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**Brief submitted for obtaining
Academic Master's degree**

Study and sizing of grid connected PV system using hybrid on grid inverter: application electricity and gas distribution company of M’sila

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بسم الله الرحمن الرحيم

Thanx

*First of all, we thank "**ALLAH**" Almighty who gave us the courage, the will and strength to accomplish this modest work.*

Thank you for enlightening us on the path to success, reaching our purpose and achieving.

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Dedication

At the end of this modest work, I dedicate this work:

To my little family BAADJI

In the first place I dedicate this work to my dear onespeople in the world to my heart in life, my parents in tribute to their sacrifices.

My lovely father

My father who supported me tirelessly and gave me the strength and the will to doeffort and never give up. I have had deep respect for your love, support, patience, understanding and the comfort you have given me.Unfortunately, you did not live this important day in my life, which you waited for so long. May God have mercy on you.

My dear mother

To the one who always accompanies me with these prayers, who supported me morally incourse of my studies and difficult times, thanks to whom I was able to brave manypitfalls and get to where I am now. This work I dedicate to you.

Mama, May god keep you and give you health, long life and so much happiness.

My brothers "Cherif, Hamza, Taki, Abd raaouf,Khayrou"** and **my sister"Samia" (the wife of my brother)

Those who supported me tirelessly and gave me the strength and the will to do

effort and never give up. Thank you for your help, your listening and your advice when themorale was at an all-time low,May God keep and protect you and inshallah may your path be full of success.

*And in the end, I would like to say I love you, my little ones, "**Safa** and **Khadidja**" (my nieces) because they are my happiness in this world.*

Wafa

Dedication

To the owner of fragrant biography and enlightened thought; my dear father* ***"Abderrazek"

Who got the first credit for my graduate studies

God prolong your age.

***To the one who put me on the path of life,*

Who took care of me, the source of my strength

***"my dear mother"**.*

***To my brothers Nadjib, Adel and my little brother AbdelAziz; Which had a great impact on many obstacles and difficulties. Pray to God to protect you and grant you success in your life*

***And to all my honorable teachers; Who did not hesitate to reach out to me*

I dedicate this research to you.

siham.

Summary

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list of symbols

Symbol	Designation	Unit
ΔU	The voltage drop between the panels and the other elements	V
P	The resistivity of copper	Ω.m
Impp	The current produced by the PV generator	A
L	Length of the electric cable	M
E	The maximum voltage drop	
S	The section of the cable used	mm^2
U_{sys}	The nominal voltage of the photovoltaic field (system).	V
P_i	The total power for the receivers (connected in parallel)	W
I_s	The allowable intensity of the output current of the regulator	V
N_p	Number of modules connected in parallel	
N_{bs}	Number of batteries in series	
N_{btotal}	The total number of batteries.	
C_{bat}	The capacity of a battery	Ah
C_{sys}	The storage capacity of the system	Ah
A	The number of days of autonomy.	
E_P	Energy produced	
Ec	The energy consumed per day	(Wh/d)
U_{CPV}	The voltage of the PV array	V
ir	irradiation average irradiation of country of installation	WC
N	The number of panels	

Abreviations list

Symbol	Designation
DOD	Maximum discharge of batteries we can call italso PDD (depth of discharge).
DC	Directcurrent
AC	Alternatingcurrent
PV	Photovoltaïque
MPPT	Maximum Power Point Tracking
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	AmbientTemperature
GlobInc	Globalincidentincoll plane
GlobEff	EffectiveGlobal,corr forIAMandshadings
EArray	Effectiveenergyattheoutputofthearray
E_Grid	Energyinjectedintogrid
PR	PerformanceRatio
N/A	Not available/Not applicable

General introduction

Energy in all its forms is of great importance in our daily lives as it is a necessary form of lifefor all living things. On the other hand, it is considered the main engine for economic developmentand technological progress in all countries of the world, as electric energy comes at the forefront ofthese energies as a result of its ease of transportation, conversion and storage.

Electric energy has radically changed human life in all aspects, especially economic andsocial, and with technological progress and the emergence of the industrial revolution, electricenergy consumption has increased and doubled in recent years, especially in industrialized countries [1].

Coal, oil and natural gas, which are known as traditional sources or fossil fuel sources, are themain sources of electrical energy generation in the world as a whole since many years. Theavailability of electrical energy has led to an improvement in the standard of living of people, anincrease in population growth, and economic and social prosperity. On the other hand, as a result ofthe increase in human activity through the increasing consumption of electrical energy, thisnegatively affected the environmental and health aspects, which led to an environmental imbalance,and a high level of carbon dioxide, methane and some other gases in the atmosphere, which causedthe phenomenon of global warming. In addition to these disadvantages, the total dependence onfossil fuel resources throughout these decades has led to decrease in their reserves and depletion [1].

Therefore, in order to address such challenges and find more applicable solutions, it is represented in moving to more sustainable sources of renewable energy, as the latter includes wind energy, thermal energy, solar energy (that will be studied in this project).

Algeria has high qualifications to generate electric power from renewable energy sources, includingphotovoltaic energy, as it has one of the largest solar energy fields in the world, with a sunshineperiod estimated at about 3000 an hour per year. That is why Algerian government has adopted astrategy to exploit these potentials by establishing the Algerian Renewable Energies Company tofollow up on the completion of the 1000 megawatt solar project. Several projects are currentlybeing programmed at the national level, consisting in equipping schools and national institutionswith photovoltaic energy stations in capacity between 6 to 25 kilowatts to feed part of theirequipment, reduce the consumption bill and introduce these environmentally friendly systems [2].

A large part of the global demand for electrical energy is met by photovoltaic (PV) energy, as PV modules are used to generate electricity by converting solar radiation falling on their surface intoelectrical energy. However, PV energy faces challenges in terms of the electrical power generated from it, which responds to changes in weather conditions, which may result in a mismatch betweenthe total power generated with the instantaneous load requirements.

Therefore, to meet the load requirements at all times across any PV plant with high efficiency andreliable performance throughout the life of the system and with minimal investment, componentsmust be optimally selected and their size optimized, ensuring maximum output power and good performance.

The realization of PV installations requires a method of calculation and dimensioning of high precision. So the sizing is based on the different technical characteristics of the systems constituting the PV installation (The PV source, the batteries, converters, wires....) on the one hand and the useful sizing methods on the other hand. In this context, the objective of our work is to simulate the PV power plant installed in the electricity and gas distribution company of M'sila by PVsyst software, in addition to analyze and to evaluate the performance of the PV system through several aspects.

The thesis is organized as follows:

- The first chapter containsaSolar energy systems, and we studied the principle of solar panels to generate electricity, and we also learned about the types of these panels.

In addition, we introduced the photovoltaic system and its classifications, at the end, we talked about the basic elements of the photovoltaic system, including batteries, inverter, regulator...

- The second chapter presents the study of our grid-connected solar system located in the electricity and gas distribution company of M'sila through the PVsyst program.
- The third chapter we sizing our system (computation without PVsyst software), the display of the PVsyst program's results and their discussion (analysis) such as losses, energy produced by the system performance report, and so on.
- As for the last chapter, it contains a comparison between the study result obtained from the simulationwithinstalled project in the electricity and gas distribution company of M'sila.

This work endes with a general conclusion.

Chapter I:

Solar energy systems

I.1. Introduction

Renewable energy is defined as any energy that is produced naturally and is sustainable. It is also known as clean energy because it does not pollute the environment and is inexhaustible because it is available in nature in unlimited and sometimes limited quantities. These include geothermal energy, watershed energy, wind energy, wave energy, and solar energy, Figure (I.1). Tidal energy, burning household and agricultural waste are also categorized by scientists as renewable energy.

Solar energy is the main source of energy on the surface of the earth, as studies indicate that the amount of solar energy that falls on the surface of our planet can provide us with our energy requirements, only if advanced technologies found to harvest and exploit it appropriately. The amount of solar energy sent towards the surface of the earth's crust is estimated between 15750 EJ to 49837 EJ, equivalent to 4375-13843 PWh per year, and the amount of energy received per square meter of the Earth's atmosphere is about 342 W/m^2, but the amount of available energy, which passes through the atmosphere, does not exceed 70%, or 239 W/m^2, and the rest (30%) is reflected to spread back through space. Unfortunately, this huge amount of energy is not fully exploited, both by humans, or because it is an intermittent resource that is controlled by many factors like changes in weather conditions that prevent the arrival of solar radiation, in addition to the rotation of the earth.

Currently, there are many studies and researches that deal with finding technologies to convert solar energy into other forms of energy, most notably electrical and thermal energy through photovoltaic and solar thermal technology respectively.

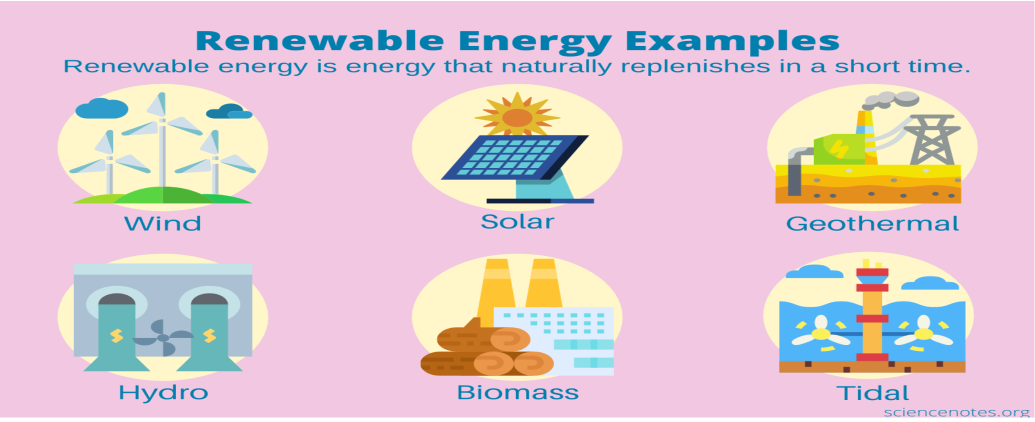


Figure I.1: Renewable energy sources.

I.2. Solar energy

Solar energy is an energy source that is dependent on the sun. This means that the raw material is the sun. It is placed in the category of renewable energies since it is considered inexhaustible. It is also said to be 100% green energy because its production emits little CO2.

Thanks to this energy, it is possible to produce electricity. It will be captured by solar panels or thermal power stations. These installations capture the rays produced by the sun. They then convert the sun's energy into electricity or heat[3].

I.2.1. What are the main pros and cons of solar energy?

The employ solar energy as an electrical or thermal energy source has much pros, we mention the following [3]:

- RenewableEnergy Source
- Reduces Electricity Bills: Since you will be meeting some of your energy needs with the electricity your solar system has generated, your energy bills will drop
- Diverse Applications: Solar energy can be used for diverse purposes. You can generate electricity (photovoltaics) or heat (solar thermal). Solar energy can be used to produce electricity in areas without access to the energy grid, to distil water in regions with limited clean water supplies and to power satellites in space
- Low Maintenance Costs : Solar energy systems generally don't require a lot of maintenance
- Technology Development : Technology in the solar power industry is constantly advancing and improvements will intensify in the future

Despite the advantages of solar energy, there are some disadvantages too. For example [4]:

- Cost: The initial cost of purchasing a solar system is fairly high
- Weather-Dependent: Although solar energy can still be collected during cloudy and rainy days, the efficiency of the solar system drops. Solar panels are dependent on sunlight to effectively gather solar energy
- Solar Energy Storage is expensive: Solar energy has to be used right away, or it can be stored in large batteries. These batteries, used in off-the-grid solar systems, can be charged during the day so that the energy is used at night. This is a good solution for using solar energy all day long but it is also quite expensive
- Uses a Lot of Space
- Associatedwith Pollution

I.2.2. The different forms of solar energy

There is not only one type of installation to produce your own solar energy. Here are the best known and most promising[3].

- Solar thermal energy, which produces heat.

- Photovoltaic solar energy, which produces electricity for individuals and professionals.

- Thermodynamic solar energy found mainly in large power plants.

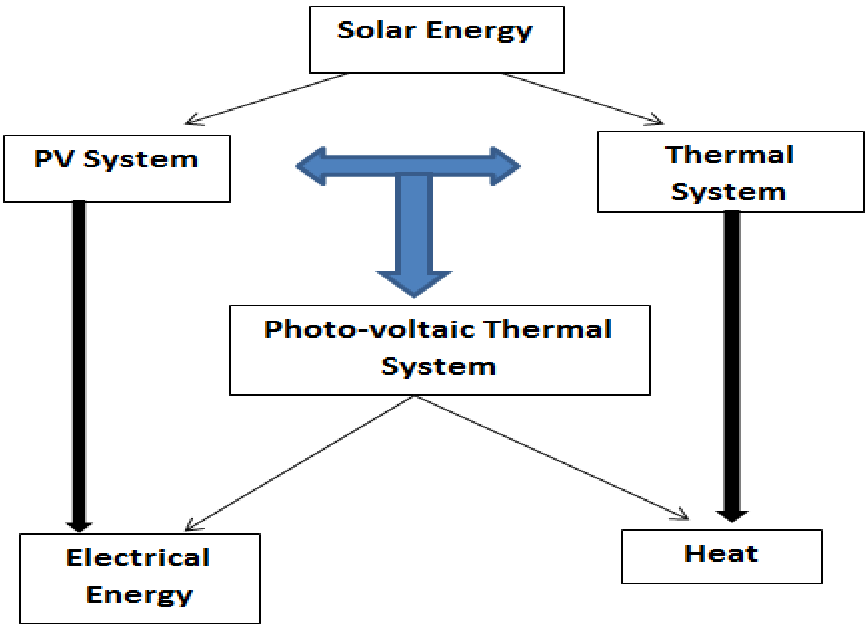


Figure I.2: Schematic-layout-of-various-forms -of-solar-energies.

I.2.3. What are the practical uses of solar energy?

Solar energy is a very useful and practical resource that is usually used to take advantage of its two main forms: heat and light. Solar energy can be harnessed in a number of ways.

We will discuss the applications of this energy and where and how we can use solar energy in our lives [3]:

- By building a dwelling in such a way as to directly recover sunlight to illuminate it, and heat to heat it.

- By using thermal sensors for heating a building or a water heater.

- By collecting sunlight and transforming it into electricity using solar panels.

- By converting the heat of the sun into electricity via photovoltaic power plants.

Solar energy is considered the source of the majority of renewable energy and fossil fuels.

FigureI.3: the practical uses of solar energy

Solar energy in its three categories is one of the most encouraging renewable sources to meet the future energy demand. In this study, we will address PV technology in several aspects.

I.3. Photovoltaic energy source

I.3.1. History of photovoltaics

Some important dates in the history of photovoltaics [5]:

1839: French physicist Edmond Becquerel discovered the process of using light from the sun generates electricity in solid materials. This is the Photovoltaic effect.

1875: Werner Von Siemens exhibits an article before the Berlin Academy of Sciences on the photovoltaic effect in semiconductors. But until World War II, the phenomenon still remains a laboratory curiosity.

1905: Albert Einstein wrote that light can enter the interior of the atom, and The collision between the photon and atom will cause the electron to their Rails and allow to generate current.

1912: Albert Einstein will be the first to explain the phenomenon of photovoltaic effect, And has therefore won the Nobel Prize in Physics in 1921.

1954: Three American researchers, Chapin, Pearson and Prince, develop a cell high-efficiency photovoltaics at a time when the nascent space industry is seeking new solutions to power its satellites.

1958: A cell with an efficiency of 9% is developed. The first satellites powered by solar cells are sent into space.

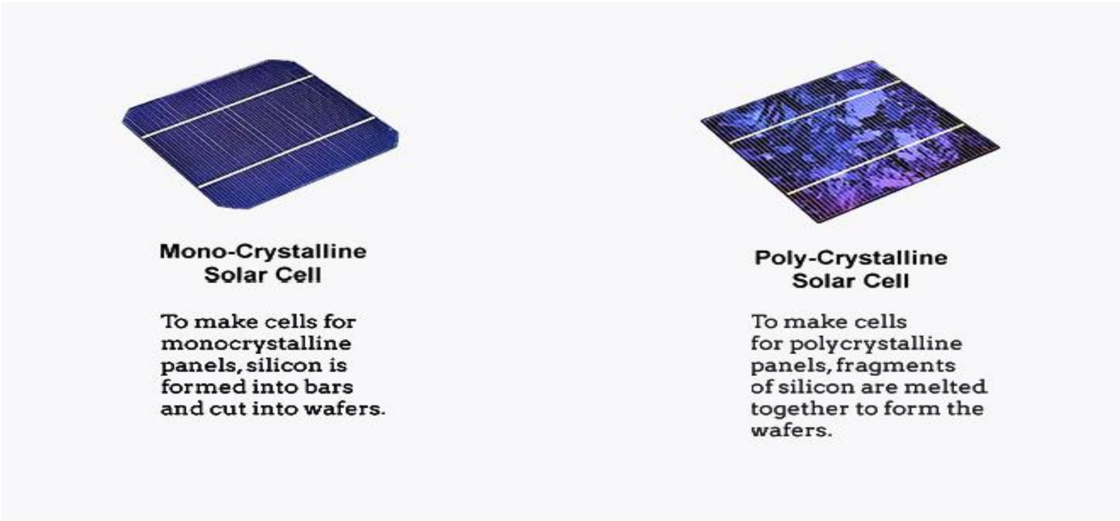
Photovoltaics gets its name from the process of converting light (photons) to electricity (voltage), which is called the photovoltaic effect. This phenomenon was first exploited in 1954 by scientists at Bell Laboratories who created a working solar cell made from silicon that generated an electric current when exposed to sunlight. Solar cells were soon being used to power space satellites and smaller items such as calculators and watches. Today, electricity from solar cells has become cost competitive in many regions and photovoltaic systems are being deployed at large scales to help power the electric grid[6].

1.4. The different types of photovoltaic cells

The cells are divided into three main families. They are produced from silicon, but the manufacturing methods give them very different properties, especially in terms of productivity:

I.4.1. Crystalline silicon cells

Silicon is derived from silica, one form of which is quartz, which is very abundant in sand. Silicon cells represent more than 95% of the market and the products trading companies have average returns of between 16.5% and 22%, depending on their technology. By cold treatment, silicon is formed of several crystals (polycrystalline). It is easy to produce and can achieve a yield rate of more than 22% in the laboratory. Molten silicon can be reconstituted into large crystals (monocrystalline) and the efficiency in the laboratory reaches 26.6% [7].



FigureI.4: Crystalline silicon cells

I.4.2. Thin layer cells

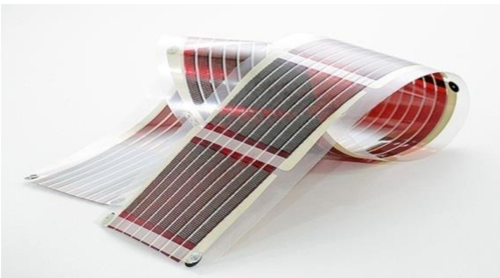
Instead of cutting the silicon into thin slices of about 200 microns, the materials semiconductors can be deposited in layers a few microns thick on a substrate, such as glass or plastic. Cadmium telluride or CIGS(copper/indium/gallium/selenium) can be used. Lab yields are close to those of silicon (respectively 22.1% and 23.3%). If the silicon is under

"amorphous" (non-crystalline) form, it can also be used in thin layers. It is a technique that small calculators have encountered for a long time, but with lower performance[7] .

FigureI.5: thin layer cells

I.4.3. Organic cells

Based on molecules or polymers derived from organic chemistry and no longer on mineral semiconductors like the previous ones, they begin to have apps. Their yields are low and the long-term stability is not adequate but these cells could have a very low production cost. There is also photosensitive pigment cell inspired by plant photosynthesis called dye cells [7].



FigureI.6: organic cells

The photovoltaic cell is made of a semiconductor material that absorbs energy light and converts it directly into electric current. The photovoltaic regime is a regime where no potential is applied, but current flows through a load. The system develops electrical power. The operating principle of the cell calls on the properties of radiation and those of semiconductors. The conversion of photons into electrons in a material capable of producing an electric current requires:

- Absorption of photons by the material (optical absorption) and the generation of carriersloads.
- Collection of excited carriers before they regain their initial energy (relaxation).

