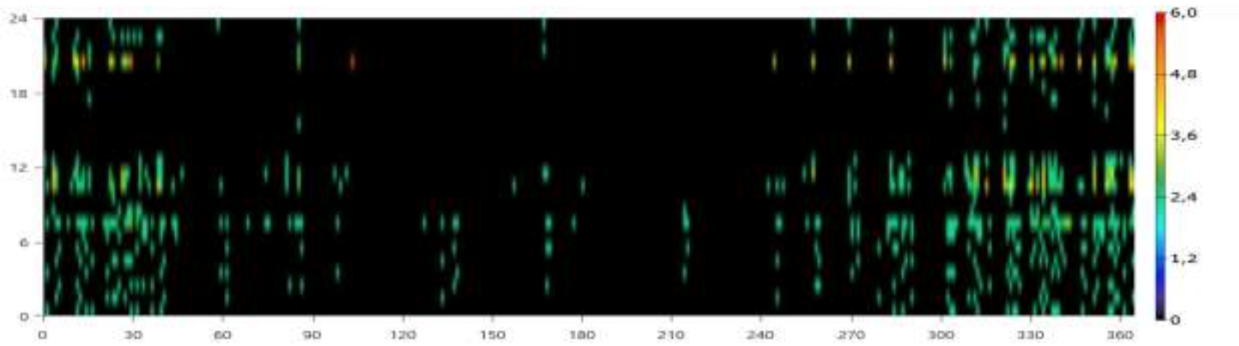


Figure III- 13 fixed capacity Genset output (KW)

The figure (13) we observe shows, an analysis of the electric power of a diesel generator was recorded throughout the year .Works in parallel with batteries, solar panels and wind generator .We note that the working periods of the diesel generator in winter and autumn are more common than summer and spring, and this is due to the lack of renewable energy sources in the winter. We also note that the working periods of the generator per day consist of (6:00 / 12:00) and (6:00 / 24:00), which is the evening and early morning period due to the lack of solar energy resources that dominate production in our system

TableIII- 12 Generic 10kW Fixed Capacity Genset Electrical Summary

Quantity	Value	Units
Electrical Production	1 444	kWh/yr
Mean Electrical Output	2,67	kW
Minimum Electrical Output	2,50	kW
Maximum Electrical Output	5,78	kW

TableIII- 13 Generic 10kW Fixed Capacity Genset Fuel Summary

Quantity	Value	Units
Fuel Consumption	673	L
Specific Fuel Consumption	0,466	L/kWh
Fuel Energy Input	6 618	kWh/yr
Mean Electrical Efficiency	21,8	%

TableIII- 14 Generic 10kW Fixed Capacity Genset Statistics

Quantity	Value	Units
Hours of Operation	541	hrs/yr
Number of Starts	421	starts/yr
Operational Life	27,7	Yr
Capacity Factor	1,65	%
Fixed Generation Cost	1,11	DA/hr
Marginal Generation Cost	0,286	DA/kWh

Table (12) (13) (14) shows information and values of energy produced during the year, which amounted to about (1444 kWh/year) The maximum power produced by the generator was (5.78 kWh) in the evening period from (19:00 to 21:00) and the value of the fuel consumed per year (673 liters)

III.2.6 System Converter Electrical

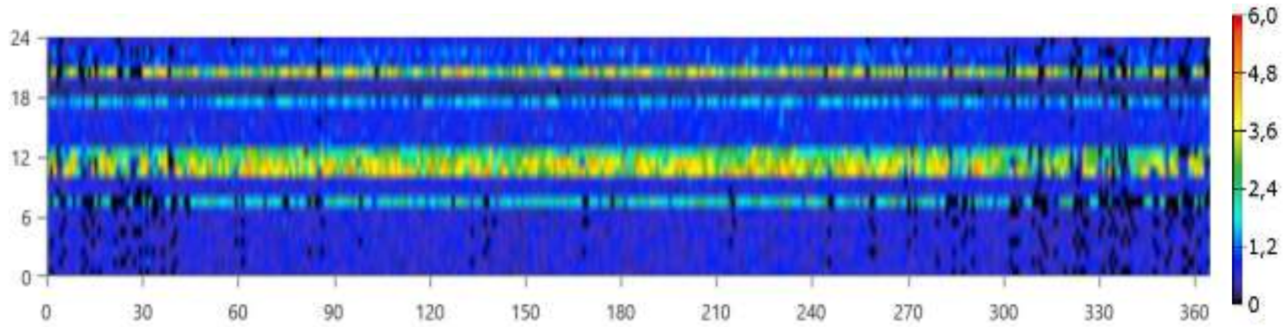


Figure III- 14 System Converter Inverter Output (kW)

Figure (14) shows us that the work of the inverter is constant throughout the year, and we note that the time of exploitation of the DC current from renewable energy sources coincides sometime between (7:00/12:00) and (18:00) / 21:00 charging time The batteries are supplied by the diesel generator after the DC supply is cut off, and we notice the lack of work of the inverter in the winter period, and this translates to a lack of the surplus in the alternating current due to the lack of renewable energy resources

TableIII- 15 System Converter Electrical Summary

Quantity	Value	Units
Hours of Operation	8 390	hrs/yr
Energy Out	10 318	kWh/yr
Energy In	10 861	kWh/yr
Losses	543	kWh/yr

TableIII- 16 System Converter Statistics

Quantity	Value	Units
Capacity	6,16	kW
Mean Output	1,18	kW
Minimum Output	0	kW
Maximum Output	5,43	kW
Capacity Factor	19,1	%

We note from Table (16) (15) the value and information of the inverter, where the number of transferred energy is 1 318 kWh/yr out of the total energy input (10 861 kWh/yr)and some losses are not significant

III.3 Off- grid Diesel generator system

III.3.1 Interpretation of results simulation

We have chosen a diesel generator that produces (10 kWh). And we recorded the results in HOMER-Pro, One suggestion was chosen by looking at sensitive variables such as the $12/liter diesel price.