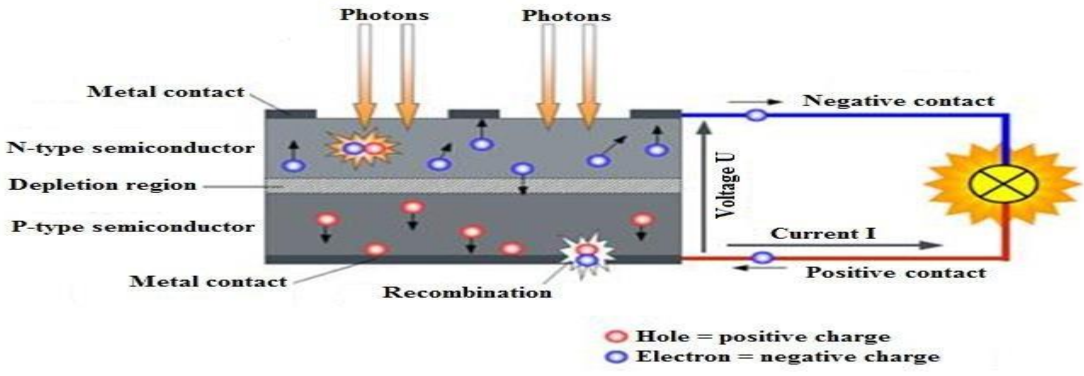
I.5. Solar Cell Working Principle

Sun's rays give off approximately 1,000 watts of energy per square meter of the planet's surface. If all of that energy can be collected, our homes and offices can be easily powered for free.

The solar cell works in several steps [8]:

- photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon.
- electrons and protons are excited from their current molecular% atomic orbital. Once excited an electron can either dissipate the energy as heat and return to its orbital or travel through the cell until it reaches an electrode.
- current flows through the material to cancel the potential and this electricity is captured. The chemical bonds of the material are vital for this process, and usually silicon is used in two layers, one layer being bonded with boron, the other phosphorus.
- these layers have different chemical electric charges and subsequently both drive and direct the current of electrons.
- An array of solar cells converts solar energy into a usable amount of direct current DC electricity.
- An inverter can convert the power to_alternating current

the most commonly known solar cell isconfigured as a large area p- n junction made from silicon.



FigureI.7: Solar Cell Working Principle

I.6. Photovoltaic module

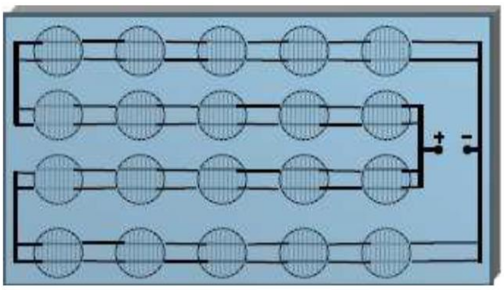
Photovoltaic module means a device used to convert light to electricity that includes an array of individual solar cells containing photosensitive material (such as silicon), wiring or circuitry that transports energy from the cells out of the module, and layers that protect the solar cells and wiring or circuitry from external stresses and the surrounding environment

* The voltage generated by a cell being very low, to have compatible voltages with loads to be supplied, it will be necessary to combine several cells in series-parallel,these are encapsulated in the same structure to form a module.

- The encapsulation thus produced will have two main roles:

1- Protection of the cells against external aggressions (shocks, humidity, etc...).

2- Cell temperature control which will allow good dissipation to the outside of the part of the incident energy which is not transformed into electrical energy.



FigureI.8:module in series array - parallel cells

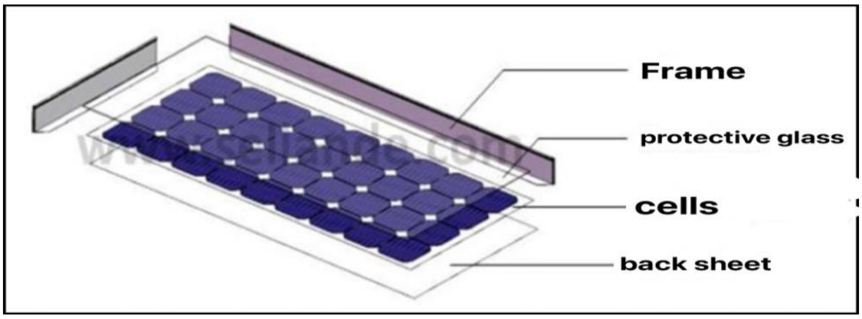


Figure I.9: Representation of a Photovoltaic Module

I.6.1. Characteristics of PV module

The choice of solar panel specifications differs according to your project, if your use is for a house, a factory, or a farm, each application has factors and requirements that must be carefully considered to make the right decision by choosing the specifications of the solar panels that are suitable for you, and these specifications areas follows**:**

• The peak power Pc: Maximum electrical power that the module can provide in standard conditions (25°C and an illumination of 1000 W/m²).

• The I/V characteristic: Curve representing the current I delivered by the module in function

voltage across it.

• No-load voltage Voc,: Voltage at the module terminals in the absence of any current, for a

"full sun" illumination.

• Short-circuit current Isc: Current delivered by a short-circuited module for a"full sun" illumination.

• Optimum operating point, (Um,Im): When the peak power is maximum in direct sunlight,

$P_m = U_m * I_m$

• Efficiency: Ratio of optimum electrical power to radiation power incident.

• Fill Factor: Ratio between the optimum power Pm and the maximum power that can have the cell: $V_{oc} * I_{sc}$.

I.7. Solar radiation

Solar radiation,often called the solar resource or just sunlight, is a general term for the electromagnetic radiation emitted by the sun. Solar radiation can be captured and turned into useful forms of energy, such as heat and electricity, using a variety of technologies. However, the technical feasibility and economical operation of these technologies at a specific location depends on the available solar resource[9].

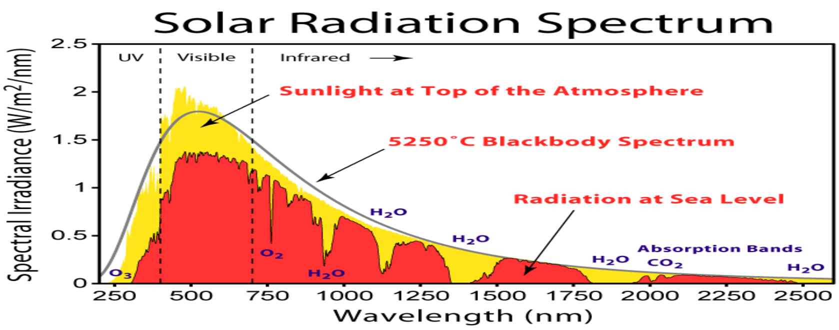


Figure I.10: The spectrum of solar radiation

The solar radiation incident on the PV panel is composed of three parts: direct radiation, diffuse radiation and reflected radiation by the Earth's surface (albedo),We explain it as follows[10]:

- **Direct radiation**: radiation which is not reflected or scattered and which reaches the Earth's surface directly.
- **diffuse radiation**: Radiation scattered in all directions of the atmosphere. A part arrives at the plane on the surface of the Earth (not directional).
- **Reflected radiation (Albedo):** Part of the radiation that strikes the earth and is reflected by the ground.
- **These three parts radiations as illustrated in theFigurebelow:**

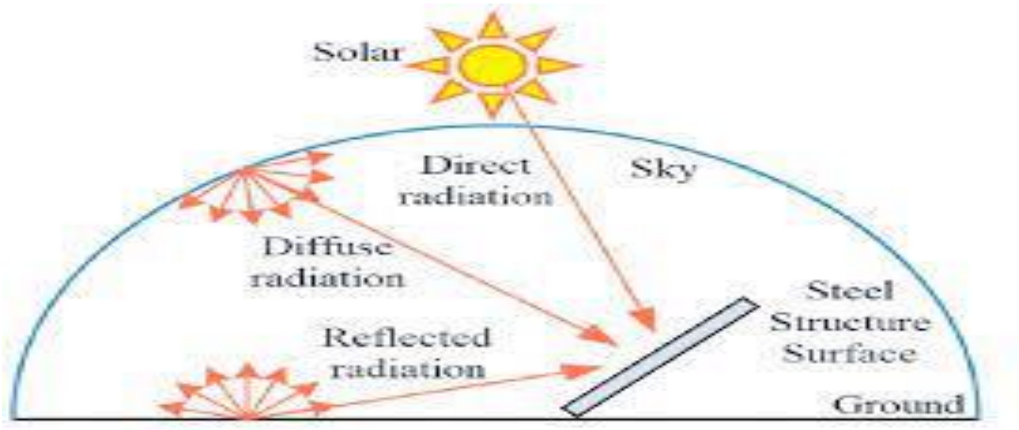


Figure I.11:Components of solar radiation on the ground

I.8.Influence of external parameters on the characteristics of the PV module

I.8.1.Influence of radiation on the characteristic I=f(V) and P=f(V)

Solar cells are affected by two main factors, namely the degree of radiation and temperature. Therefore, the tension produced is monitored according to the change in these two factors:

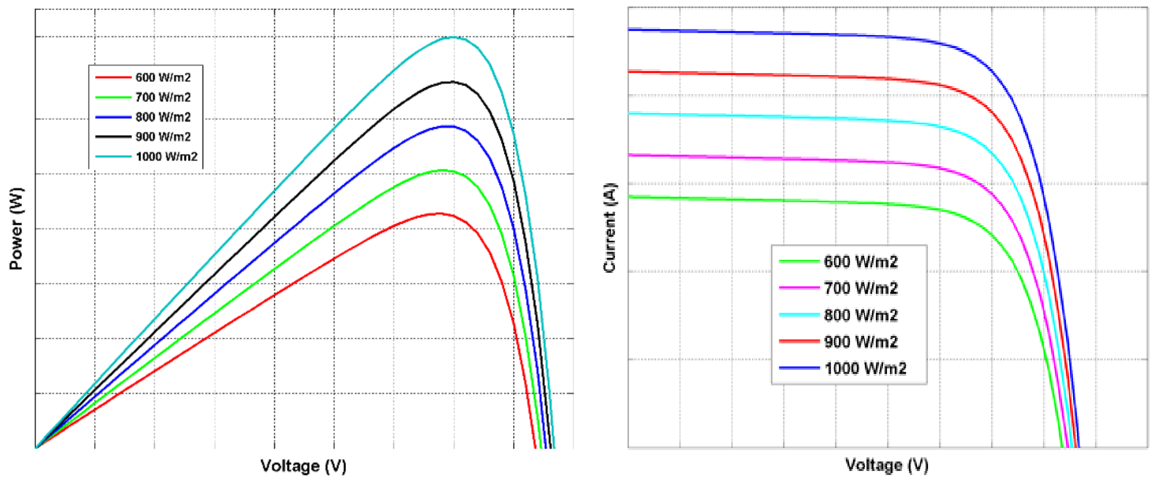


Figure I .12: Current-voltage and power-voltage characteristics of PV module under various irradiations

The electrical energy produced by a photovoltaic cell depends on the irradiation it receives on its surface[11].

* We note that the higher the degree of radiation, the higher the productivity of solar cells

I.8.2. Influence of temperature on the characteristic I=f(V) and P=f(V)

At constant temperature, the characteristic I = f(U) obviously strongly depends on the irradiation: on the following curve, we note that the short-circuit current increases with the irradiation G1>G2 while the no-load voltage varies little [12].

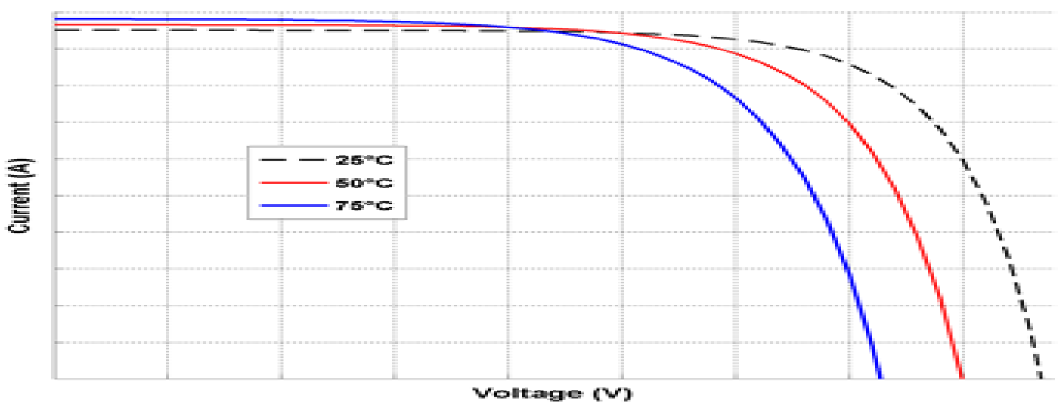
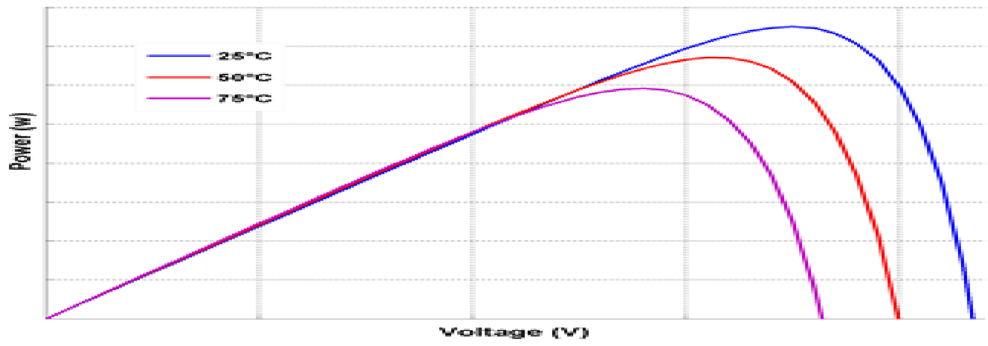


Figure I.13: Current-voltage characteristics of PV module under various temperatures

From the previous curve, we can plot the power curves P = f(U) for the 2 radiations. We no the open-circuit voltage and the maximum power decrease very slightly when the temperature increases [11].



FigureI.14: power-voltage characteristics of PV module under various temperatures

The open circuit voltage and the maximum power decrease very slightly when the temperature increases [11].

I.9. Photovoltaic systems

Photovoltaic systems (PV systems) are a renewable energy technology which transforms the energy from the sun into electricity using photovoltaics. This photovoltaics, also known as solar panels, provide a reliable green energy solution.

A solar PV system is a sustainable, low-maintenance option for anyone who wants to contribute to a greener environment, as the system does not cause any pollution or emissions.

Photovoltaic systems use photovoltaic cells to collect solar energy from the sunlight, and converts itinto direct current (DC) electricity. The reflection of the sunlight will create an electric field across photovoltaic systems, causing electricity to flow.

The DC electricity will be transported to an inverter, which will convert this DC power into alternating current (AC). This AC power is the type of electricity which is used for the electric appliances in your home, also referred to as AC load[13].

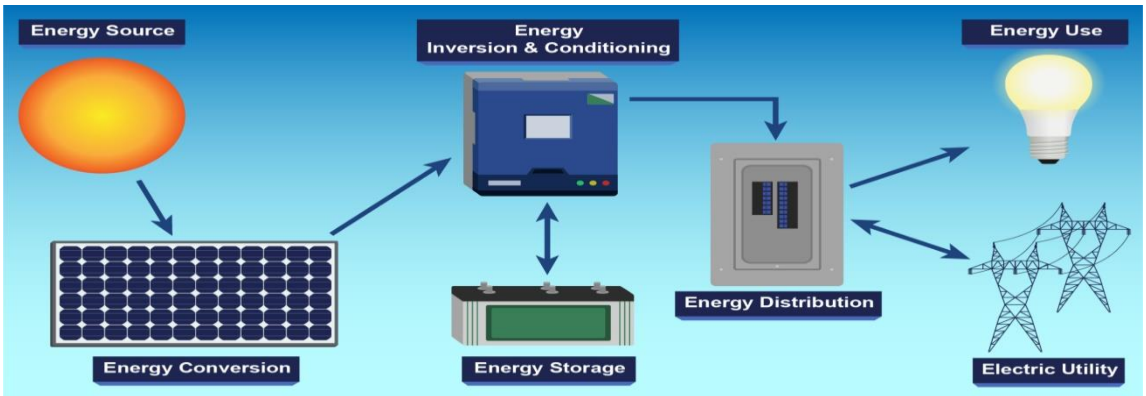


Figure I.15: photovoltaic system.

I.9.1. Classification of PV systems

Photovoltaic power systems are generally classified according to their functional and operational requirements, their componentconfigurations, and how the equipment is connected to other power sources and electrical loads. The two principal classifications are:

- Stand-alone PV systems (Off-grid)
- Grid connected systems (On-grid)

I.9.1.1.PV system Off-grid

Stand-alone systems rely on PV power only. These systems can comprise only PV modules and a load or can include batteries for energy storage.

The Stand-alone PV system is a photovoltaic system completely independent of other energy source and which supplies the user with electricity without being connected to the electricity network. In the majority of cases, a stand-alone system will require batteries or other means of storage for use during periods of unavailability of solar power (e.g. night periods, non-sunny periods, for example). Stand-alone PV systems serve usually to supply houses in isolated sites, islands, in the mountains as well as to applications such as remote monitoring and water pumping (in some cases).

Typically, stand-alone PV systems are installed where they are the source the most economical electrical energy. At present, it is in isolated places, far from a power grid and where power requirements are relatively low (typically less than 10kWp) that photovoltaic energy is the most competitive.

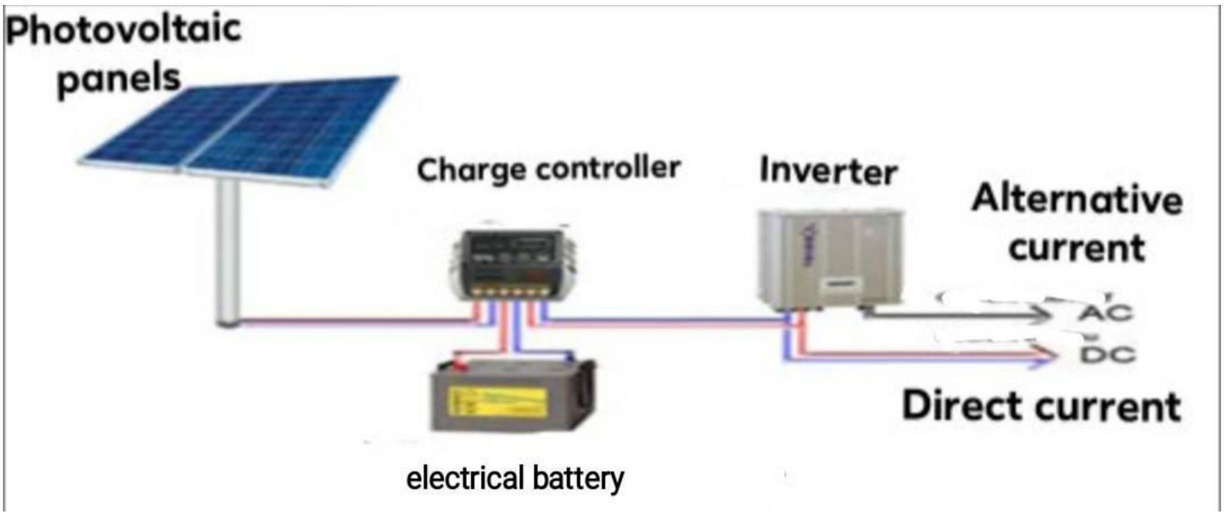


Figure I.16: Diagram of an autonomous system (off-grid)

I.9.1.1.1. Types of PV systems autonomous

Standalone solar systems are divided into two types are distinguished:

- Systems without storage
- Systems with storage

I.9.1.1.1.1. Systems without storage

They harness the energy directly solar without any back-up source. These systems are classified according to the nature of the load to be power, in two types direct current systems and alternating current systems. The application best known is photovoltaic pumping with its two types: current-driven PV pumping systems DC and AC systems. For the second case, an inverter must be added shows an example of a PV pumping system where the power conditioner can be, depending on function required, a DC/DC converter, a DC/AC converter or both at the same time. These systems are simple but their disadvantage is the power cut in the absence of the sun. These systems generally use another means of storage such as water tanks for PV pumping [14].