TableIII- 17 architecture of the System

Component	Name	Size	Unit
Generator	**Generic 10kW Fixed Capacity Genset**	**10,0**	**kW**
Dispatch strategy	**HOMER Cycle Charging**		

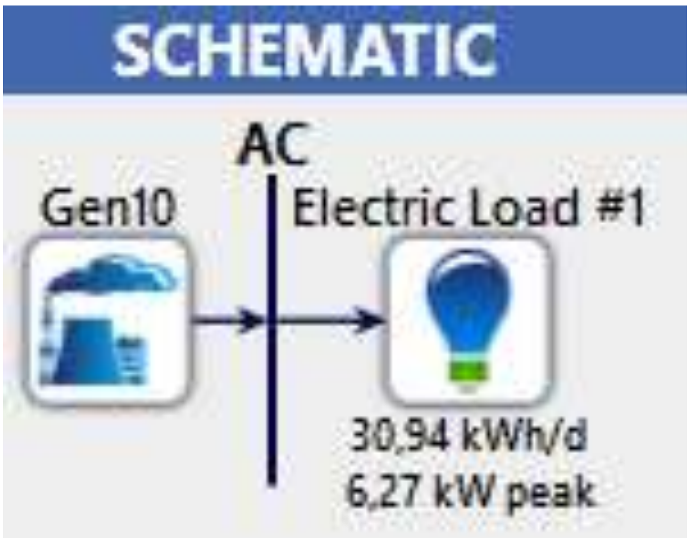
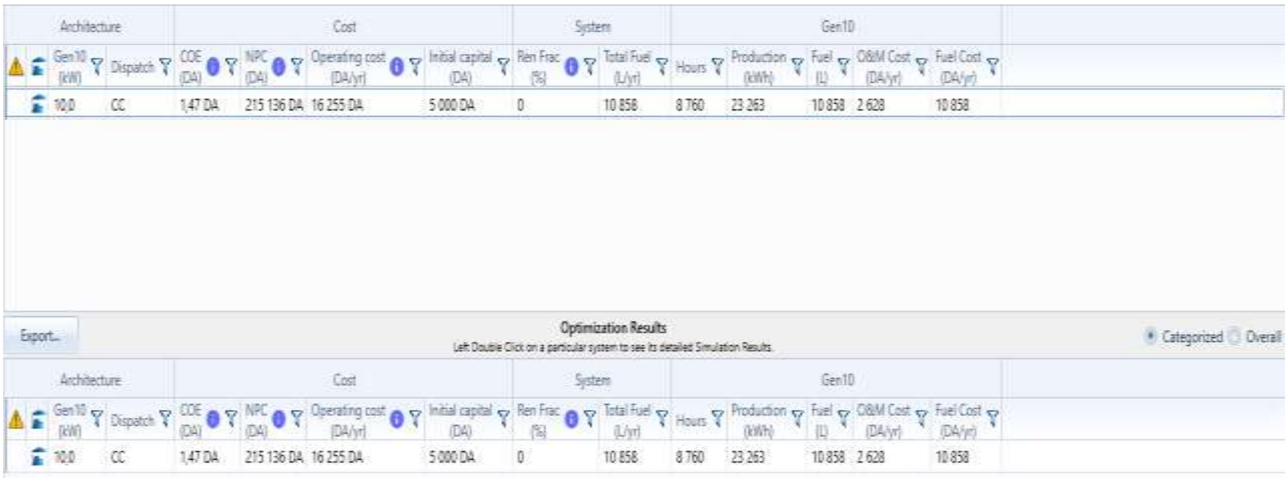


Figure III- 15 electrical installation of the DG autonomous system



Architecture		Cost				System		Gen10				
Gen10 (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fuel Cost (DA/yr)
10,0	CC	1,47 DA	215 136 DA	16 255 DA	5 000 DA	0	10 858	8 760	23 263	10 858	2 628	10 858

Optimization Results
Left Double Click on a particular system to see its detailed Simulation Results.

Architecture		Cost				System		Gen10				
Gen10 (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fuel Cost (DA/yr)
10,0	CC	1,47 DA	215 136 DA	16 255 DA	5 000 DA	0	10 858	8 760	23 263	10 858	2 628	10 858

Figure III- 16 table of all the calculation results for the autonomous system

We have one option proposed by HOMER which is the best possible solution in the isolated system, which is shown in the results shown in Figure. (16)

Optimization Results
Left Double Click on a particular system to see its detailed Simulation Results.

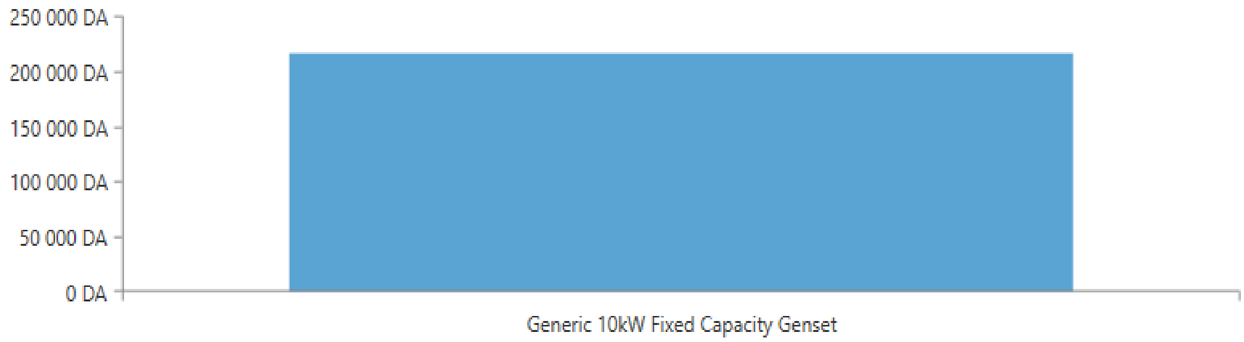
Architecture		Cost				System		Gen10				
Gen10 (kW)	Dispatch	COE (DA)	NPC (DA)	Operating cost (DA/yr)	Initial capital (DA)	Ren Frac (%)	Total Fuel (L/yr)	Hours	Production (kWh)	Fuel (L)	O&M Cost (DA/yr)	Fuel Cost (DA/yr)
10,0	CC	1,47 DA	215 136 DA	16 255 DA	5 000 DA	0	10 858	8 760	23 263	10 858	2 628	10 858

Figure III- 17 Optimal results for the autonomous system

As we already know, cost and reliability issues are among the most important issues that HOMER in project evaluation.

III.3.2 Discussion of the economic aspect

In order to evaluate this project economically, we studied the costs. This project noted that this system was technically analyzed through the results obtained from one of the houses in the off-grid BOUR AL AICHA area, and the results were as follows:



Component	Capital (DA)	Replacement (DA)	O&M (DA)	Fuel (DA)	Salvage (DA)	Total (DA)
Generic 10kW Fixed Capacity Genset	5 000,00 DA	36 273,36 DA	33 973,51 DA	140 368,39 DA	-479,12 DA	215 136,15 DA
System	5 000,00 DA	36 273,36 DA	33 973,51 DA	140 368,39 DA	-479,12 DA	215 136,15 DA

Figure III- 18 Cost summary

TableIII- 18 Net Present Costs

Name	Capital	Operating	Replacement	Salvage	Resource	Total
Generic 10kW Fixed Capacity Genset	5 000.00 DA	33 974.00 DA	36 273.00 DA	-479,12 .00DA	140 368.00 DA	215 136.00 DA
System	5 000.00 DA	33 974.00 DA	36 273.00 DA	-479,12 .00DA	140 368.00 DA	215 136.00 DA

TableIII- 19 Annualized Costs

Name	Capital	Operating	Replacement	Salvage	Resource	Total
Generic 10kW Fixed Capacity Genset	386,77.000 DA	2 628.00 DA	2 806.00 DA	-37,06.00 DA	10 858 .00DA	16 642.00 DA
System	386,77 .00DA	2 628 DA	2 806.00 DA	-37,06 DA	10 858 .00DA	16 642 DA

This table (18) (19) shows that the total cost of the project during 25 years was (215 136.15 DA) based on (capital) of (5000.00 DA) followed by (replacement) in the amount of (362 73.36 DA) after (operation and maintenance) from (33973.51 DA) and (Saving) from (-479, 12 DZD). As we note that the cost started to rise and began to increase due to operating costs and the need for maintenance and fuel

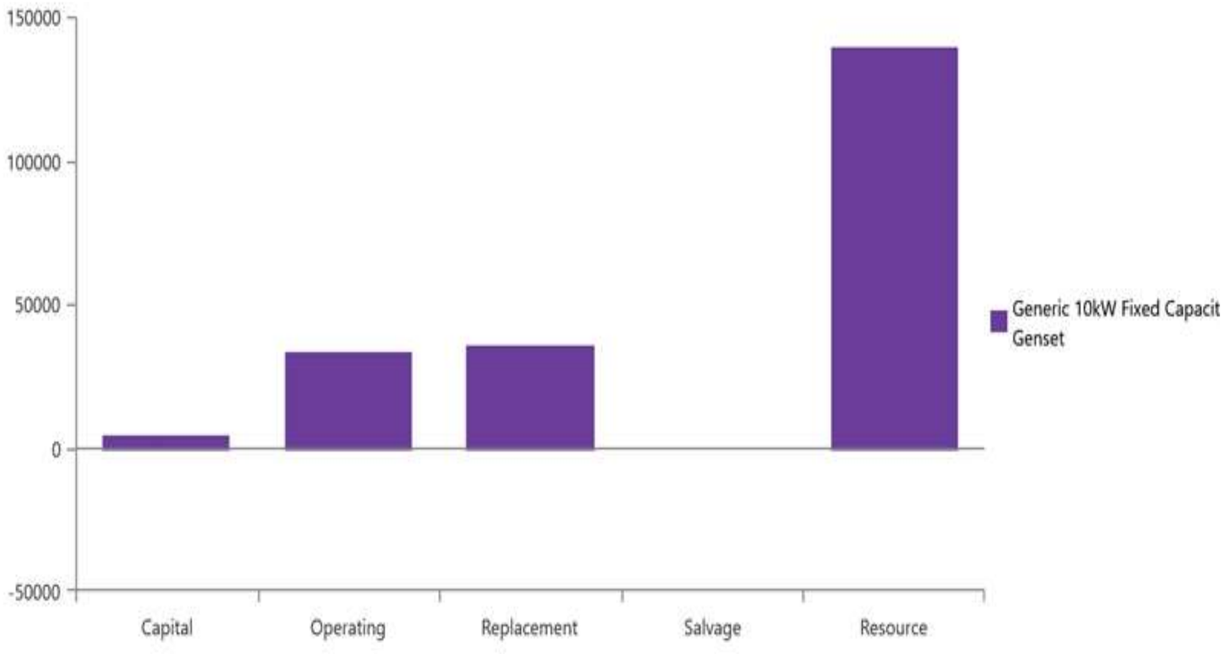


Figure III- 19 Cost summary for the system autonomous

The figure (19) also shows that the project started with a significant capital and started to increase significantly due to the need for continuous maintenance, operating requirements and the need for fuel consumption.