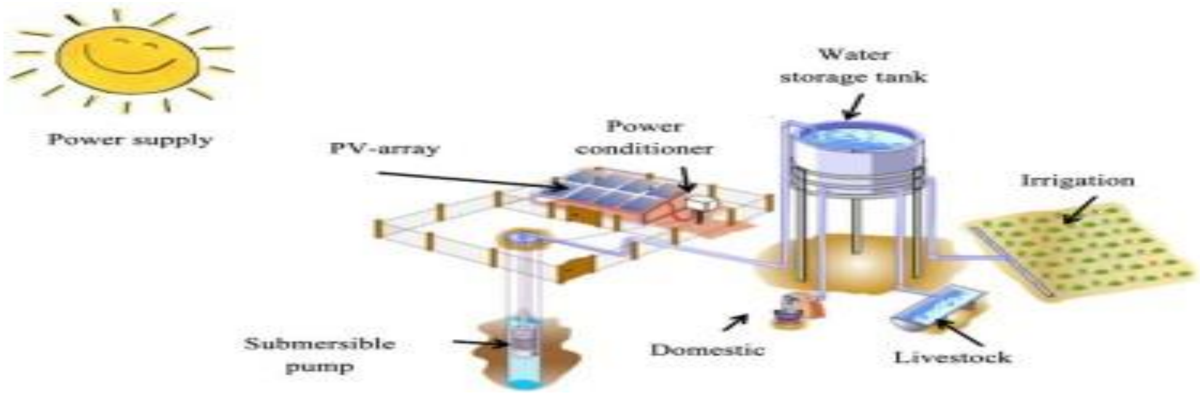


Figure I.17: PV Pumping System.

I.9.1.1.1.2. Systems with storage

Systems with storage are systems that contain means of storage. A storage system is used to supply the loads during periods with low solar radiation (passage of clouds) or a total absence of sunshine (at night). The storage system serves stored energy during the presence of excess photovoltaic energy and to restore it during other periods of energy deficiency. As an example, we can cite the food of the houses in electricity in isolated sites.

The storage system is a crucial element of the photovoltaic installationfrom a technical point of view, but also from an economic point of view because itrepresents 40 to 50% of the cost of the installation [15].

In a PV installation, storage corresponds to the conservation ofthe energy produced by the PV generator, waiting for later use.

The production of energy by PV systems is very fluctuating and dependsona lot of weather conditions. This is why it will be necessary to think ofstore this energy to restore it during the night and on 'sunless' daysandto better adapt the PV generator by fixing the system voltage [16].

I.9.1.1.1.2.1. Main characteristics of a battery

Energy storage in photovoltaic systems is generally powered by batteries.

A battery or accumulator is a device that stores energy electricity via a chemical reaction and which restores it in the form of current, to later use. Among the characteristics of the battery, we can quote [16]:

- **Nominal capacity**

This is the maximum amount of energy that a battery contains (under voltageideal of 25°C). It is expressed in Ampere hour (Ah).

The capacity is expressed in Ah or Wh and has different units depending onmeanings.

- **Capacity in Ah:** This is the amount of current that can be extracted indischarge during a given time interval and at a certain discharge rate.

- **Capacity in Wh:** it is also called energy capacity and representsthe energy that the battery can provide for a given time interval.It depends on the capacity in Ah, the operating voltage ofthe accumulator and the allowed depth of discharge.

- **Temperature**

The behavior of a battery is specified at a temperature of 27°C. Of the Lower temperatures reduce their capacity significantly. Of the higher temperatures produce a slight increase in their capacity,but this can increase water loss and decrease battery life [17].

The temperature variation influences the performance of the battery.It is therefore necessary to provide, if possible, thermal regulation to maintain its lifetime.

- **cycle and lifespan**

A battery may go through this many charge/discharge cycles before reaching its depth of drain. It determines the battery's lifespan and performance. Additionally, the accumulator has a total lifetime expressed in years (or cycles), regardless of the mode of use.

- **Depth of discharge**

The greatest amount of energy that can be extracted from a battery is this.

To extend its life, it should not be discharged above this value. For example,, if a battery with a full capacity of 100 Ah loses 25 Ah of capacity, its discharge rate is 25% and its charge rate is 75%.

- **Nominal voltage**

This is the typical battery voltage. It also corresponds to the voltage ofoperation of the autonomous system.

- **The efficiency in quantity of electricity and/or energy**

The efficiency in quantity of electricity is the ratio between the number of amperes hours provided by an accumulator and the time it takes to restore it to the state initial. This efficiency varies between 0.70 and 0.95 depending on the type of battery.

Energy efficiency is the ratio of the number of watt hours returned by the battery and the number of watt hours supplied to it. He is always lower than the yield in terms of quantity of electricity. This yield varies between 0.45 and 0.80.

- **Self-discharge rate**

Self-discharge is the loss of capacity by leaving the battery at rest (without load) for a given time.

- **Number of days of autonomy**

This is the time during which a battery can meet the needs of charging at all times, running the installation alone, without being recharged or damaged.

I.9.1.1.1.2.2. Operation and composition of a battery

Batteries work by converting chemical energy into electrical energy by electrochemical reaction. They are composed of one or several cells, each containing a positive electrode, an electrodenegative, a separator, and an electrolyte.

I.9.1.1.1.2.3. Types of accumulators

There are several types of storage in the PV system, the powers encountered are less than one MW, the only possible electrical energy storage is electrochemical storage. We summarize in Table I.1 the different types of batteries found on the market [15].

Table I.1: Type of battery currently on the market

Battery Type	Properties	Lowerpower (Wh/kg)	Cost
Lead –acid	Reliable, recyclable, Withmaintenance	35	Not tooexpensive
Lead-acidseal	Zero maintenance, used in any position	39	Not tooexpensive
Bipolar lead –acid	Fast charging allowed and especially sustainable	50	Veryexpensive
Nickel-Cadmium	Toxic, thesiseffect	45	Veryexpensive
Nickel –Iron	Non-toxic, durable	55	Veryexpensive
Nickel - Metal hydride	Non-toxic, durable	90	Veryexpensive
Zinc –Bromide	Analogous to the previous but very toxic	90	Veryexpensive
Sodium – sulfide	Operates at 300°C; from Wherefire hazard	110	Veryexpensive
Lithium-Ion(SAFT)	Safe, powerful, shapesvarious	150	Veryexpensive
Gel	It does not require regular maintenance, It has a long Lifedue to its ability to transfer heat to the outside	32	Not tooexpensive

Type of battery used

The two main types of accumulators currently used in thephotovoltaic system are lead-acid batteries and Nickel-Cadmium accumulators [15,18].

Due to its widespread availability and relatively inexpensive price, lead-acid batteries are the kind of energy storage that are employed the most frequently in electric vehicles.

Batteries made of nickel-cadmium, which are more costly, are utilised in applications where dependability is crucial. As a result, in this study,we use gel batteries.

I.9.1.2. Grid connected PV systems (On-grid)

A grid-connected photovoltaic power system is connected with the state electric grid and do not require batteries. The system operates to supplement the grid power during the daytime when a substantial quantum of solar energy is extracted from the sunlight. During night the grid power alone feeds the load. This system also supplies emergency power during any short period of grid failure as shown in Figure (1.18) This system requires additional equipment to control voltage, Frequency and waveform so as to conform to conditions for feeding the power into the grid[19].

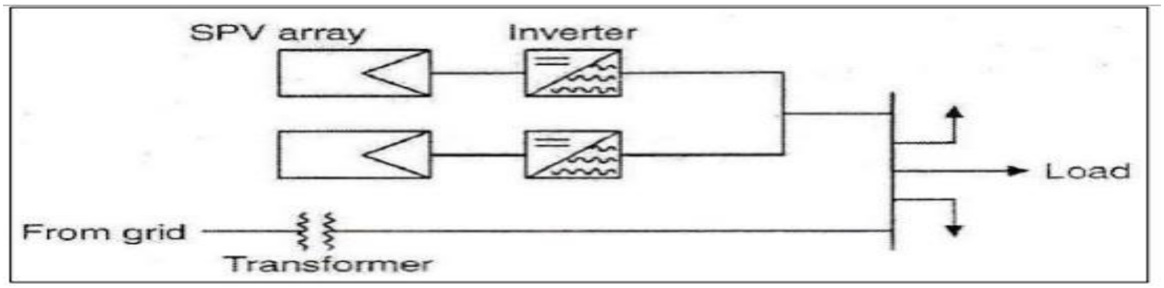


Figure I.18: grid-connected systems.

I.10. Regulation system

In practice, control systems are elements of a systemphotovoltaics which aim to carefully control the charge and thedeep discharge of a battery to maximize battery life and optimize the transfer of energy from the PV field to the use [20].

The main role of a regulator is to reduce the current when the batteries almost fully charged. When a battery approaches a state offully charged, small bubbles begin to form on the electrodes. Charge not only to avoid damage but also to better achieve the state of full charge. Too high current may cause deformationelectrodes inside, could create a short circuit.

The voltage at the battery terminals is the indication to which the regulator to perform its function. The controller continuously measures thisvoltage and compares it to two preset voltage thresholds: high threshold and low threshold[20].

There are several types of regulators:

- discharge regulator
- charge regulator:

-Series type regulator

-Parallel type regulator (shunt)

-The MPPT controller(in our work method MPPT controller).

I.10.1. The MPPT controller

MPPT, in English Maximum Power Point Tracking is a law of specific command allows to follow, as its name suggests, the point of maximum power of a nonlinear electric generator, in our case a photovoltaic generator [21].

MPPT regulators have advanced technology that researches permanently the maximum power point. This is based on the variation of the duty cycle α of the signal controlling the converterof energy, at an adequate value so as to maximize the power at the output of the module [22].

They optimise battery charging and increase battery life in addition to giving a building an energy boost. Regulators MPPT search for the maximum power output point by scanning the panel voltage. They may adjust the voltage from the panel to make it compatible with the voltage the battery can accept.

The MPP varies with changing conditions such as levelsillumination and temperature. To permanently shoot from the fieldphotovoltaic its maximum power, it is essential to always operate atMPP. (FigureI.20) represents a typical elementary chain of conversionphotovoltaic associated with an MPPT control providing powerelectrical to a DC load [21].

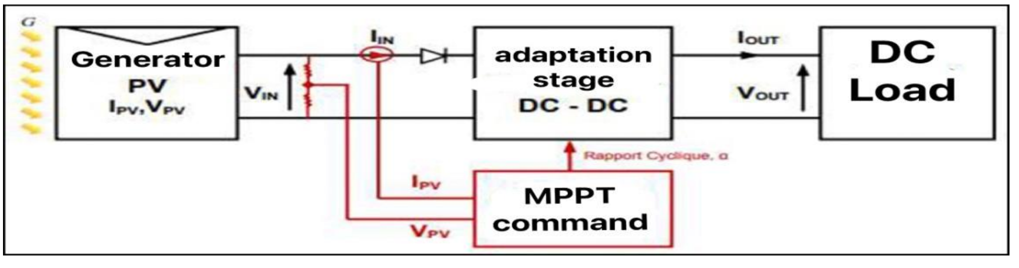


Figure I.19: Diagram of an elementary associated photovoltaic conversion chainto an MPPT command

I.11. Conversion system

An energy conversion system is an equipment of devices tosemi-conductors electronic component capable of modifying the shape and/or thefrequency of an electric wave, which is generally inserted either between the fieldPV and load (without storage with continuous load, it will be calledDC/DC converter), or between the battery and the load (it will then becalled inverter AC/DC) [16].

The power conversion can contain both stages, a first DC/DC conversion then a DC/AC.

I.11.1. DC-DC converters (choppers)

It can happen that in a PV system, the output voltage of the field or of the battery is lower or higher than that of the use, which must be powered continuously. It is therefore necessary for this system, a DC-DC converter [23].

The choppers are converters of the continuous-continuous type transforms a DC voltage of its input into a lower DC output voltage or higher than that of the entrance depending on the structure, it can be step-down or step-up Of voltage. It is used to control the power supply signal of the load and the stabilize with high efficiency [23,24].

1.11.1.1. Types of DC-DC converters

DC-DC converters (or choppers) are used in systems of solar energy to adapt the continuous source with variable amplitude (panel PV) to the load which generally requires a constant DC voltage. The threebasic configurations are: [26,25]:

- boost converter (parallel) converter;

- buck converter (series);

- buck-boost chopper converter (series – parallel).

1.11.2. Inverter

The conversion of electrical energy from the continuous form (DC) to the alternating form (AC) is ensured by an inverter, a static converter. In actuality, semiconductors are used as a control device to fulfil this energy conversion.

A three-phase inverter is made up of three switching cells that may recreate a three-phase system of voltages and currents by having their orders offset by a third of a period from one anotherin our work we will use a inverter two-level.

1.12. Topology of a classic two-level inverter

This topology, which is characterized by a wide range of power levels.As an application, it is used to compensate reactive power. To improve the production quality, switches are controlled by width modulation (PWM) and switching losses are reduced to a lower level. Figure (I.20) below shows atwo-levelphase [27].

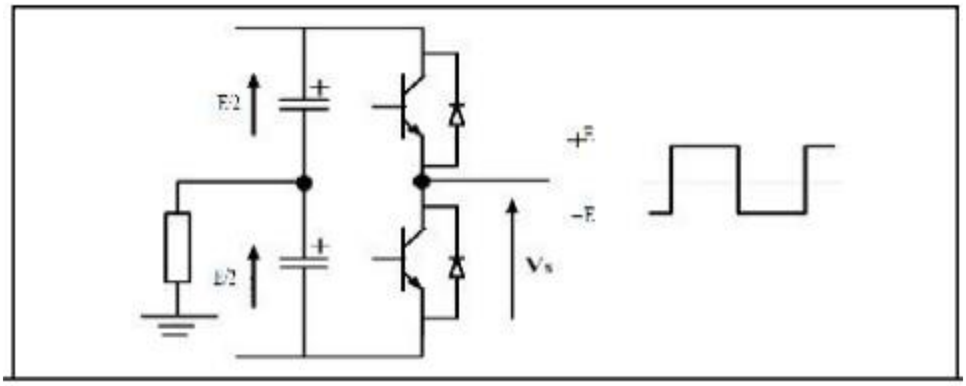


Figure I.17: One phase of a two-level converter

I.13. Conclusion

Renewable energies represent a good sustainable source of production of electricity, especially solar energy which is always available, pure and clean without forgetting that it is also the source of other renewable energies.

In this chapter we talked about the solar energy systemsof system (inverter, converter(chopper),battery...) also we described the hybrid system,The MPPT controller,Topology of a classic two-level inverter,the different types of photovoltaic cells.

Chapter II:

Study of the solar energy by PVsyst software

II.1.Introduction

In general, there are two methods for sizing the components of PV systems; The first is done in a mathematical way using formulas, while the second, which is the most widespread, is done using software tools that give optimal system sizing, highest efficiency with ensuring the generation of energy to feed the load during the entire year.

Numerous sizing software tools for PV systems have been documented, including

Sketchup, Helioscope, Homer and PVsyst.

In our study, we will use the PVsyst software.

The PVsyst is a software very precise used to evaluate and simulate various solar systems. He includes multiple processes and mockups that deliver cost-effective reports withadvice for increasing projects. It makes it possible to provide reliable information from the sitesgeographies of the study area.

so In this chapter, we will focus on the study and description of the different steps of sizing solar energy systems connected to the grid,precisely our solar system at the company of Distribution of gaz and electricity in M’sila, This is done through the PVsyst program, which measures the photovoltaic dimensions and gives an estimate of the system's energy and storage capacity, based on very general criteria and onsolar energy in monthly values. This is why PVsyst proposals are precise compared to other studies and analyzes.

II.2. Presentationof PVsyst simulation software

PV syst is a software for research, simulation and sizing of solar panels on photovoltaic systems that provides various information such as energy production, solar radiation, installation cost, required area or production of annual energy. More information for a very complete study.

PVsyst 7.3 is a PC software package for the study, sizing and data analysis of complete PV systems.

It deals with grid-connected, stand-alone, pumping and DC-grid (public transportation) PV systems, and includes extensive meteo and PV systems components databases, as well as general solar energy tools.

This software is geared to the needs of architects, engineers, researchers. It is also very helpful for educational training[28].

Figure II.1: Basic information about our project completed on the PVsyst.

II.2.1. ThePVsyst software allows you to

- Pre-sizing

- Quick estimate of production for a first study of your installations

- Project design

- Detailed study, sizing and hourly simulation, results in a reportcomplete printable.

- Weather data (import from various sources, synthetic generation,…).

- Component database (PV module, inverter, batteries, etc...)

-didactic tools, (solar geometry, optimization of orientation, behaviorelectricity ofPV arrays with shading).

-real measured data analysis (advanced)[29].

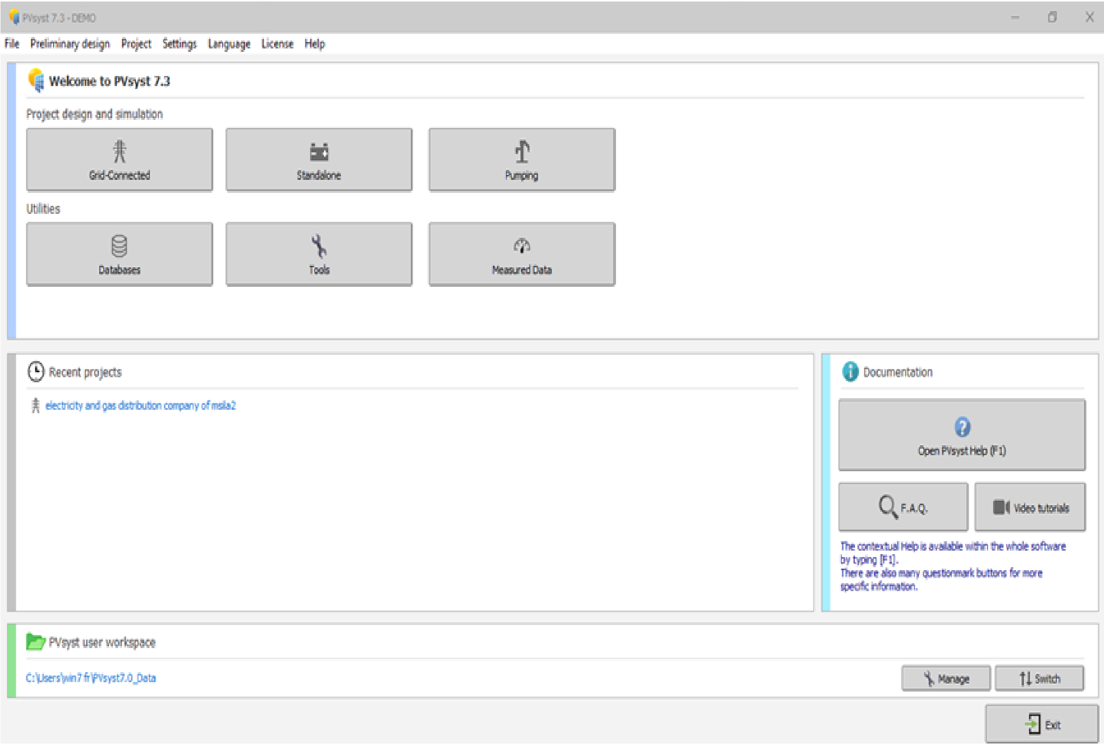


Figure II.2: PVsyst software

II.2.2. PVsyst Software Options

There are four (04) options characterize the PVsyst software: pre-sizing, Design of the Project, Databases, Tools[30].

II.2. 2.1. pre-sizing

Pre-sizing step of a project. In this mode the system efficiency evaluations are performed very quickly in monthly values, using only a very few general system characteristics or parameters, without specifying actual system components. A rough estimation of the system cost is also available**.**

For grid-connected systems, and especially for building integration: this level will be architect-oriented, requiring information on available area, PV technology (colors, transparency, etc), power required or desired investment.

For stand-alone systems:this tool allows to size the required PV power and battery capacity, given the load profile and the probability that the user will not be satisfied (("Loss of Load probability, or equivalently the desired "solar fraction").

For Pumping systems, given water requirements and a depth for pumping, and specifying some general technical options, this tool evaluates the pump power and PV array size needed. As for stand-alone systems, this sizing may be performed according to a specified probability that the water needs are not met over the year

II.2.2.2. Project design

Thorough system design using detailed hourly simulations.

Within the framework of a "project", the user can perform different system simulation runs and compare them. He has to define the plane orientation (with the possibility of tracking planes or shed mounting), and to choose the specific system components. He is assisted in designing the PV array (number of PV modules in series and parallel), given a chosen inverter model, battery pack or pump.

- In a second step, the user can specify more detailed parameters and analyze fine effects like thermal behavior, wiring, module quality, mismatch and incidence angle losses, horizon (far shading), or partial shadings of near objects on the array, and so on.

- Results include several dozens of simulation variables, which may be displayed in monthly, daily or hourly values, and even transferred to other software. The "Loss Diagram" is particularly useful for identifying the weaknesses of the system design. An engineer report may be printed for each simulation run, including all parameters used for the simulation, and the main results.

- A detailed economic evaluation can be performed using real component prices, any additional costs and investment conditions.

- **Grid-connected systems :**

System linked to the grid, by default the grid works as an unlimited consumer.

Add load profiles of self-consumption and grid storage to handle self-consumption, peak shaving or weak islanding. The addition of MV and HV transformers and grid limitation lets you manage your system up to the injection point.

- **Stand-alonesystems :**

Off-grid systems, defined primarily by the user's needs.

- **Pumping systems :**

Off-grid pumping systems, defined by the user's needs in water

II.2.2.3. Database

- **Meteo Databases :**

Creation and management of geographical sites, generation of synthetic hourly data file, visualization of hourly meteorological data, comparison of meteo data, import of meteorological data from several predefined sources or from custom files.

- **Component Databases :**

Database management of manufacturers and PV components, including PV modules, Inverters, Regulators, Generators, Pumps, etc...

II.2.2.4. Tools

Contains a set of tools to display tables and graphs of meteo data or solar geometry parameters, irradiation under a clear day model, PV-array behavior under partial shadings or module mismatch, optimizing tools for orientation or voltage, etc

II.3. Project presentation

In our project, we presented a PV installation injected into the network forsupply the gas and electricity distribution company of M’sila, simulated by the PVsyst software.

II.4. The site

we obtained the geographical and meteorological coordinates of the gas and electricity distribution company of M’sila with google maps

II.4.1. Google Maps

is a web mapping platform and consumer application offered by Google. It offers satellite imagery, aerial photography, street maps, 360° interactive panoramicviews of streets (Street View), real-time traffic conditions, and route planning for traveling by foot, car, bike, air (in beta) and public transportation[31].

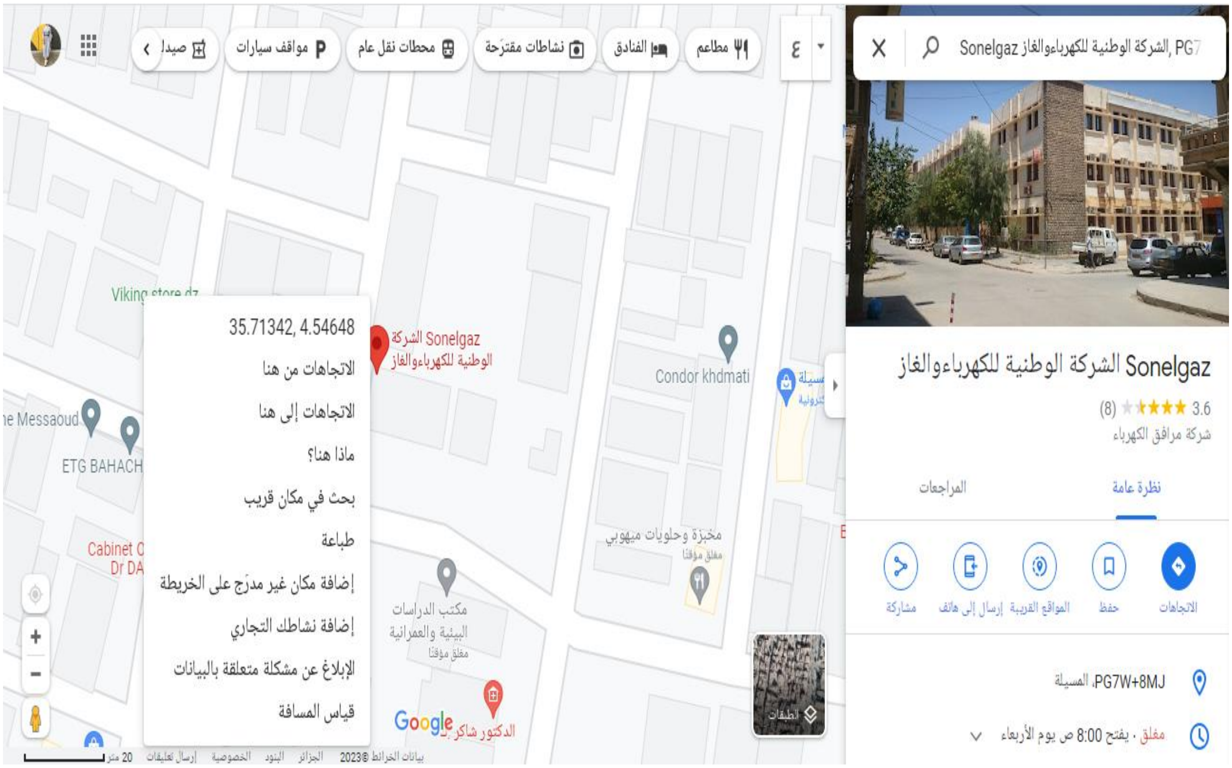


Figure II.3: geographical and meteorological coordinates of Gas and Electricity Distribution Company in M'sila

II.4.2. Geographical cord of Gas and Electricity Distribution Company in M'sila

Each point on the earth's surface is identified by latitude and longitude coordinates . The longitude corresponds to the angle formed by two meridian planes (passing through the polar axis), one at the origin (0° meridian of Greenwich). The other is determined by the position considered. Latitude indicates the position of a point relative to the equator,latitude is the vertical geometric height between a point and the sea level

For gas and electricity Distribution Company in M'sila thelongitude is 4.54648˚ east, the latitude is 35.71342˚ north, and a altitude of 479 m.

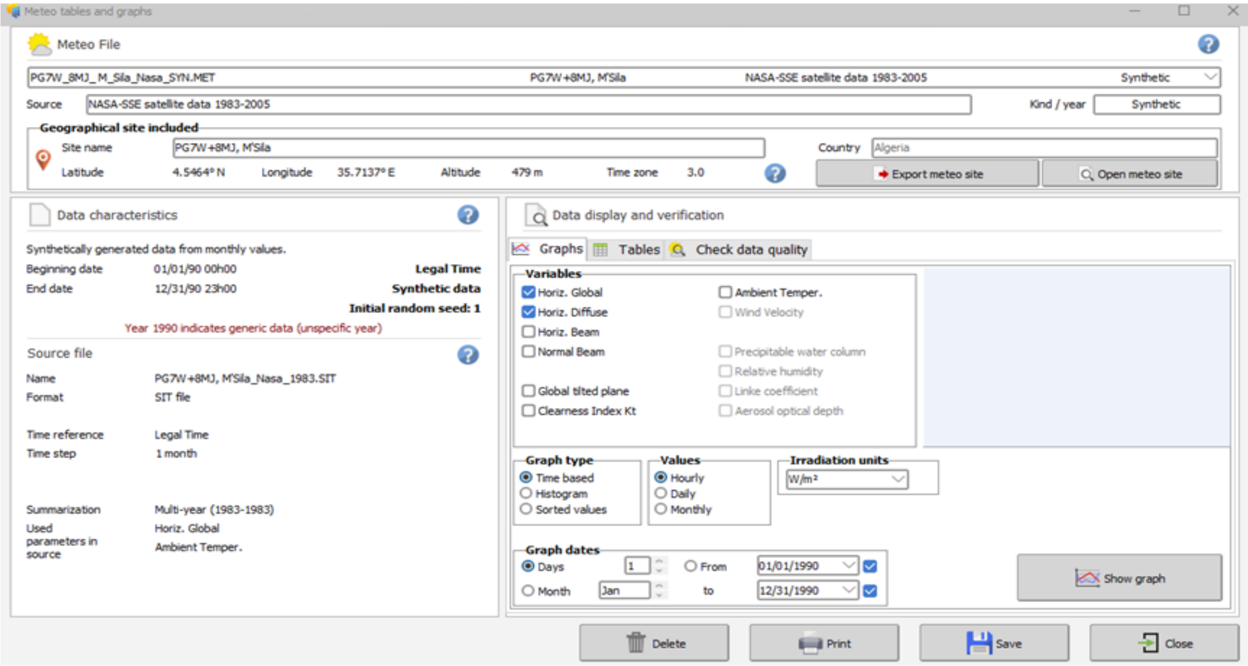


Figure II.4: Geographical characteristics of the area within PVsyst software

II.5. Project implementation

II.5.1. installation of panels

to install the solar panels in a site, it is necessary to verify the following conditions:

II.5.1.1. Placement of panels

The structure of the installed panels must be firmly anchored to the ground to withstand wind speeds of at least 150 km/h.(Anodizedaluminum, stainless steel screws and tamper proof screws).

II.5.1.2. Calculation of electricity needs

The installation of solar panels begins with the calculation of the electricity needs of your home according to the living area and the number of occupants. It is essential to take your current consumption into account.

II.5.1.3. Choice of solar panels

You will have the choice between several types of solar panels which all have advantages and rare disadvantages, but above all different yields.

II.5.1.4. Choose the orientation and inclination of solar panels

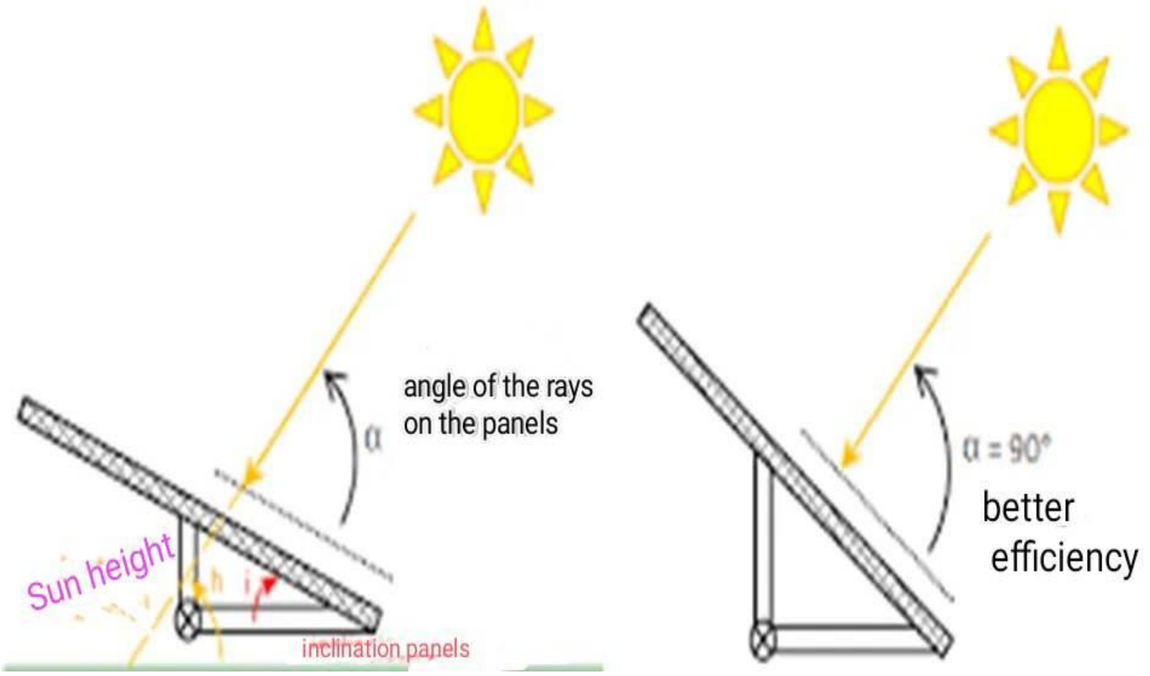


Figure II.5:the inclination of a solar panel .

As part of a solar panel installation project, the choice of their location is a very important decision that impacts the number and type of panels that can be installed. The two essential criteria to consider are the orientation and inclination of the modules. The orientation refers to the cardinal point facing the panel (north, south, east, west, northeast, etc.); the inclination corresponds to the angle formed by the panel with the ground (horizontal, vertical or somewhere in between). Depending on the location of the dwelling and the energy needs of its occupants, the optimal inclination and orientation for the solar panels are not the same.

II.5.1.4.1. Choice of panel inclination

The inclination is the angle between the solar panel and the ground that we consider here as perfectly flat. A panel inclined at 0° is therefore flat against the ground, or horizontal; a 90° panel is vertical, for example fixed to the facade of a building. The course of the sun varies greatly from one geographical area to another and during the year, it is extremely difficult to give a value to the ideal inclination for solar panels. However, there are general recommendations that will help every consumer make the best possible choice.

The inclination, although mostly expressed in degrees, can also be indicated in percentages. This is rather rare for solar panels, but can happen. To help our readers find their way around, here is a correspondence table; the percentages have been rounded to the nearest integer.

II.5.1.4.2. Choice of panel orientation

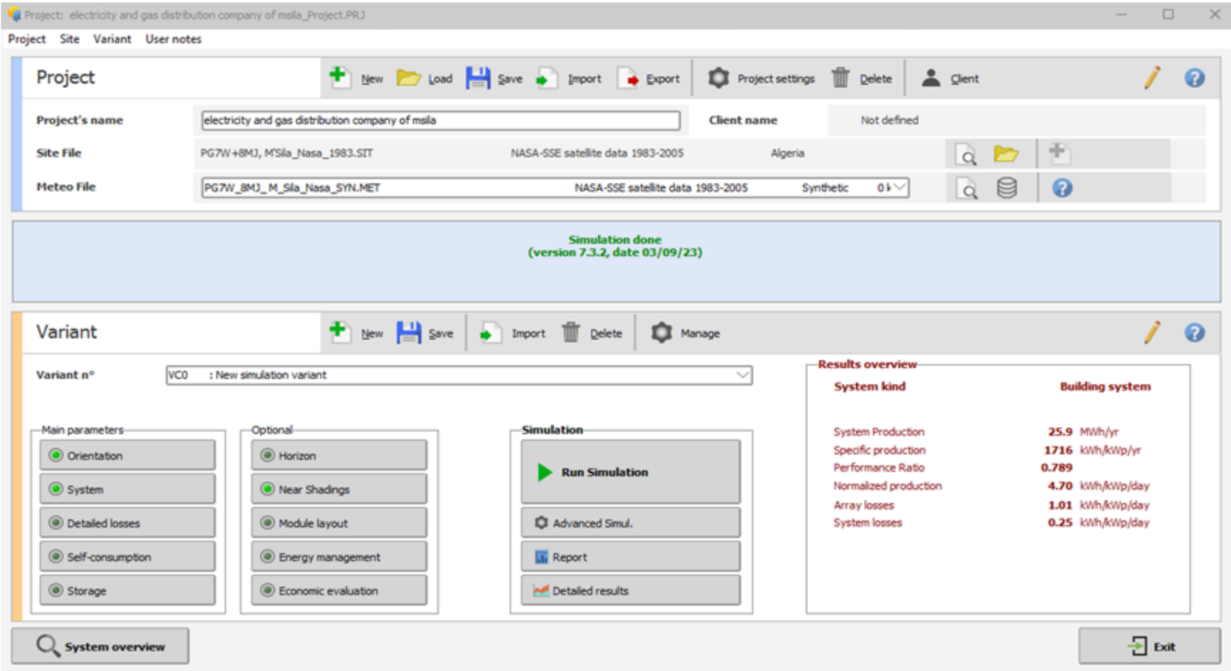


Figure II.6: Simulation steps of a photovoltaic system.

The angles of the solar panels are determined relative to the surface of the Earth and to the east, west and south positions, taking into account the offset coefficients, the optimal and overall losses on the collector. We chose a fixed inclined plane with an angle of inclination of 13° (relative to the horizontal plane),.Takes into account annual improvements and all losses. The offset

coefficient is defined as the ratio of incident radiation in the plane (GlobInc) to horizontal radiation (GlobHor). In our system, it is FT = 1.01, which we get when we tilt the collection plane

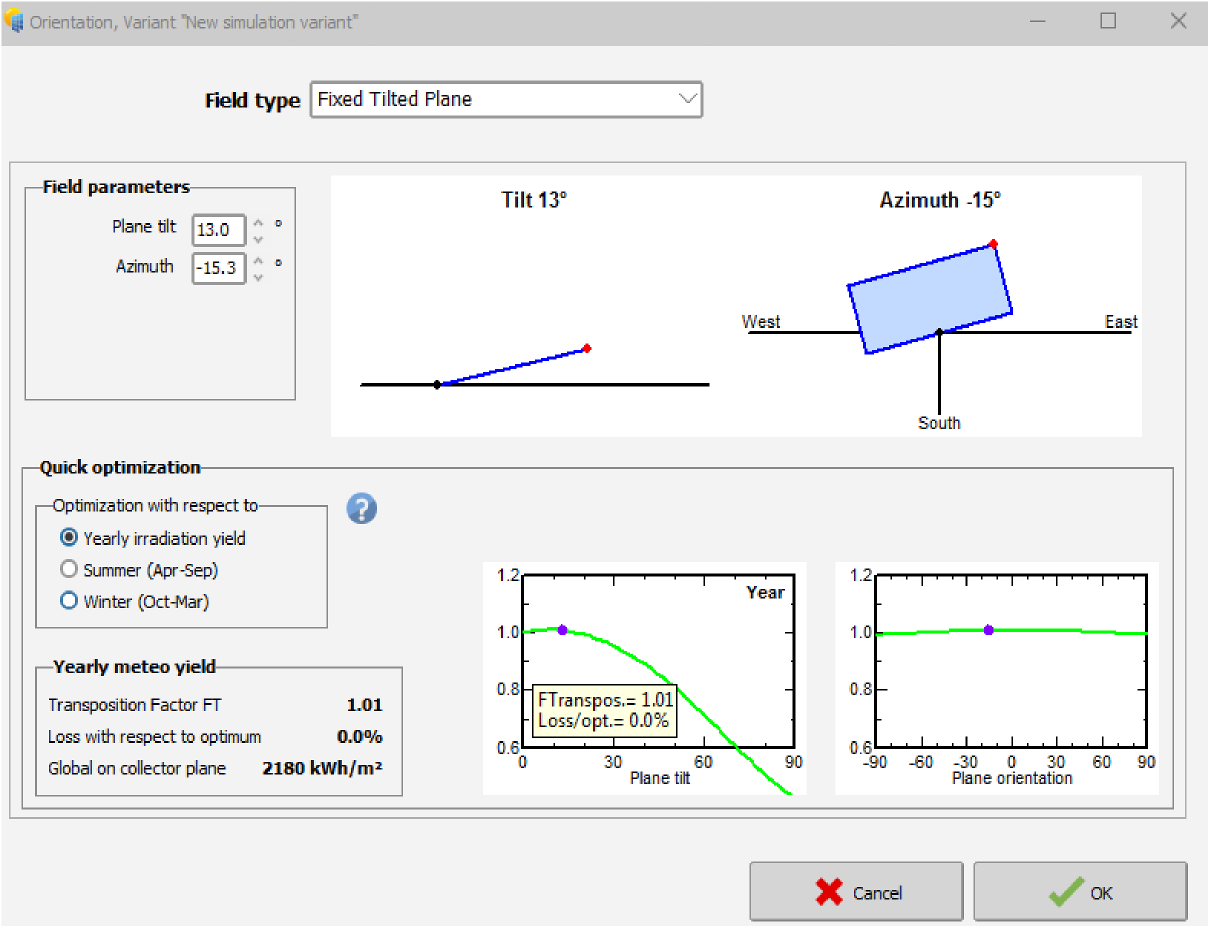


Figure II.7: Choice of panel orientation

II.6. Sizing a network system

Dimensioning of the built-in system: The dimensions of the photovoltaic system are measured using PVsyst in several steps, where the number of photovoltaic modules and converters has been determined to supply the photovoltaic generator with a rated power of 15 kW and an area of 56 m^2 for the power grid. We chose the blue solar modules of the type "290 WP poly" brand -60 BSM290P, and since the customer requested that there be two inverters, the first with a value of 10kv and the second with a value of 5kv instead of one reflector with a value of 15kv, in accordance with the book of conditions , including the first brand of the inverter 10 KV "LAYER-GC-234 from 2008", frequency 50Hz. VOLTAGE RANGE “100-700V and the second inverter of HUAWEI TECHNOOGIES -SUN 2000-5KTL-M1-380V of 2022 yearsfrequency50HZ . PVsyst Suggests to configured a module/system that allows the first initial simulation. The program includes colored error or warning codes and will notify you in the appropriate window if any inconsistencies, errors or warnings occur.