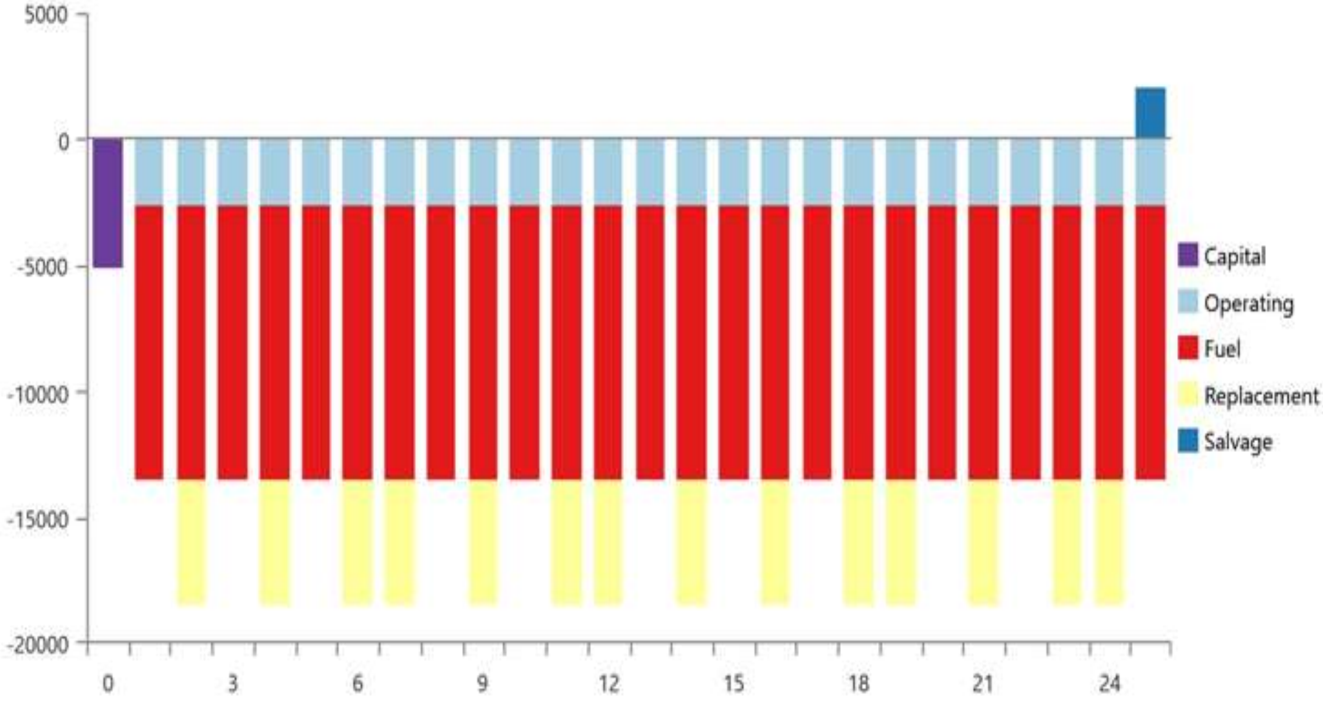


Figure III- 20 summary of O&M and replacements

The figure (20) represents a graph of the cost of operation, maintenance and replacement of the diesel generator system for each year in the project period, as we summarize it in the following stages;

- A very small amount of capital compared to the stages of operation and maintenance
- The need for operating requirements year
- Great value for fuel consumption abut 10 858 liters every year
- The need for maintenance and parts will be replaced approximately every two years

III.3.3 System electrical outputs

The rate of electrical power produced by a diesel generator they are distributed as follows:

- Electrical summary

TableIII- 20 Excess and Unmet

Quantity	Value	Units
Excess Electricity	11 971	kWh/yr
Unmet Electric Load	0	kWh/yr
Capacity Shortage	0	kWh/yr

TableIII- 21 Production Summary

Component	Production (kWh/yr)	Percent
Generic 10kW Fixed Capacity Genset	23 263	100
Total	23 263	100

TableIII- 22 : Consumption Summary

Component	Consumption (kWh/yr)	Percent
AC Primary Load	11 292	100
DC Primary Load	0	0
Total	11 292	100

The table shows that the amount of energy produced, consumed and stored from the diesel generator, where the energy produced was estimated at about (23 263kwh/yr)

- Generator: Generic 10kW Fixed Capacity Genset (Diesel)

TableIII- 23 Generic 10kW Fixed Capacity Genset Electrical Summary

Quantity	Value	Units
Electrical Production	23 263	kWh/yr
Mean Electrical Output	2,66	kW
Minimum Electrical Output	2,50	kW
Maximum Electrical Output	6,27	kW

TableIII- 24 Generic 10kW Fixed Capacity Genset Fuel Summary

Quantity	Value	Units
Fuel Consumption	10 858	L
Specific Fuel Consumption	0,467	L/kWh
Fuel Energy Input	106 844	kWh/yr
Mean Electrical Efficiency	21,8	%

TableIII- 25 Generic 10kW Fixed Capacity Genset Statistics

Quantity	Value	Units
Hours of Operation	8 760	hrs/yr
Number of Starts	1,00	starts/yr
Operational Life	1,71	Yr
Capacity Factor	26,6	%
Fixed Generation Cost	1,11	DA/hr
Marginal Generation Cost	0,286	DA/kWh

By observing the results in the table above, we note

- The energy produced by the diesel generator system is (23263 KWh), after consuming (10 858 L) of fuel for an operating period of (8 760 hours per year).
- Energy consumed (11292 kWh)
- The amount of surplus energy from the output (11971 kWh)
- The lowest value produced by the generator is (2.50 kWh)
- The maximum value produced by the generator (6,27 kilowatt-hours).