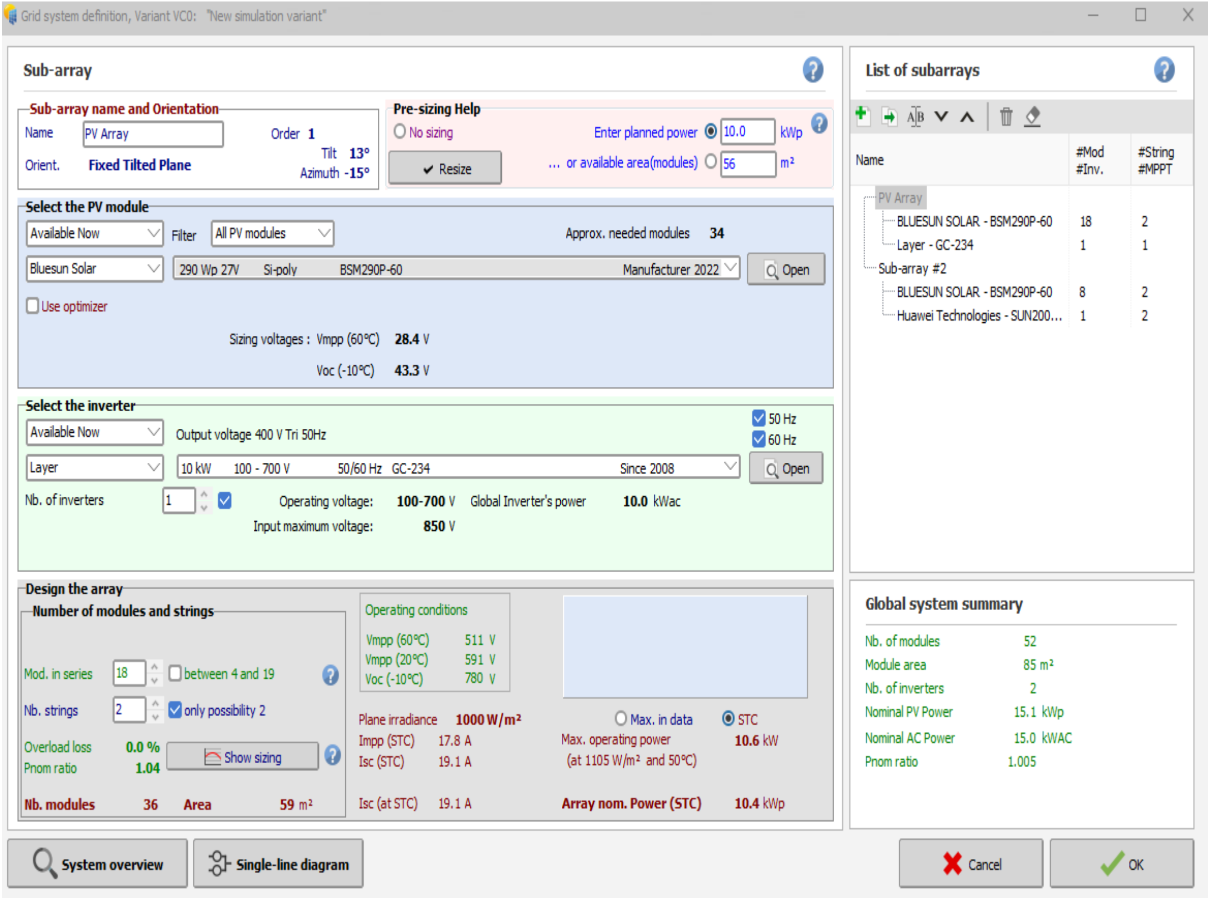


Figure II.8: Choice of module and inverter parameter.

II.7. Characteristics of the photovoltaic module

Regarding photovoltaic modules, it should be noted that the power the product of this unit is proportional to the value of solar radiation by oppose site ambient temperature values. Ditto for the effortand current painting.

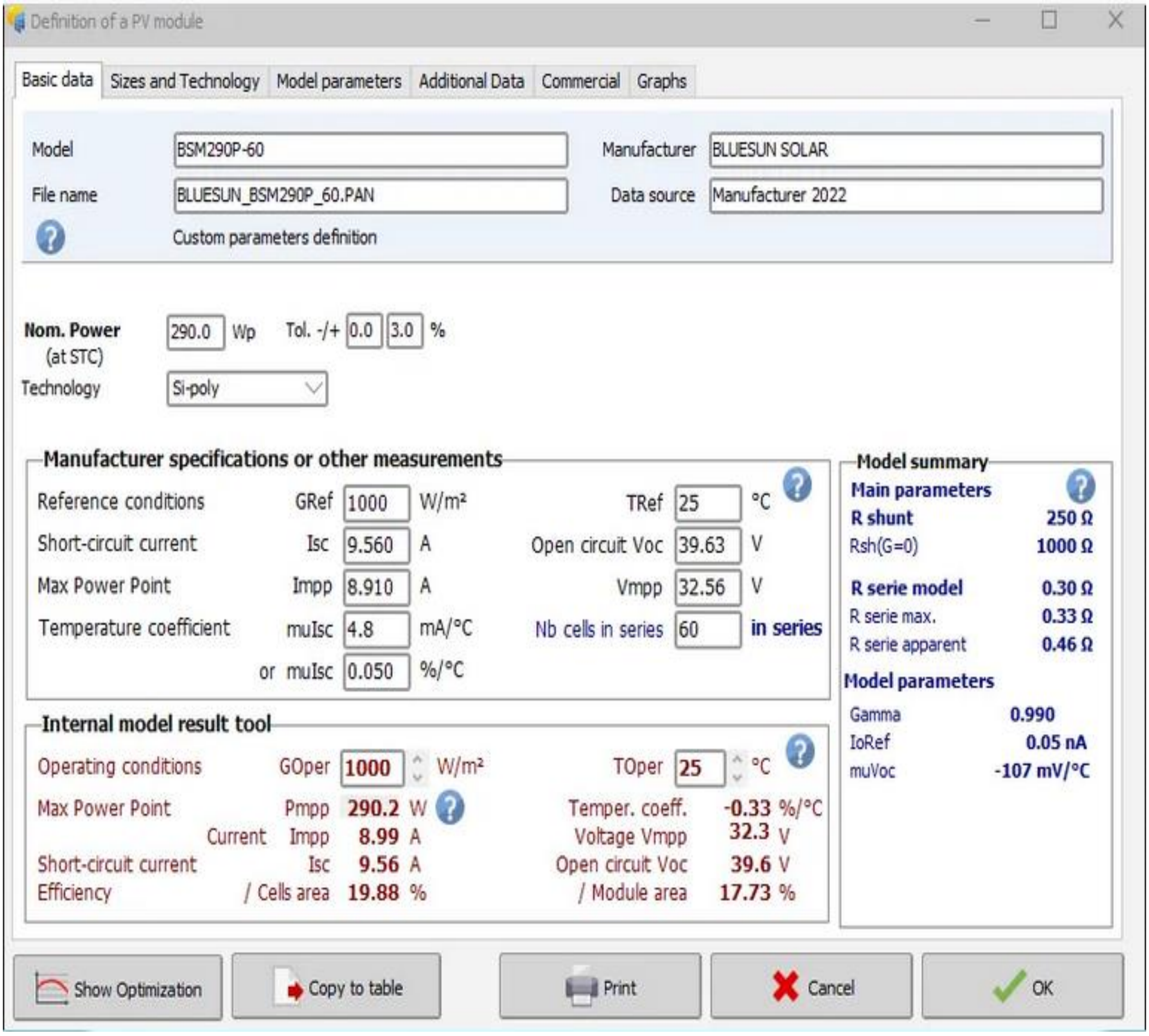
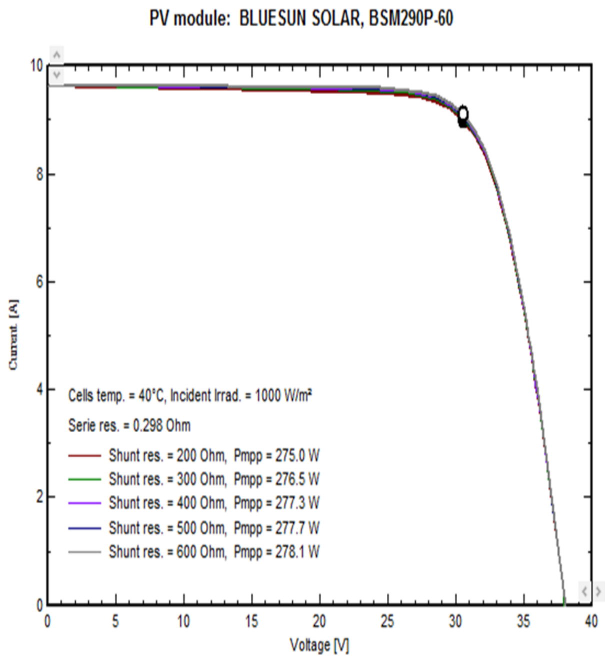
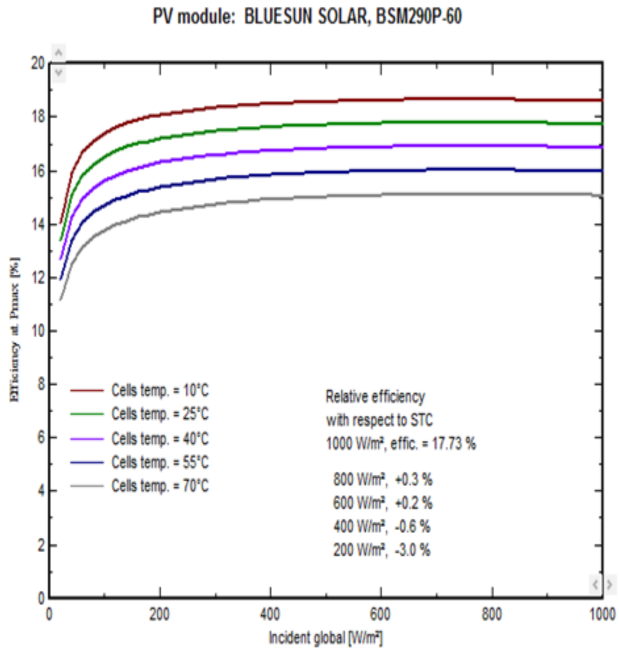
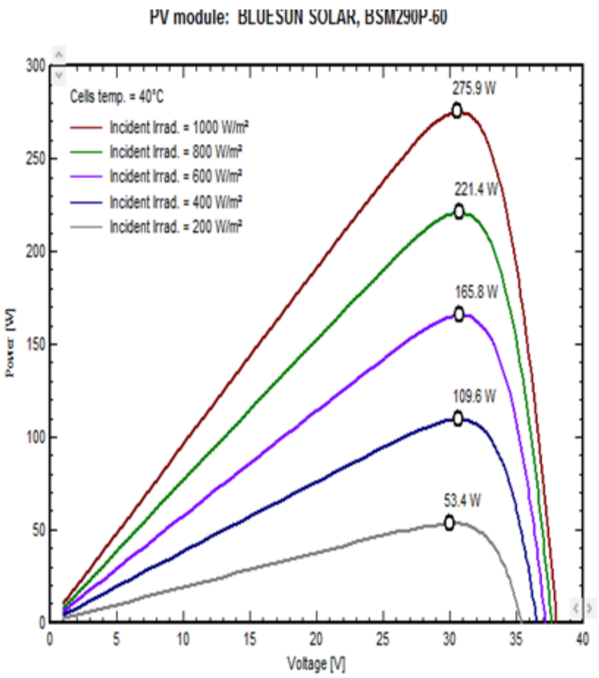
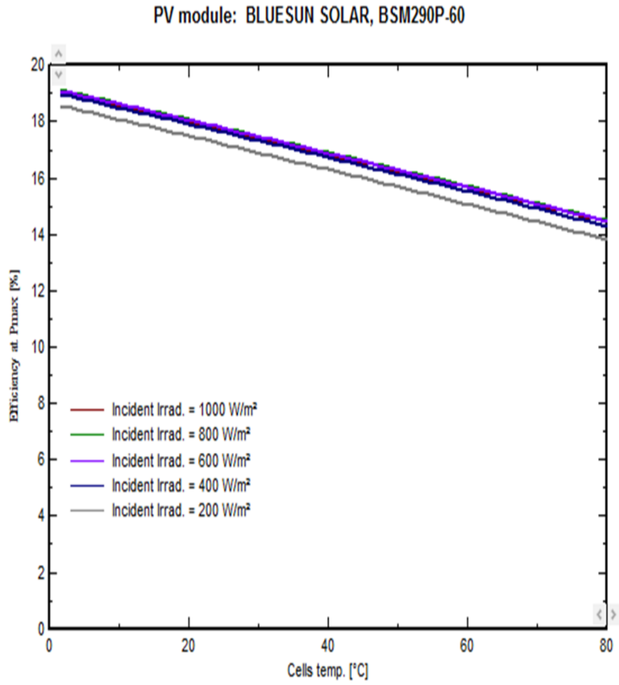


Figure II.9: PV module characteristics.


PV module: BLUESUN SOLAR, BSM290P-60
Current [A]
Voltage [V]
Cells temp. = 40°C, Incident Irrad. = 1000 W/m²
Serie res. = 0.298 Ohm
Shunt res. = 200 Ohm, Pmpp = 275.0 W
Shunt res. = 300 Ohm, Pmpp = 276.5 W
Shunt res. = 400 Ohm, Pmpp = 277.3 W
Shunt res. = 500 Ohm, Pmpp = 277.7 W
Shunt res. = 600 Ohm, Pmpp = 278.1 W


PV module: BLUESUN SOLAR, BSM290P-60
Efficiency at Pmax [%]
Incident global [W/m²]
Cells temp. = 10°C
Cells temp. = 25°C
Cells temp. = 40°C
Cells temp. = 55°C
Cells temp. = 70°C
Relative efficiency
with respect to STC
1000 W/m², effic. = 17.73 %
800 W/m², +0.3 %
600 W/m², +0.2 %
400 W/m², -0.6 %
200 W/m², -3.0 %


PV module: BLUESUN SOLAR, BSM290P-60
Power [W]
Voltage [V]
Cells temp. = 40°C
Incident Irrad. = 1000 W/m²
Incident Irrad. = 800 W/m²
Incident Irrad. = 600 W/m²
Incident Irrad. = 400 W/m²
Incident Irrad. = 200 W/m²
275.9 W
221.4 W
165.8 W
109.6 W
53.4 W


PV module: BLUESUN SOLAR, BSM290P-60
Efficiency at Pmax [%]
Cells temp. [°C]
Incident Irrad. = 1000 W/m²
Incident Irrad. = 800 W/m²
Incident Irrad. = 600 W/m²
Incident Irrad. = 400 W/m²
Incident Irrad. = 200 W/m²

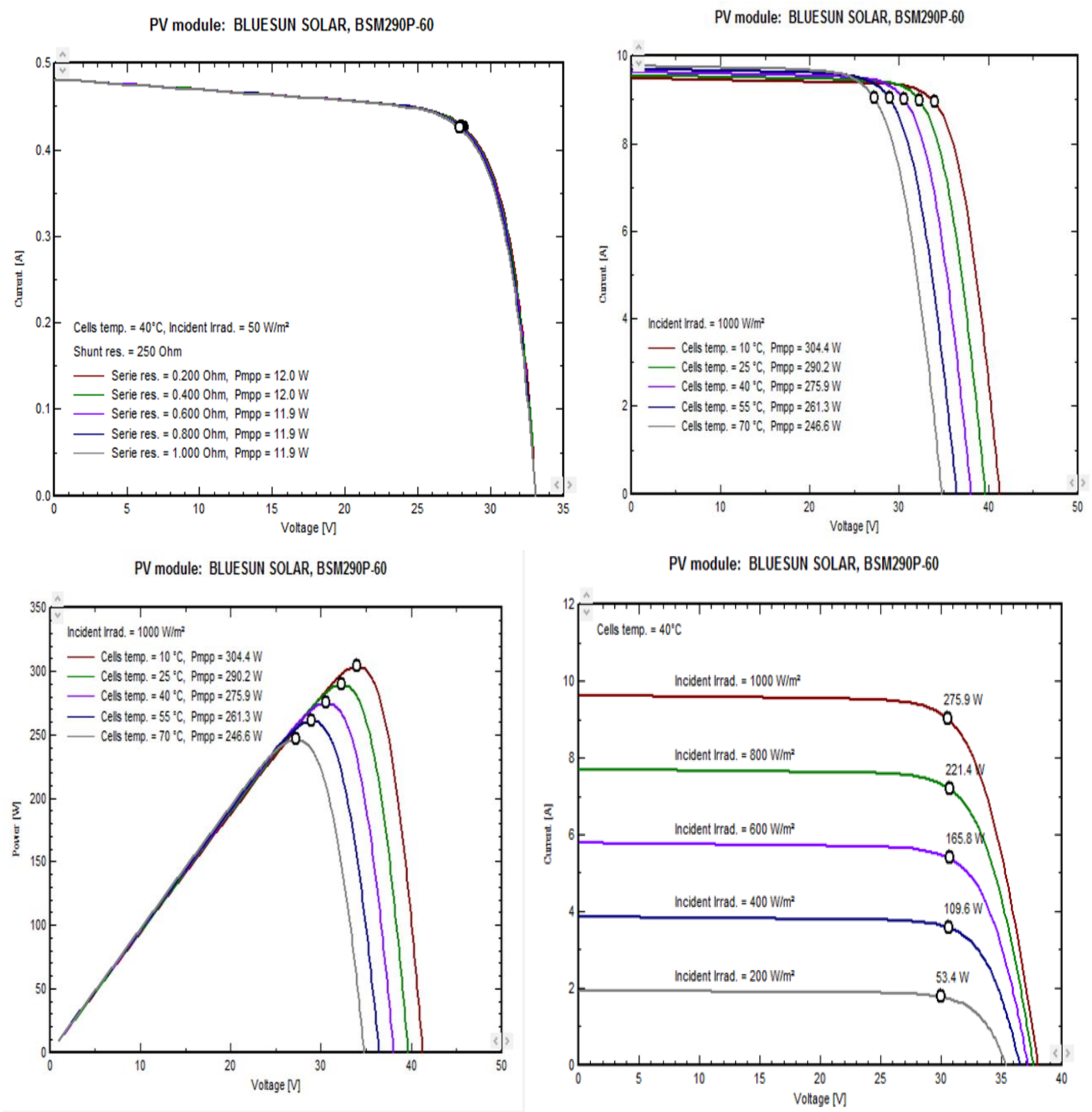


Figure II.10: Curves of characteristics of PV-module.