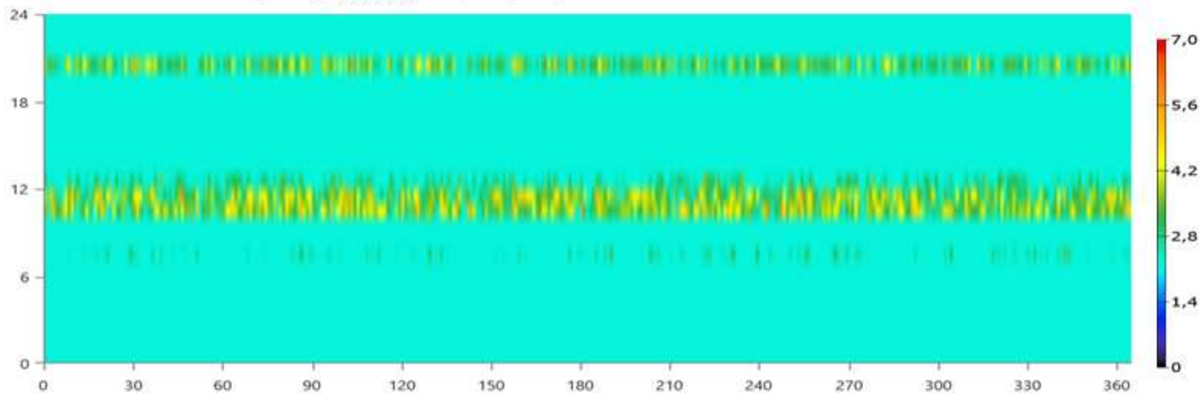


Figure III- 21 Capacity Genet Output (KW)

From Figure (21), we can notice that the period during which (8:00/12:12:00) (17:30/21:30) the generator is at its maximum value is within (6.27 kilowatt-hours). It is constant throughout the year and the rest of the day the generator is at its lowest value (2.50kw/yrr).

III.4 Comparison between hybrid and conventional systems (diesel generators)

We conducted a study and research for the electrical network in the BOUR AL AICHA region of Ouargla for two isolated systems, hybrid and conventional (diesel generators). We will take this comparison from the economic aspect (project costs) and the environmental aspect (emissions ratio);

III.4.1 Economic side

We faced many economic problems in delivering electricity to isolated and rural areas. On the other hand, the province of Ouargla, located in the south of Algeria, has excellent potential for photovoltaic and wind energy. In this context, we will compare the results presented by the program in terms of cost to prove the success of the hybrid system, which consists of:

{8 PV modules (6.35 kW) // wind turbine (1kw) // Diesel Generator (10 KW) // 36 batteries (lead acid) // converter (4.54 kW) }

TableIII- 26 Total economic cost and energy value of the hybrid system and diesel generator

Component / Comparison Parameters	System Hybrid PV/W/D	System Diesel Generator
Capital	44 344,41DA	5 000 ,00DA
Operating	8 675,00 DA	33 974,00 DA
Replacement	23 907,00 DA	36 273,00 DA
Salvage	-2 726,00 DA	-479,12,00 DA
Total(NPC)	82 896,00 DA	215 136,00 DA
Cost of energy (COE)	0.568,00 DA	1.47,00 DA
total energy production	15 640(kwh/yr)	23 263(kwh/yr)
Total fuel consumed(1year)	673 liters	10 858 liters
Average fuel per day	1,84 L/day	29,7 l/day

Through the difference in the results presented in the table (26), we can say that we have achieved that economic solution due to continuous maintenance and fuel consumption, using the hybrid system for renewable energy and achieving living development in these isolated areas.

We note that there is an excess of electricity production in both systems that can be analyzed for two reasons :

1) We used an electric generator (10 kWh).This is due to the lack of a diesel generator with a capacity of (5 kWh) in th HOMER softwar
2) the batteries do not bear the excess energy due to the renewable energy resource, especially in the summer period