II.8. Characteristics of inverters

The first inverter chosen for the "LAYER – GC.ONO-234, Since 2008" network can characterize parameters shown in the Figure below:

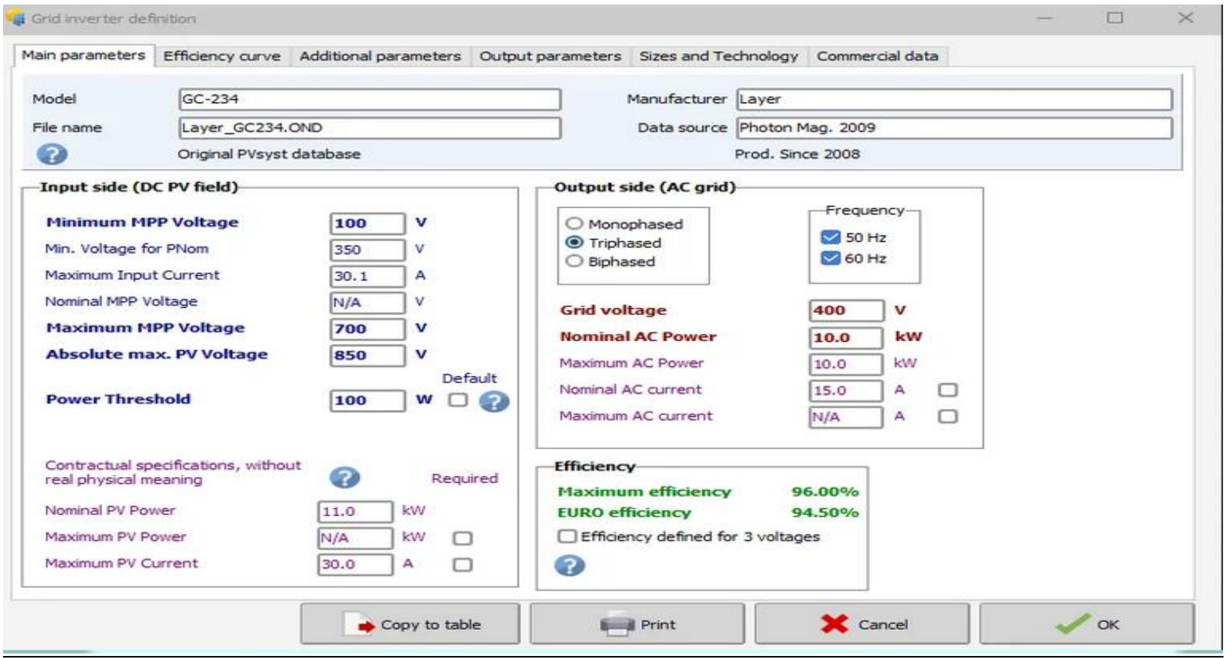


Figure II.11: Technical characteristics of first inverter.

We find the parameters of this inverter in the table with efficiency (94%),

Of MPPT voltage range (100-700V) , and frequency 50 [HZ] .

Table II.1:Input and Output Parametersof first inverter.

	Maximum power	Maximum voltage	Maximum current
Inputparameters	N/A	850850V	30A
Outputparamaters	10 KW	400V	N/A

The second inverter chosen for the "" HUAWEI TECHNOOGIES -SUN 2000-5KTL-M1-380V from 2022 year frequency 50Hz network can characterize parameters shown in the Figure below:

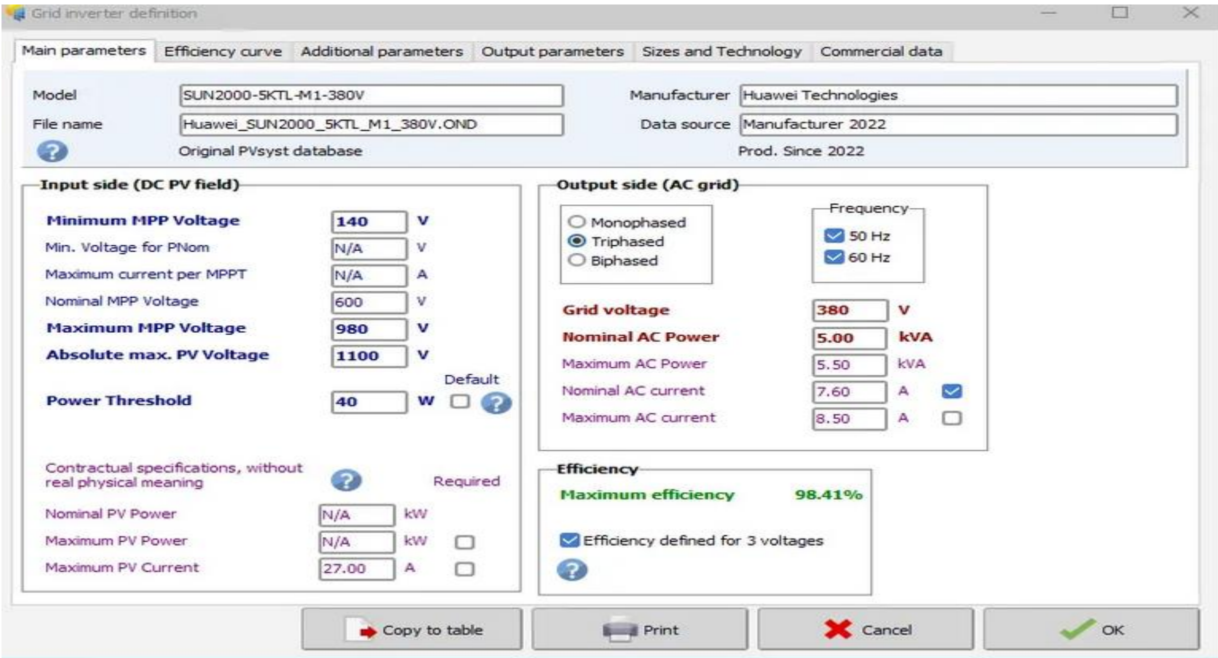


Figure II .12: Technical characteristics of second inverter.

We find the parameters of second inverter in the table with efficiency (98.41%),of MPPT voltage range (140-980V) , and frequency 50 [HZ] .

Table II.2: Input and Output Parameters of second inverter.

	Maximum power	Maximum voltage	Maximum current
Input parameters	N/A	1100V	27A
Output paramaters	5 KVA	380V	8.50A

II.9. Conclusion

In this chapter, we first introduced the most important system used for sizing solar energy systems, mentioned its importance, and explained how we used it to sizing our solar system located in the electricity and gas distribution company of M'sila.

Chapter III :

Sizing,Analysis and Discussion The results of PVsyst software

III.1. Introduction

The objective of this chapter is to analyse, and evaluate the outcomes and performance of Company solar power plant.

This system has two inverters, one of 10 KW brand "Deye SG04LP3-EU" and one of 5KW brand "SOLAX" with a frequency of 50/60HZ. The first part of the chapter is about the solar system dimensioning (calculation without PVsyst software).

The second portion is concerned with the display of the PVsyst program's results and their discussion (analysis) such as losses, energy produced by the system performance report, and so on.

The photovoltaic installation requires a method of calculation and high precision sizing.

The purpose of sizing a photovoltaic solar system is to determine the power of the photovoltaic generator and the associated battery capacity to be installed, based on the sunshine data of the location, and the electrical energy needs of the user.

III.2. Project display

In our project, we demonstrated a PV installation injected into the network to power M’sila firm site, which was simulated using the PVsyst software.

Google Maps was used to gather the climatic data.

III.3. The purpose of sizing

Sizing is an important part of the design process for solar systems.

The technical and economic optimum of dimensioning is obtained when all economic costs during the system's life cycle are minimised, allowing the system to fulfil all operational restrictions while also meeting all user needs.

III.4. The steps to follow for the dimensioning of the PV system

The steps below demonstrate in detail the Procedure to Design a Photovoltaic System (Figure III.1):

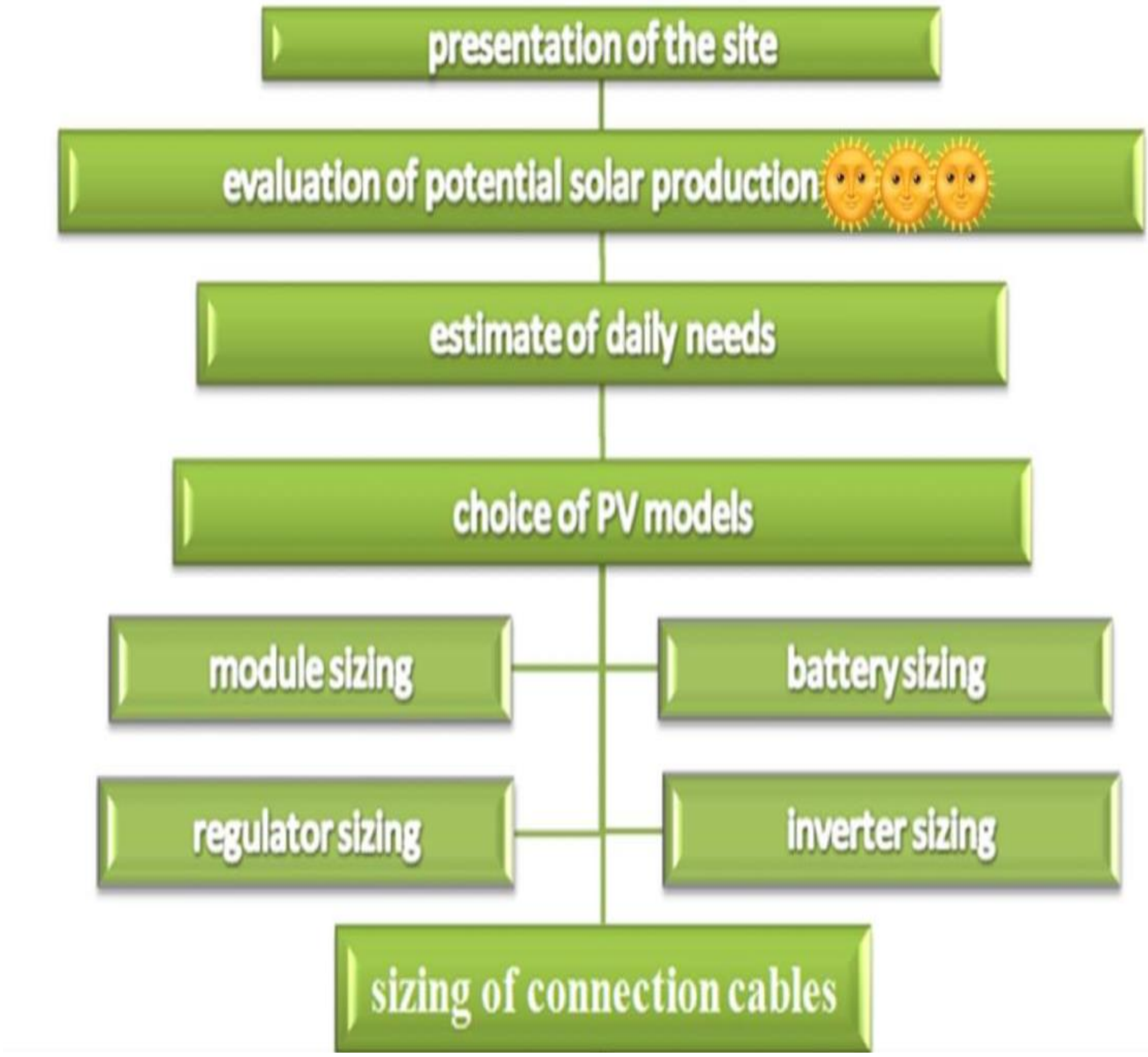


Figure III.1: Simplified diagram of the dimensioning of a photovoltaic system

- **Step 1:**present the site (FigureIII.2).
- **Step 2:** Assessing prospective solar production based on the site's geographical location (local solar deposit).
- **Step 3:** Estimation of the user's daily electricity demands (in Wh/d): power of appliances, time of usage, and energy spent.
- **Step 4:**Choice of PV models

- **Step 5:** Photovoltaic module sizing (total peak power, number of modules) (FigureIII.3).
- **Step 6:** Determine the size of the battery (FigureIII.3).
- **Step 7:** Determine the size of the regulator.
- **Step 8:** Determine the size of the inverter (Figure III.3).
- **Step 9:** Determine the size of the connecting wires (Figure III.3).

Project: electricity and gas distribution company of msila

Variant: New simulation variant

PVsyst V7.3.2
VC0, Simulation date:
03/09/23 19:19
with v7.3.2

Project summary

Geographical Site	Situation		Project settings	
PG7W+8MJ, M'Sila	Latitude	4.55 °N	Albedo	0.20
Algeria	Longitude	35.71 °E		
	Altitude	479 m		
	Time zone	UTC+3		

Meteo data
PG7W+8MJ, M'Sila
NASA-SSE satellite data 1983-2005 - Synthetic

Figure III.2: project summary

System summary

Grid-Connected System		Building system	
PV Field Orientation		**Near Shadings**	**User's needs**
Fixed plane		Linear shadings	Unlimited load (grid)
Tilt/Azimuth	13 / -15.3 °		

System information

PV Array		Inverters	
Nb. of modules	52 units	Nb. of units	2 units
Pnom total	15.08 kWp	Pnom total	15.00 kWac
		Pnom ratio	1.005

Figure III.3: system summary

III.4.1. Sizing of photovoltaic modules

This step consists of calculating the quantity of photovoltaic modules thatwe will need to have to cover these electricity needs. For that it is necessarysizing the solar modules by the following steps:

- Estimation of the peak power of the photovoltaic field.
- Determination of the number of photovoltaic modules.

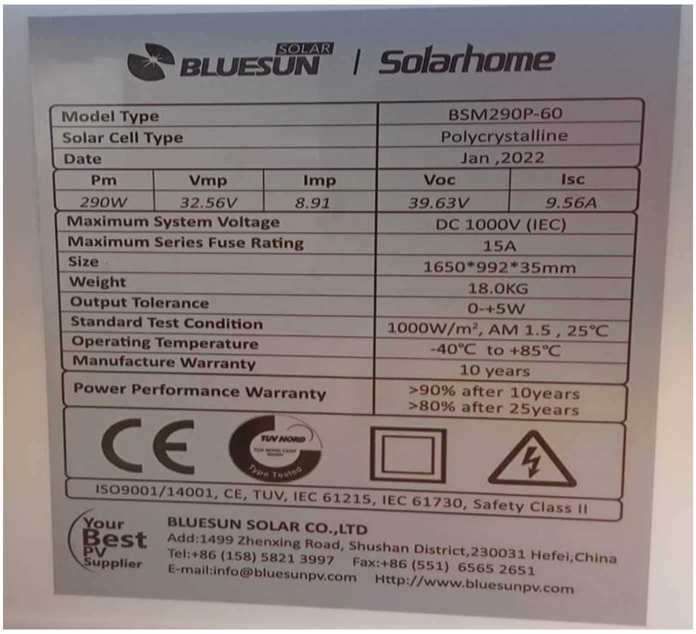


Figure III.4: Characteristic of photovoltaic panel Bluesun BSM290P-60

a-calculate the number of panels used in this system

$N = P_c / P_{max}$ (III.1)

with P_{max} : the unitary peak power of a panelcalculate the peak power:

We have:

$P_c = E_p / ir$ (III.2)

Withir: irradiation average irradiation of country of installation "wc"

To determine Pc it is necessary to calculate Ep

$E_p = E_c / K$ (III.3)

With K=0.65 ; E_p : energy produced

E_c = the power of the loads * time of use; Ec:energy consumed

N=1500 / 290=51.7 ≈ 52

b-The number of panels in series

$Nps = UCPV/Up$ (III.4)

$UCPV$ = The voltage of the PV array in V.

Up = The voltage of a panel in V.

Using a voltmeter, we measured the voltage supplied by the field:

$UCPV$ = 2060.76 V

Nps=2060.70 / 39.63= 52

c-The number of parallel panels

Npp=Nptotal/Nps (III.5)

Npp=52/52 =1

III.4.2. Battery sizing

Having a battery means choosing a storage capacity making it possible to overcome temporary climatic variations on the scale of the hour or the day (night operation) and a few days of bad weather (absence of solar radiation). Moreover, the method to be adopted is different in hot and temperate countries.

The battery is often the most vulnerable component in a systemphotovoltaic, its lifespan is generally 6 years. It will therefore be necessaryreplace the panels beforehand if high reliability and a long life are desired.Lifetime of the system [32].

It is very important to choose the working voltage of the current systemcontinuous, because this tension according to the load directly influences the choiceconversion and regulation systems, as well as on the wiring and also onappliances for domestic use [33].

The choice of the nominal voltage of a system depends on the availability ofhardware (modules and receivers), also, it depends on the power levels andof energy required depending on the type of application, TableIII.1 gives us thesuitable voltage for the different powers of the PV field [34]:

Table III.1: The system voltages corresponding to each interval ofpeak power

Peak power	0_0.5KWc	0.5_2KWc	3KWc_10KWc	>10KWc
System voltage Usys(DC)	12V	24V	48V	>48V

In our case study: 15kwc

Then the voltage of the chosen system isU_{sys}>48V

III.4.2.1. Calculation of battery storage capacity

The total capacity that the batteries will have to accumulate is given by the following formula:

$$Csys=\frac{Ec\times N}{DOD\times Usys} \qquad (III.6)$$

Csys: Battery storage capacity in (Ah).

Ec: The energy consumed per day in (Wh/d).

DOD: Maximum discharge of batteries we can call italso PDD (depth of discharge).

Usys: The system voltage.

N: The number of days of autonomy.

Application:

$$Csys=\frac{6000\times 4\times (\frac{4}{24})}{0.5\times 48}=166.66Ah$$

III.4.2.2. The choice of batteries

We choose a solar battery with characteristic:

Ubat=12 V Cbat= 200 Ah

Type:gel

a-Calculation The total number of batteries

$$Nb_{total}=\frac{Usys}{Ubat}\times\frac{Csys}{Cbat} \qquad (III.7)$$

Nbtotal: The total number of batteries.

Usys: The voltage of the PV system in (V).

Ubat: The battery voltage in (V).

Csys: The storage capacity of the system in (Ah).

Cbat: The capacity of a battery in (Ah).

Application :

$$Nb_{total}=\frac{48}{12}\times\frac{166.66}{200}=3.33\approx 4\text{Battery}$$

b-The number of batteries in series

$$Nb_{série}=\frac{Usys}{Ubat} \qquad (III.8)$$

Application:

$Nb_{série}$=48/12= 4

c- Number of Batteries in Parallel

$$Nb_{Parallel}=\frac{Csys}{Cbat} \qquad (III.9)$$

Application :

$Nb_{Parallel}$ =166.66/200= 0.83≈ 1Battery.

III.4.3. Regulator sizing

Among the different types of regulators, one must choose the one that is thebetter suited to our setup. In order to determine its characteristics,often separates the two regulator functions (charging and discharging).Materials and methods:

The sizing of the load regulation (at the input) depends on the generator power. The permissible intensity of the input current of the regulator must be greater than the maximum value produced by the generator, To estimate this current, we take 1.5 times the total short-circuit current of the modules.

The input current of the regulator is calculated by the following Formula [19]:

$$Ie = I_{sc}\times Np\times A \qquad (III.10)$$

Ie :The allowable input current of the regulator.

I_{sc}: the short-circuit current of a module.

Np: Number of modules connected in parallel.

A: Take 1.5 as the safety value to avoid regulator damage.

The sizing of the discharge regulation (at the outlet) depends on the total power of the receivers (or uses. The admissible intensity of the regulator output current must be greater than the maximum value called by the receivers, this current calculated by the following Formula [35]:

$$Is =\frac{Pi}{Usys}\times A \qquad (III.11)$$

Is: The allowable intensity of the output current of the regulator.

Pi: The total power for the receivers (connected in parallel) (W).

U_{sys}: It is the nominal voltage of the photovoltaic field (system).

III.4.4. Inverter sizing

When the application contains devices operating in alternative (AC), it convert the continuous electricity produced by the photovoltaic collectors into alternative electricity usable by these devices. The sizing of a inverter is based on the sum of the maximum powers of each piece of equipment at connect to alternating current, and is done according to several criteria [36]:

-The voltage between: the inverter must be supported a voltage betweenupper field voltage.

- Output voltage: in Algeria we use 220/380 VAC, 50Hz.

- Nominal power: Nominal power of the inverter (KW), defined according tothe needs expressed. It takes into account the number of devices and theirpowers.

Finally, be careful of the voltage of the strings connected to the inverter.

III.4.4.1. Data sheet of the inverters used

The inverters chosen for our study is a three-phase intelligent inverter of the type: DeyeSUN-10K-SG04LP3-EU (FigureIII.6), and SOLAX power (FigureIII.5).