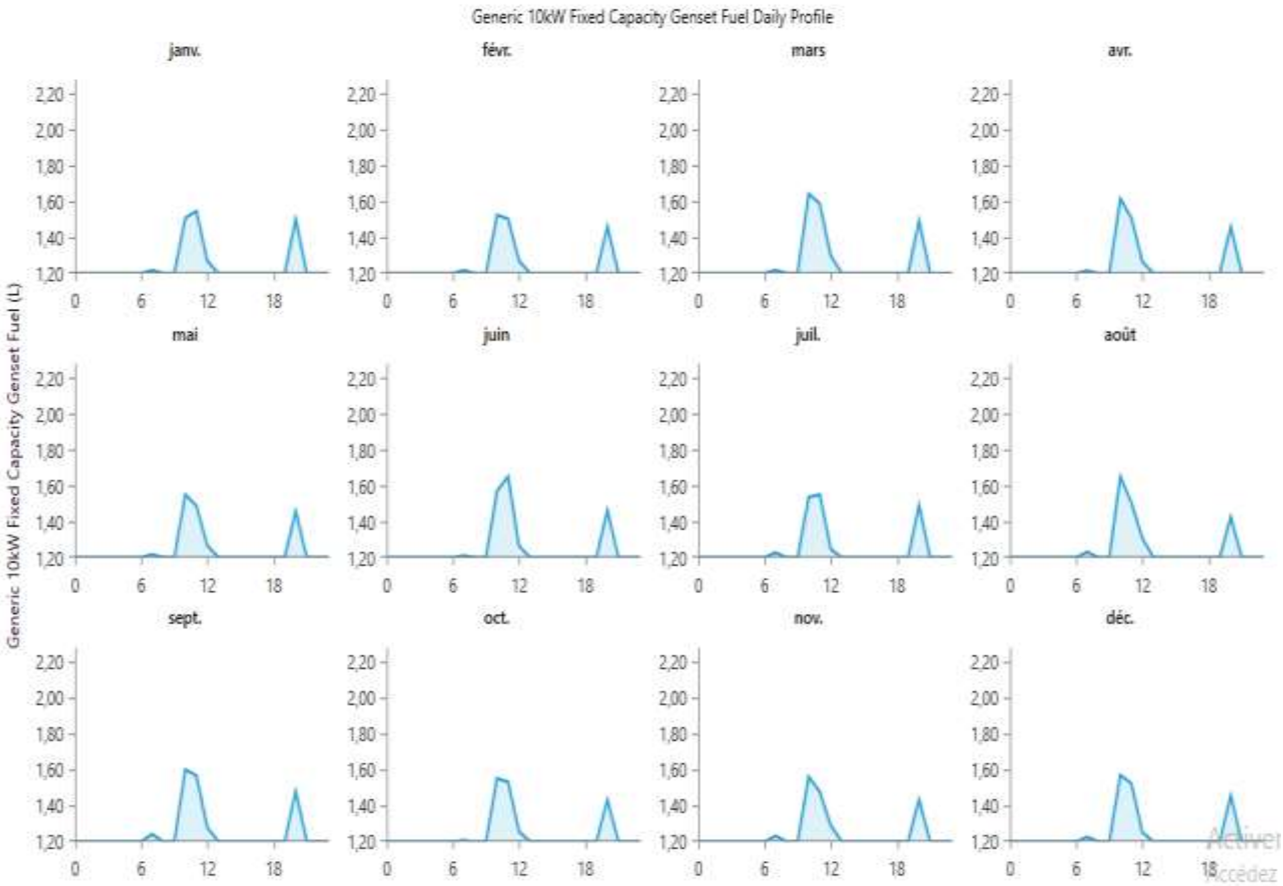


Figure III- 22 capacityGeneset fuel daily profile diesel generator system

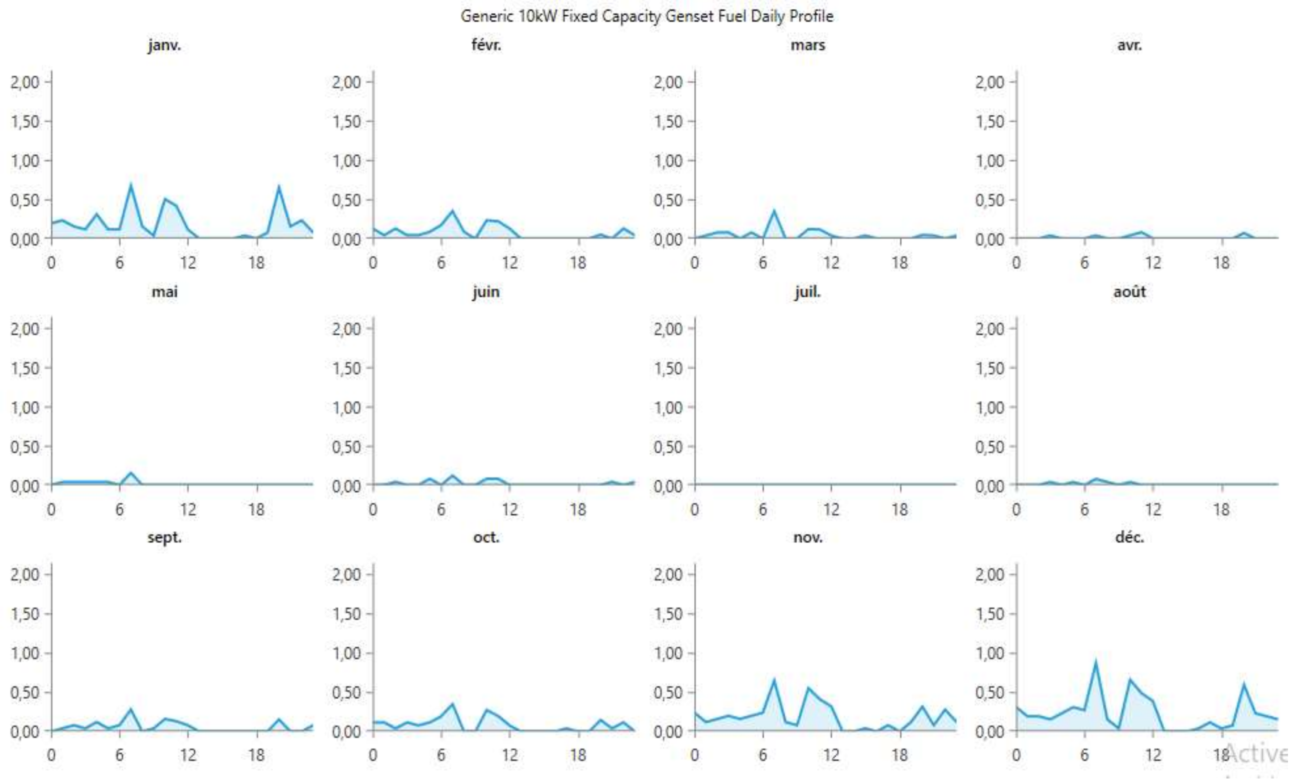


Figure III- 23 capacity Geneset fuel daily profile diesel generator of hybrid system

The table represents a summary of the difference between the economic cost and energy value of the hybrid system and diesel generator, where we note the large difference in the economic cost according to the total cost of the NPS system, the significant increase in cost in the operating stages and the need for maintenance and the large consumption of fuel.

Figure (22) and (23) represent the great difference in fuel consumption, as the hybrid system consumes only in the winter period, when the renewable energy resource is small for me in the Summer We note that the diesel generator system consumes fuel throughout the year, and from here we conclude that the hybrid system is one of the best solutions in the production of electricity for isolated sites. Economically

III.4.2 Environmental Impact

Because of the continuous consumption of fuel,which leads to gas emissions and negatively affects the environment. The HOMER® program recorded the value of the emitted gases and the difference between the two systems, which are shown in the tables (27) and figures (22) (23)

TableIII- 27 Emission of pollutants during a year

Pollutant	Emission.Hybrid system	Emission. diesel generator
Carbon Dioxide	1 757 kg/yr	28 367 kg/yr
Carbon Monoxide	13,3 kg/yr	215 kg/yr
Unburned Hydrocarbons	0,484 kg/yr	7,82 kg/yr
Particulate Matter	0,806 kg/yr	13,0 kg/yr
Sulfur Dioxide	4,31 kg/yr	69,6 kg/yr
Nitrogen Oxides	15,1 kg/yr	244 kg/yr

III.5 Conclusion

In this chapter, we have analyzed the results obtained in terms of the economic cost and the energy value of the required load for one house through modeling and simulating the hybrid system elements (PV / Wind / GD / with battery storage) in the isolated area of BOUR AL AICHA located in the state of Ouargla, which has the appropriate characteristics and conditions For a term of 25 years.