	X3-4.0-T	X3-5.0-T	X3-6.0-T	X3-7.0-T	X3-8.0-T	X3-9.0-T	X3-10.0-T	X3-4.0-S	X3-5.0-S
INPUT (DC)									
Max.DC power [W]	5200	6500	7800	8400	9600	10800	12000	4800	6000
Max.DC voltage [V]	800	800	800	1000	1000	1000	1000	1000	1000
Nominal DC operating voltage [V]	600	600	600	600	600	600	600	600	600
Max. input current (input A/input B) [A]	11/11	11/11	11/11	11/11	11/11	11/11	11/11	11	11
Max. short circuit current (input A/input B) [A]	14/14	14/14	14/14	14/14	14/14	14/14	14/14	14	14
Operating voltage range [V]	160-780	160-780	160-780	160-950	160-950	160-950	160-950	160-950	160-950
Start output DC voltage [V]	180	180	180	180	180	180	180	180	180
No. of MPP trackers	2	2	2	2	2	2	2	1	1
Strings per MPP tracker	1	1	1	1	1	1	1	1	1
OUTPUT (AC)									
Nominal AC power [W]	4000	5000	6000	7000	8000	9000	10000	4000	5000
Max. apparent AC power [W]	4000	5000	6000	7000	8000	9000	10000	4000	5000
Rated grid voltage (AC voltage range) [V]	3/N/PE, 3/PE, 230/400(310-480)								
Rated grid Frequency [Hz]	50/60;+-5								
Max. AC current [A]	6.4	8.0	9.6	11.2	12.8	14.4	16.0	6.4	8.0
Displacement power factor	0.8leading-0.8lagging								
THDi, rated power [%]	<2								
EFFICIENCY									
MPPT efficiency [%]	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9
Euro-efficiency [%]	97.8	97.8	97.8	98	98	98	98	97.8	97.8
Max. efficiency [%]	98.3	98.3	98.3	98.4	98.4	98.5	98.5	98.3	98.3
POWER CONSUMPTION									
Night consumpotion [W]	<2								
STANDARD									
Safety	EN62109-1/-2								
EMC	EN61000-6-1;EN61000-6-2;EN61000-6-3;EN61000-3-2;EN61000-3-3								
Certification	AS4777.2-2015; VDE4105								
ENVIRONMENT LIMIT									
Protection class	IP65								
Operating temperature range [OC]	-25~+60(derating at 45)								
Humidity [%]	0~100								
Altitude[m]	2000								
Storage temperature [OC]	-25~60								
Noise emission(typical)[dB]	<35								
Over voltage category	III(electric supply side), II(PV side)								
GENERAL									
Demensions(WxHxD) [mm]	534*419*179								
Weight [kg]	30	30	30	30	30	30	30	28	28
DC input type	MC4								
Cooling concept	Natural								
Topology	Transformerless								
Earth fault alarm	Yes(80dB)								
Communication	Rs485 /DRM / POCKET-WIFI(optional) / POCKET-LAN (optional) /Meter (optional) / USB / RF								
LCD display	Backlight 16*4 character								
Warranty [year]	5								
DC disconnection switch	optional								

FigureIII.5: Data sheet of the invertersolax power 5kw.

Technical Data www.deyeinverter.com

Model	SUN-5K -SG04LP3-EU	SUN-6K -SG04LP3-EU	SUN-8K -SG04LP3-EU	SUN-10K -SG04LP3-EU	SUN-12K -SG04LP3-EU
Battery Input Data					
Battery Type	Lead-acid or Lithium-ion				
Battery Voltage Range (V)	40-60				
Max. Charging Current (A)	120	150	190	210	240
Max. Discharging Current (A)	120	150	190	210	240
External Temperature Sensor	Yes				
Charging Curve	3 Stages / Equalization				
Charging Strategy for Li-Ion Battery	Self-adaption to BMS				
PV String Input Data					
Max. DC Input Power (W)	6500	7800	10400	13000	15600
Rated PV Input Voltage (V)	550 (160-800)				
Start-up Voltage (V)	160				
MPPT Voltage Range (V)	200-650				
Full Load DC Voltage Range (V)	350-650				
PV Input Current (A)	13+13			26+13	
Max. PV Isc (A)	17+17			34+17	
No.of MPP Trackers	2				
No.of Strings per MPP Tracker	1+1			2+1	
AC Output Data					
Rated AC Output Active Power (W)	5000	6000	8000	10000	12000
Max AC Output Active Power (W)	5500	6600	8800	11000	13200
AC Output Rated Current (A)	7.6/7.2	9.1/8.7	12.1/11.6	15.2/14.5	18.2/17.4
Max AC Output Current (A)	8.4/8	10/9.6	13.4/12.8	16.7/15.9	20/19.1
Max. Three-phase Unbalanced Output Current (A)	11.4/10.9	13.6/13	18.2/17.4	22.7/21.7	27.3/26.1
Max Output short circuit current (A)	75				
Max. Continuous AC Passthrough (A)	45				
Peak Power (off grid)	2 time of rated power, 10 S				
Power Factor	0.8 leading to 0.8 lagging				
Output Frequency and Voltage	50/60Hz; 3L/N/PE 220/380, 230/400Vac				
Grid Type	Three Phase				
Efficiency					
Max. Efficiency	97.60%				
Euro Efficiency	97.00%				
MPPT Efficiency	99.90%				
Protection					
Integrated	Anti-islanding Protection, PV String Input Reverse Polarity Protection, Insulation Resistor Detection, Residual Current Monitoring Unit, Output Over Current Protection, Output Shorted Protection, Surge Protection				
Over Voltage Category	DC Type II/AC Type III				

Figure III.6: Data sheet of the inverter Deye SUN-10K-SG04LP3-EU

III.4.5. Cable sizing

It is necessary to limit the length of the electrical cables between the generatorphotovoltaic and the regulator, the regulator and the batteries or the inverter with thereceivers, This distance never exceeds a few meters. Most of the systemssolar panels generally operate at low voltage (12V, 24V, 48V), so with a high current for the same power (P = U×I).

Carrying this current of several amperes over long distances causes lossesby Joule effect at conductor levels [37]:

$P_j = \Delta U \times I = R \times I^2$ (III.12)

In calculation the sections of the cables according to the following formulas:

We have: $\Delta U = R \times I = e \times U$ (III.13)

We have: $R = \frac{\Delta U}{I} = \rho \times \frac{L}{S}$ (III.14)

$$S=\frac{\rho\times L\times I}{\Delta U} \qquad \text{(III.15)}$$

e: the maximum voltage drop [3% - 5%]

L: Length of the electric cable

ρ: The resistivity of copper $\rho = 1.7\times 10^{-8}\Omega.m$.

ΔU: The voltage drop between the panels and the other elements

Impp: The current produced by the PV generator

III.4.5.1. Calculation of the section of the cable used

Taking into account the optimal intensity delivered by a solar panel (FigureIII.4), i.e.:

I_{mpp}= 8.91 A

I_{max} =8.91 × 1.25= 11.14 A

The voltage of the batteries being 48V, the voltage drop allowed for the cablesconnection will then be:

ΔU = 48 × 0.03 = 1.44 V

We consider that the length of the solar cable to be used is equal to 30 m:

$$S = \frac{11.14\times 30\times 1.7\times 10^{-8}}{1.44} = 3.94 \approx 4mm^2$$

III.5. Materials and methods

In this project we used as materials: two inveters and 52 solar panels,equipments and accessory (wiring fuses circuit breaker,…) ...etc.

PVsyst software is used to develop and simulate a grid-connected solar system for this investigation. The primary goal of this research is to calculate the yearly energy production and performance ratio of the specified PV system. Various indicators are evaluated in order to analyse the performance analysis.

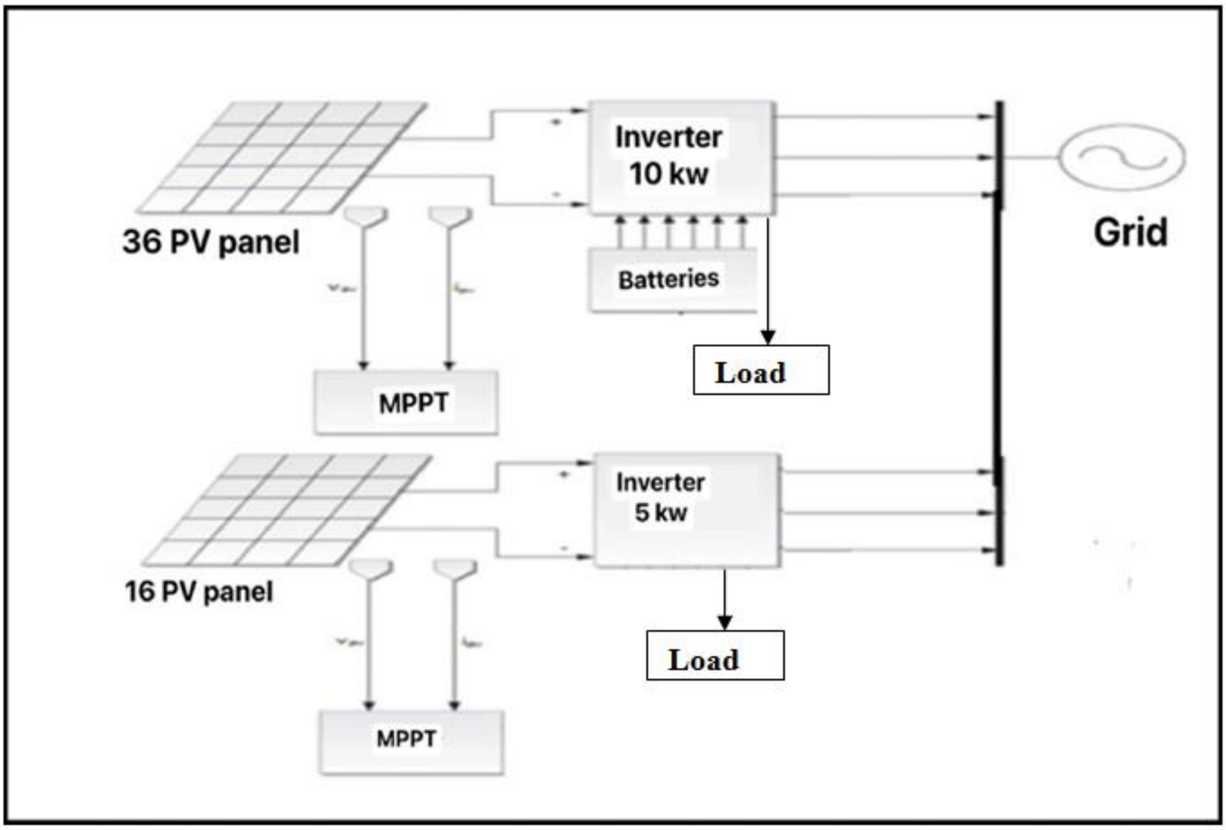


Figure III.7: Block diagram of the grid connected PV system of electricity and gas distribution in M'sila

PV Array Characteristics

Array #1 - PV Array

PV module		Inverter	
Manufacturer	Generic	Manufacturer	Generic
Model	BSM290P-60	Model	GC-234
(Custom parameters definition)		(Original PVsyst database)	
Unit Nom. Power	290 Wp	Unit Nom. Power	10.00 kWac
Number of PV modules	36 units	Number of inverters	1 unit
Nominal (STC)	10.44 kWp	Total power	10.0 kWac
Modules	2 Strings x 18 In series	Operating voltage	100-700 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.04
Pmpp	9.58 kWp		
U mpp	531 V		
I mpp	18 A		

Array #2 - Sub-array #2

PV module		Inverter	
Manufacturer	Generic	Manufacturer	Generic
Model	BSM290P-60	Model	SUN2000-5KTL-M1-380V
(Custom parameters definition)		(Original PVsyst database)	
Unit Nom. Power	290 Wp	Unit Nom. Power	5.00 kWac
Number of PV modules	16 units	Number of inverters	2 * MPPT 50% 1 unit
Nominal (STC)	4640 Wp	Total power	5.0 kWac
Modules	2 Strings x 8 In series	Operating voltage	140-980 V
At operating cond. (50°C)		Max. power (=>50°C)	5.50 kWac
Pmpp	4259 Wp	Pnom ratio (DC:AC)	0.93
U mpp	236 V	No power sharing between MPPTs	
I mpp	18 A		

Total PV power		**Total inverter power**	
Nominal (STC)	15 kWp	Total power	15 kWac
Total	52 modules	Number of inverters	2 units
Module area	85.1 m²	Pnom ratio	1.01

FigureIII.8: characteristic of PV array

III.6. Grid-connected photovoltaic system description

This section describes a grid-connected photovoltaic system, as depicted in FigureIII.7. PV modules, inverters, and grid lines are the main components for creating a grid-connected solar system. PV modules generate direct current (DC) electricity, which is the product of current and voltage. The inverter transforms DC voltages to alternating current voltages. The inverter's alternating current output is fed into the grid through a utility meter, which is then connected to a fuse box. Inverters in grid-connected PV systems always attempt to work in phase with the grid. The inverter generates a sinusoidal output indefinitely. The grid connection can be made from the output terminals of an inverter with the connection of circuit breaker in fuse box and the utility meter [12].

III.7. Simulation using PVsyst

A grid-connected solar system simulation model is technically scaled according to project parameters and simulated using the PVsyst software tool. This model is made up of PV modules, inverters, and a grid interface network.

The simulation approach used for analysis is as follows:

- In the project design menu, a grid-connected PV system project is built by providing the geographical location and climatic data of the specific place where the plant is to be installed.
- The second stage is to specify appropriate data linked to the plant architecture. This comprises the orientation of the PV modules, the available space to place the PV plant or the power necessary based on the load, the kind of PV modules to be used, and the type of inverter to be used from the PVsyst database.
- Once all of the necessary data is supplied, subsequent versions are added and simulation is performed.

III.8. Result and Discussion

In this chapter, the simulation results of a photovoltaic system are examined shown in FigureIII.9 by the PV syst software. The simulation model provided the results. This simulation provided primarily produced energy, specific production, performance ratio, and arrow losses. The findings obtained were analysed in order to evaluate the performance of the photovoltaic system.

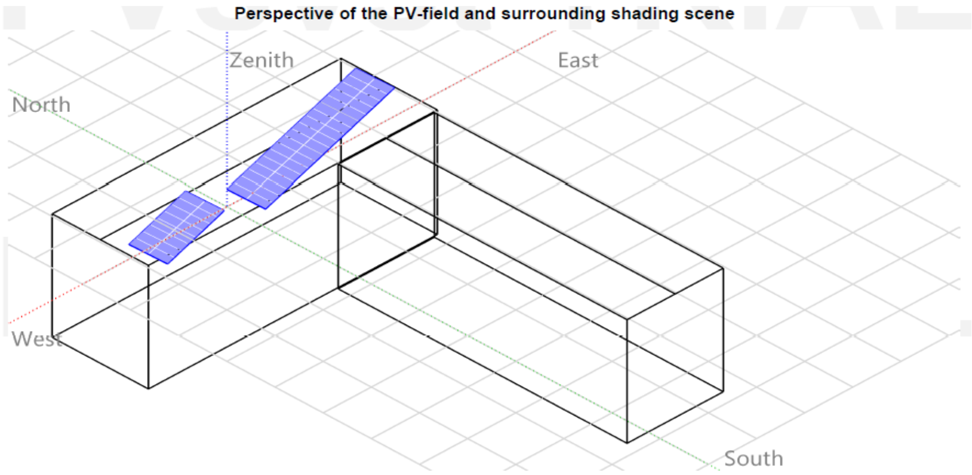


Figure III.9: Perspective of the PV-field and surrounding shading scene

III.8.1. The main simulation outcomes(results)

Three primary parameters were evaluated based on the main simulation findings. The first parameter is the entire quantity of energy generated by the solar system on a yearly basis, denoted as produced energy. The second parameter is the yearly specific production per installed kWp. The yearly average performance ratio (PR) is the third parameter.

III.8.2. Balances and main results

TableIII.2:Balances and main results of 15 kWpphotovoltaic systems

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	191.0	57.03	28.20	210.7	199.3	2586	2460	0.774
February	182.3	54.18	29.24	193.5	185.5	2381	2264	0.776
March	191.3	67.54	29.01	193.1	186.1	2420	2301	0.790
April	169.2	70.96	27.85	162.4	155.2	2044	1939	0.792
May	177.0	66.41	26.85	163.6	155.9	2073	1968	0.797
June	169.5	64.36	26.43	153.4	145.6	1949	1850	0.799
July	175.5	67.40	25.99	160.5	152.9	2050	1945	0.804
August	186.6	64.37	26.40	176.1	168.9	2234	2122	0.799
September	194.1	62.02	27.25	192.1	185.4	2421	2304	0.795
October	179.8	68.72	27.12	186.5	179.0	2352	2237	0.795
November	166.5	65.56	26.39	179.5	169.4	2232	2123	0.785
December	182.6	55.40	26.95	203.1	190.1	2481	2362	0.771
Year	2165.3	763.95	27.29	2174.4	2073.1	27224	25873	0.789

Table III.2 shows the balances and key results for variables such as global irradiance on the horizontal plane, ambient average temperature, global irradiance on the collector plane without any optical adjustments, effective global irradiance considering soiling losses, and shading losses.

Each variable stated in the balances and major findings was computed in terms of monthly and annual values.Yearly values of the variables are possible as averages for temperature, efficiency, and irradiance and energy summation. The yearly worldwide irradiance on the horizontal plane at the research site is 2165.3 kWh/m^2, and the global incident energy on the collector without optical adjustments and effective global irradiance after optical losses are 2174.4 kWh/m^2 and 2073.1 kWh/ m^2, respectively. The yearly DC energy produced by the PV array and the annual AC energy injected into the grid are 27224 KWh and 25873 KWh, respectively, with this effective irradiance.

III.8.3. Normalized productions

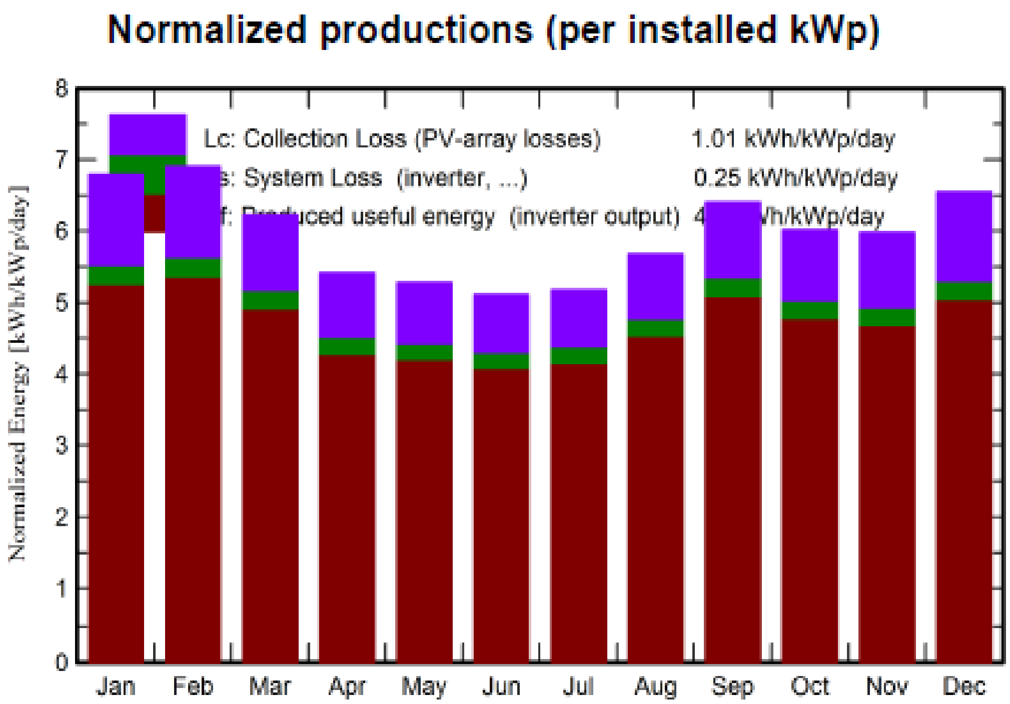


Figure III.10: Normalized energy productions per installed kWp

The simulation research assessed normalised productions such as collection losses, system losses, and produced useable energy per installed kWp/day, as shown in (FigureIII.10). The IEC rules establish these normalised outputs, which are standardised variables for evaluating PV system performance. Lc denotes the collection losses or PV array capture losses, which are 1.01 kWh/kWp/day. Lsis the system loss, which is 0.25 kWh/kWp/day, and Yf is the produced useful energy (inverter output), which is 4.42 kWh/kWp/day.