We compared it with the traditional diesel generator system, and the hybrid system proved its success through the big difference in total cost and energy value.

General conclusion

The work presented in this project is the modeling and simulation of the multi-source electricity generation system in isolated sites in the Ouargla region, and in order to achieve this goal, we formed the following plan

- The first chapter relates to the definitional aspect of the system
- The second chapter is related to the practical aspect, where we modeled the project in a house
- In the third chapter, we analyzed and discussed all the results and followed the comparative method in order to know the difference between the hybrid and traditional systems.

And indeed, we found in our project an ideal solution to the problems of supplying the electricity network in rural and isolated areas, and this achieved us an attractive economic solution. Regarding the environment, we have found a solution to reduce fuel consumption and emissions of gases that cause environmental pollution by using the HOMER® simulation software that has a database that enables us to predict tasks with high accuracy. The hybrid system consists of (PV / Wind turbine / DG) with storage of batteries and climatic conditions in the BOUR AL AICHA area, which helped the system to achieve effective yield and great reliability. The project elements are formed fromwind turbine (1kw)

- Diesel Generator (10 KW)
- 36 batteries (lead acid)
- converter (4.54 kW)
- 8 PV modules (6.35 kW)

1) Economically

I. Hybrid system

- The cost of energy (COE) in the hybrid system for our study is (0.568DA/KWh),
- While the initial capital required is (44344.41 DA), the net
- The cost of the college for the hybrid system (NPC) (82896.00 DA). Approximately 39, which is a very attractive percentage
- The total annual energy production is 18,353(kWh/year), and solar panels produce
- the highest energy rate of 85.8%.

II. System (Diesel Generators)

- The cost of energy (COE) (1.47 DA / kWh),
- The initial capital required is (5000.00 DA)
- The net present cost (NPC) is (215 136 DA)
- The total annual energy production is 2326(kWh/year)

2) Environmentally

The large difference in the spent fuel between the hybrid and conventional systems contributes to reducing the Greenhouse gas emissions and preserves the environment for us, as we have a large Proportion of fuel consumed by the traditional system, unlike the hybrid system where ;

- The diesel generator system emits 28 367 kg/yr kg carbon dioxide (CO_2), unlike

7% hybrid system released.

- Diesel generator system 215 kg carbon monoxide (CO) is released, unlike

The hybrid system is released 13,3 kg (about 16.43%). Through our in-depth study of the hybrid system (PV / Wind / DG) with battery storage, it proved to us its efficiency and great success in areas isolated from the network and the great difference in many economic and environmental fields.

After analyzing and discussing the system in many areas, we encountered some difficulties, and we look forward to finding a solution for them in the future, which is as follows

- We had a problem with storing excess batteries because of their short life and poor storage .Which leads to an increase in the cost of the project.
- In the future, we look forward to using surplus electricity to analyze water, store electricity in the form of hydrogen or green energy, improve system efficiency and get rid of costly batteries.

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Appendix

The private information of the items used in the system (PV/W/D) with batteries

Table ♣ 1 Details of capital, replacement and O&M costs

List of component	Capital Cost	Replacement Cost	O&M Cost
PV (6.35 KWh)	**2 500,00.00DA**	**2 500,00.00DA.**	**10,00.00DA**
Wind turbine (1KWh)	**7 000,00.00 DA**	**7 000,00 DA**	**70,00 .00DA**
Generator(10KWh)	**5 000,00DA**	**5 000,00DA**	**0,300.00DA**
Storage (1KWh)	**300,00.DA**	**300,00.DA**	**10.00 DA**
System Converter (4.54 KWh)	**300,00.DA**	**300,00DA**	**00DA**

Table ♣ 2 Configuration of Generic flat plate PV

Generic flat plate PV	
Manufacture	**Generic**
Rated Capacity	**7,88 Kw**
Operating temperature	**47 c_o**
temperature coefficient	**-0.5 c_o**
Efficiency	**13%**
Electric Bus	**DC**
Capital initial	**2 500DA**
Life time	**25 years**
Panel type	**Flat plate**

Table ♣ 3 Configuration of Wind Turbine G1

Wind turbine generic 1 KW	
Manufacture	Generic
Abbreviation	G1
Rated Capacity	1 KW
Hub Height	10 m
Electric Bus	DC
Capital Initial	7000DA
Life time	20 years

Table ♣ 4 Configuration of Battery Storage

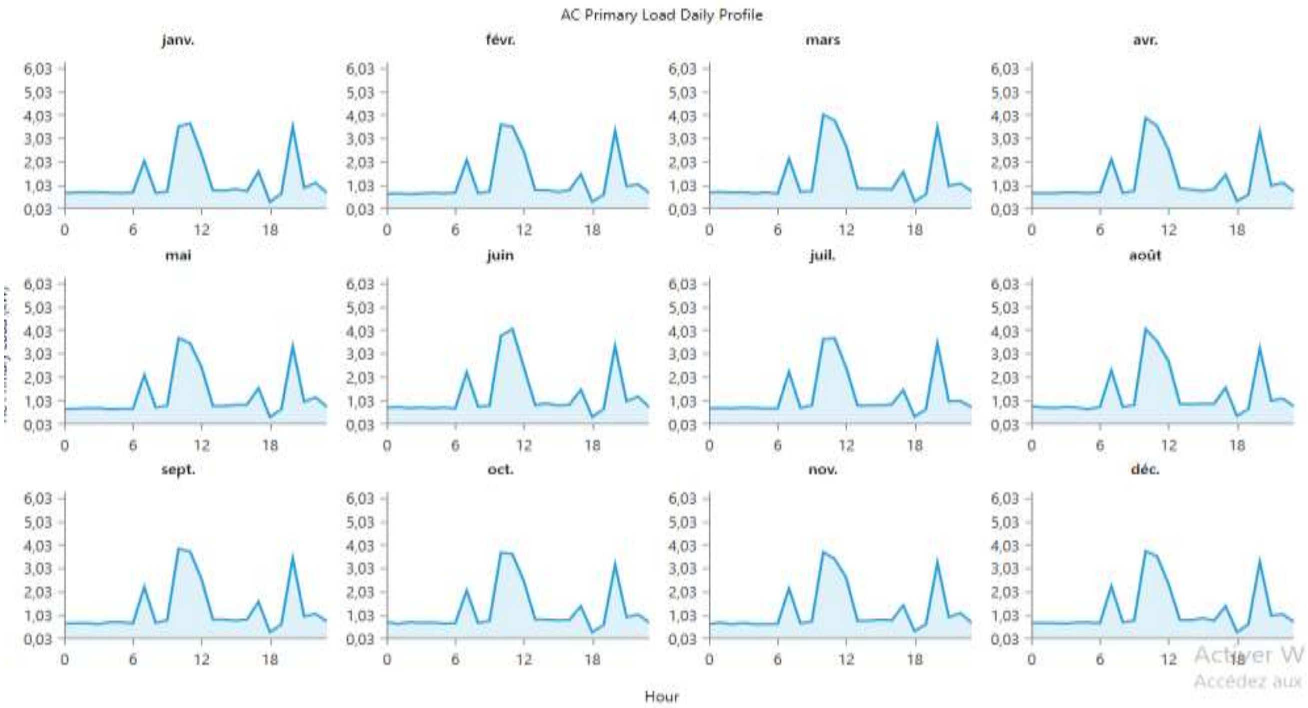
Battery kinetic model	
Name	Generic 1KWh Lead Acid
Maximum capacity	83 % Ah
Nominal capacity	1 kWh
Nominal voltage	12 V
Capacity ratio	0.403
Rate constant (1/hr)	0.827 1/yr
Roundtrip efficiencies	80 %
Maximum charge current	16.7 A
Maximum charge rate (A/Ah)	1 A/A
Life time	5 years
Capital initial	300,00DA

Table ♣ 5 Configuration of System Converter

System Converter	
Name	System converter
Life time	15 years
Capacity Factor	19,1%
Capital Initial	300,00 DA

Table ♣ 6 Configuration of Diesel generator

Generic 10KW	
Name	Generic 10 KW Fixed Capacity Genset
Fuel	Diesel
Fuel curve intercpt	0,480 L/hr
Fuel curve slope	0,286 L/hr/KW
Electrical Bus	AC
Capacity	10 KW
Minimum Load Ratio	25,00%
Life Time	15 000,00



♣ **Figure- 1 AC Primary load Daily Profile In the BOUR AL AICHA area**

Abstract

Due to the expansion of the area of the state of Ouargla, where there are many regions and municipalities isolated from the city This makes the cost of connecting to the electrical network very high. Currently, most of the technology The electricity commonly used in isolated areas is diesel generators. The Ouargla region in southern Algeria presents excellent potential for wind and photovoltaic energy. Based on this data, we combined diesel generators into a single hybrid system consisting of (PV panels, wind generators and diesel generators) with storage batteries. We ran it and designed it in an off grid house in Bour El Aisha in Ouargla (Algeria) using the HOMER® program and the results were very impressive in economic and environmental terms, thus we achieved the desired goal of clean and economical production.

Keywords: renewable energies, wind energy, photovoltaic energy, hybrid systems, isolated networks, modeling,

Résumé

En raison de l'expansion de la zone de l'état de Ouargla, où se trouvent de nombreuses régions et communes isolées de la ville Cela rend le coût de raccordement au réseau électrique très élevé. Actuellement, la plupart des technologies L'électricité couramment utilisée dans les zones isolées est constituée de générateurs diesel. La région de Ouargla au sud de l'Algérie présente un excellent potentiel en énergie éolienne et photovoltaïque. Sur la base de ces données, nous avons combiné des générateurs diesel en un seul système hybride composé de (panneaux photovoltaïques, éoliennes et générateurs diesel) avec des batteries de stockage. Nous l'avons exécuté et conçu dans une maison hors réseau à Bour El Aisha à Ouargla (Algérie) en utilisant le programme HOMER® et les résultats ont été très impressionnants d'un point de vue économique et environnemental, ainsi nous avons atteint l'objectif souhaité de propreté et d'économie. production.

Mots clés : énergies renouvelables, énergie éolienne, énergie photovoltaïque, systèmes hybrides, réseaux isolés, modélisation

الملخص

نظرا لاتساع مساحة ولاية ورقلة . حيث هناك العديد من مناطق والبلديات المعزولة عن المدينة وهذا ما يجعل تكلفة التوصيل بالشبكة الكهربائية عالية جدا. حاليا ، من أكثر تقنيات الكهرباء استخداما المناطق المعزولة هي مولدات الديزل . وتمثل منطقة ورقلة في جنوب الجزائر إمكانات ممتازة لطاقة الرياح والطاقة الكهروضوئية. بناءً على هذه البيانات ، قمنا بدمج مولدات الديزل في نظام هجين واحد يتكون من (الألواح الكهروضوئية ومولدات الرياح ومولدات الديزل) مع بطاريات التخزين. وقمنا بتشغيله وصممناه في منزل خارج الشبكة في منطقة بور الهيشة في ورقلة (الجزائر) ®HOMER وكانت النتائج جيدة جدا من الناحية الاقتصادية والبيئية باستخدام برنامج وبالتالي يمكننا القول اننا حققنا الهدف المنشود في انتاج اقتصادي ونضيف للطاقة الكهربائية بالنسبة للمناطق المعزول

الكلمات المفتاحية: الطاقات المتجددة ، طاقة الرياح ، الطاقة الكهروضوئية ، الأنظمة الهجينة ، الشبكات المعزولة ، النمذجة ،