III.8.4. Performance ratio

The yearly average performance ratio (PR) for the simulated 15 kWp photovoltaic system is 80.0%. The PR value varies somewhat on a monthly basis, as seen in FigureIII.11.

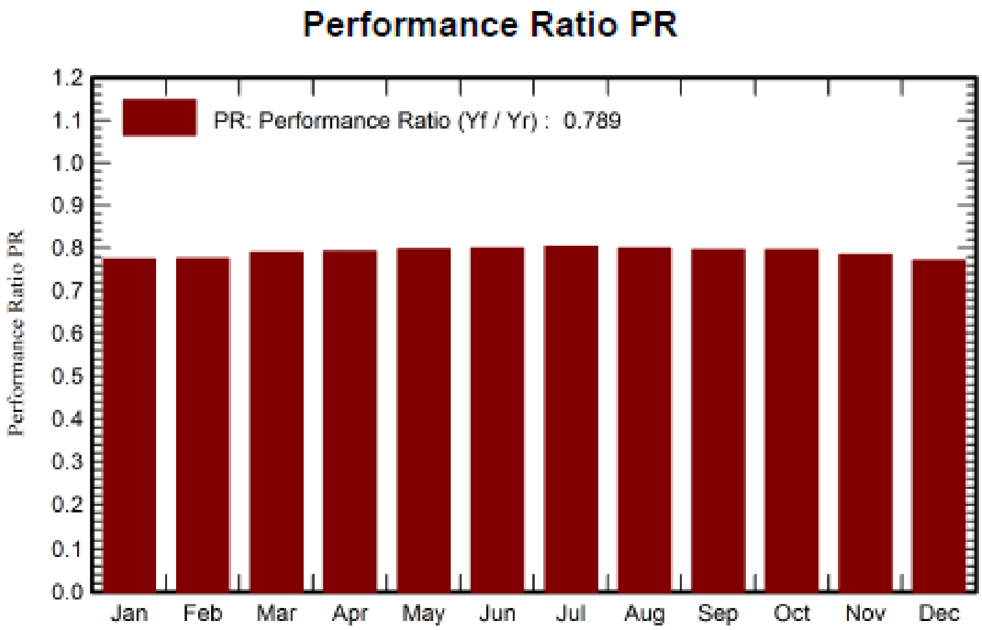


Figure III.11: Performance ratio (%)

III.8.5. Arrow loss diagram

This Figure represents all the annual losses of the PV system.

Where begins when solar radiation enters the photovoltaic panels and continues to the grid supplied by the energy generated by the system. We find that the global horizontal irradiation is equal to 2165KWh/m2. The system will increase on global incident plant sensors, then it will lose 2.70% IAM factor on global. The power becomes represented by the isotropic solar radiation At 2073 kWh/m * 85 m² (area of the panels), we know the efficiency of the photovoltaic panels is -17.73%, then the nominal field energy is equal to 31289 MW, which loses a significant energy of 10.48% due to the temperature of the field, with losses for module quality of +0.75%, -2.10 % of losses mismatch.

When the energy is equal to 27224 MW, it will be connected to the inverter, which also has losses (inverter losses in operation -4.84% and inverter power threshold losses -0.03%).

The inverter produces energy 25873 Kwh which is connected to the electricity grid.

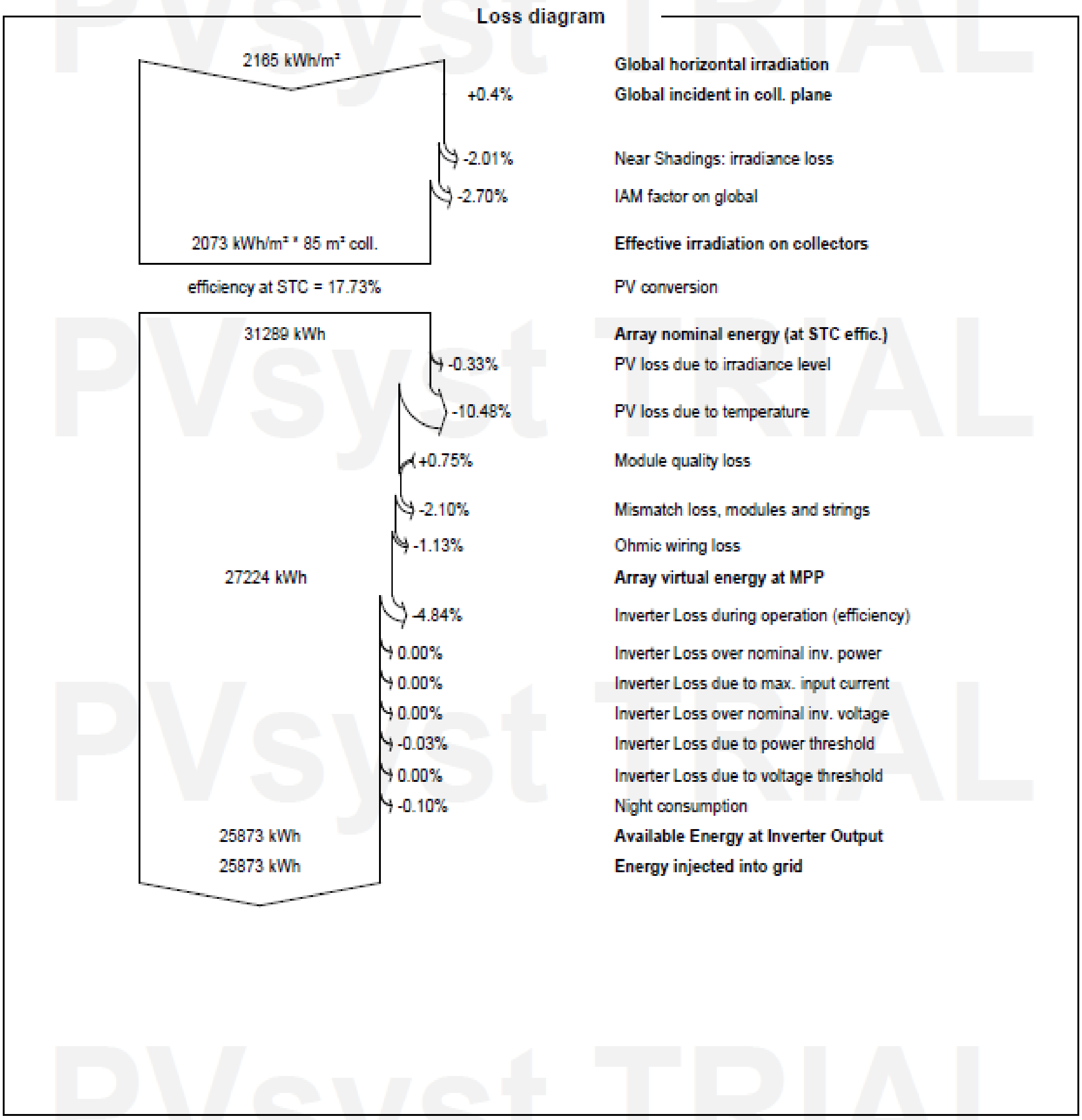


Figure III.12: Arrow loss diagram for the planned gird tied 15kWpphotovoltaic system

III.8.6. path of the sun

The knowledge of the apparent movement of the sun for a given point of the land surface is required for any solar application. The position of the sun is defined by two angles: its height HS (angle between the sun and the plane horizontal of the place) and its Azimuth AZ (angle with the direction of the south, counted negatively to the east).

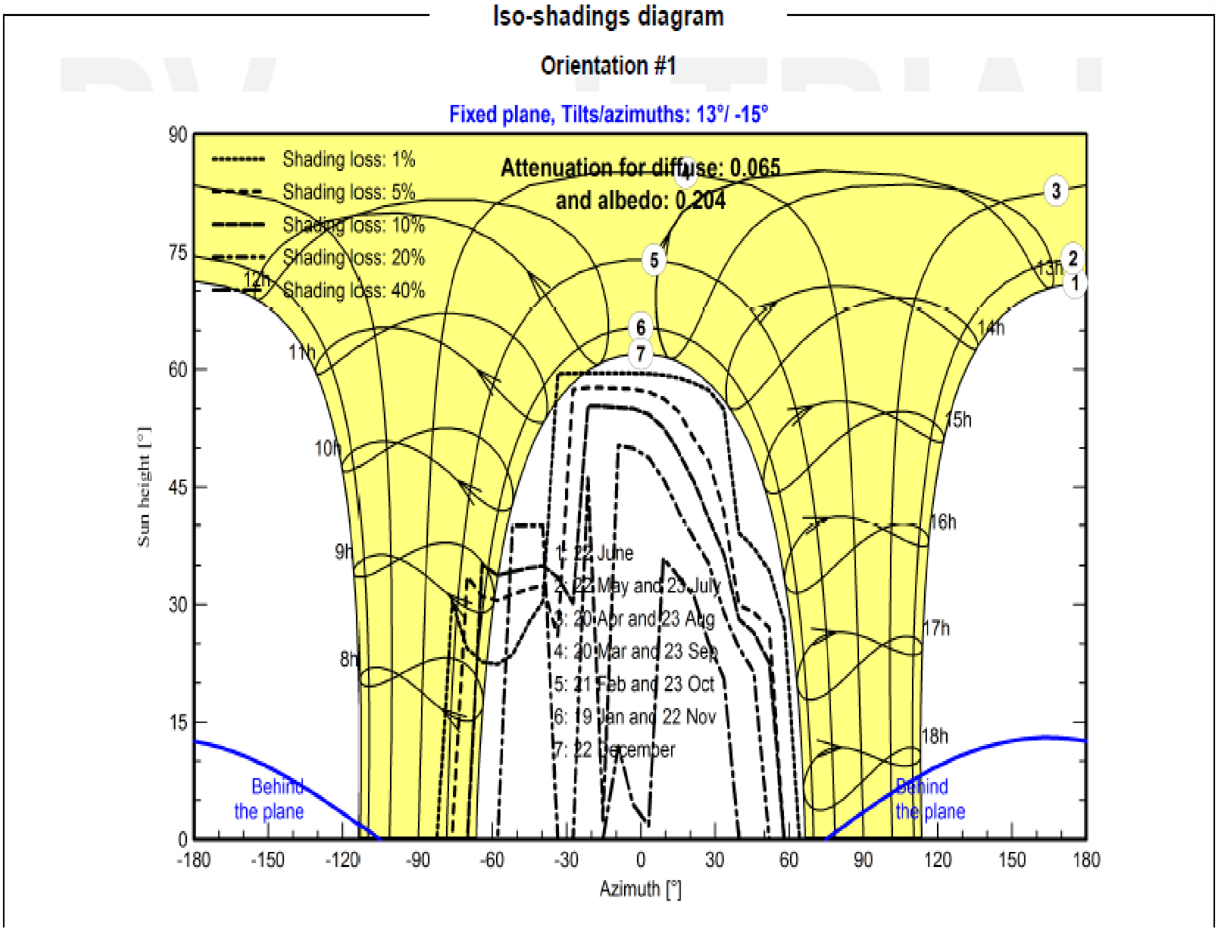
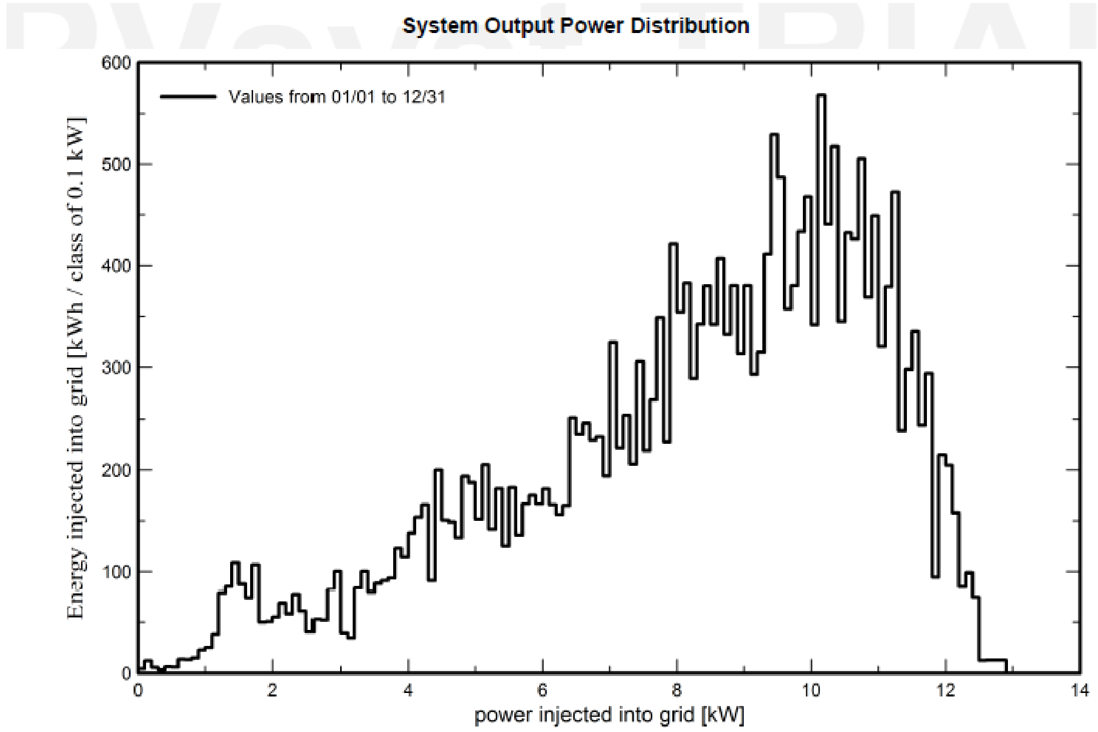


Figure III.13: Path of the sun in electricity and gas distribution company of M'sila

III.8.7. PV system output energy

This Figure shows the evolution of the energy injected into grid according to the power injected into grid,Where we notice a gradual escalation of energy into grid so that the greater the charged power in the grid , the energy values increase with it, and this is shown in the corresponding Figure from 0 to 6 kilowatts, then the energy begins to rise rapidly until it reaches its maximum value, which is estimated at about 580 kwh/class of 0.1kw at a power Charged at an estimated value of 10 kilowatts, then this energy decreases rapidly into grid until it ceases to exist at a power estimated at 13 kilowatts.

From it, we can say that the charged power in the network significantly affects the energy production of the network, especially when this force reaches the maximum values in which the energy production is maximum.



FigureIII.14: system output power distribution

III.8.8. Daily input/output diagram

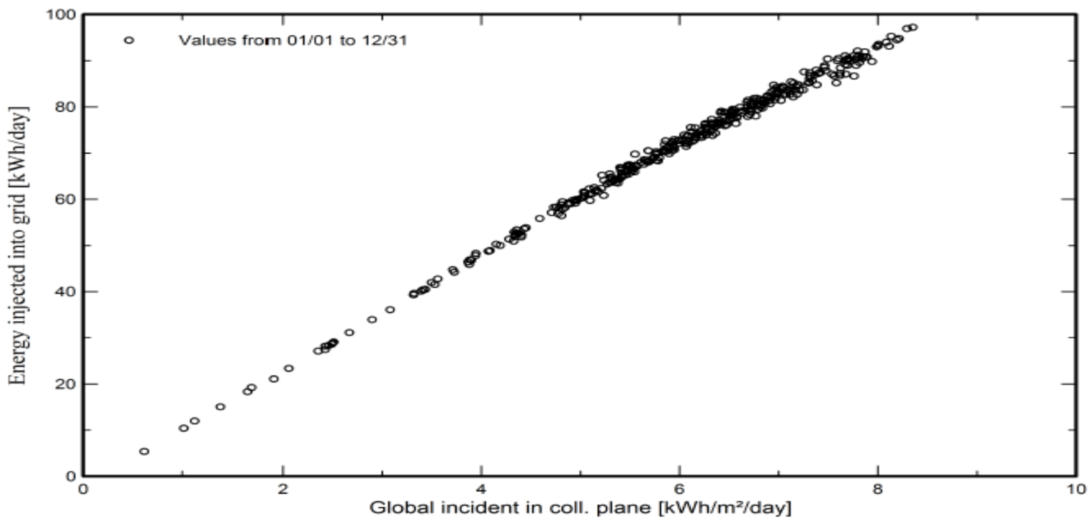


Figure III.15: diagram daily input/output diagram

A diagram representing the energy injected into grid [kwh/day] in terms global incident in coll plane [kwh/m^2/day]

III.8.9. Single line diagram

Single line diagram of the système.

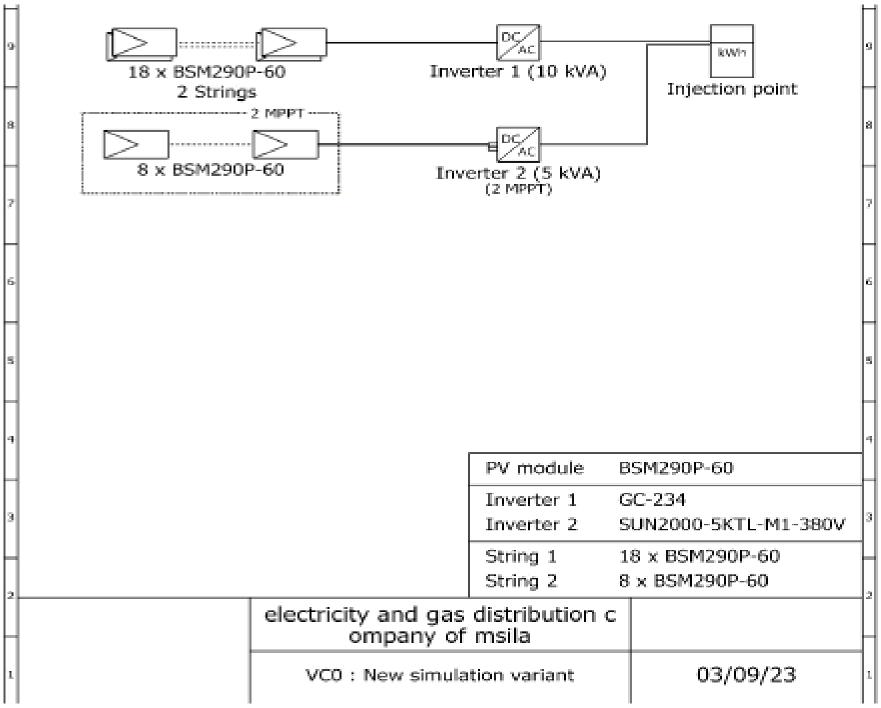


Figure III.16: Single line diagram of system

III.9. Conclusion

The process of sizing a photovoltaic installation involves attempting to strike a balance between the power needed to satisfy the indicated energy demand and the power that can be placed, both in terms of the modules and the batteries.

From we chose the photovoltaic component providers servo-controls that were most suited to our requirements from their offerings. With different modules, batteries, regulators, and inverters, different installation configurations would be possible.

ChapterIV :

Comparison of study result with installed project

IV.1. Introduction

Solar energy has now become an important renewable resource and is available daily. The use of solar energy significantly reduces dependence on oil derivatives, coal and natural gas for the production of electricity. Since it is clean and does not cause pollution, it protects the environment and does not harm the ozone layer. We can get electricity day and night as it can be stored in batteries, which will greatly reduce the financial burden of electricity bills (and this is the matter that we studied in this project).

This chapter we will compare the results of our study with the results of the project installed in the electricity and gas distribution company in M'sila.

IV.2. Comparison

We have sized and studied the pv system project of the electricity and gas distribution company in M'sila, and we have concluded that our study is similar to their project, and we are satisfied with the work that they have done. Below we will comparesolar panels, inverters,battery, module area and cable:

IV.2.1. Solar panels comparison

In the following table, we will compare the most important characteristics of the solar panel.

Table IV.1 : Solar panels comparison

	Study work	in the project of company
The brand	Bluesun solar	Bluesun solar
Model Type	BSM290P-60	BSM290P-60
Solar cell Type	Polycrystalline	Polycrystalline
Pm	290W	290W
number of panels used in this system	52	52

IV.2.2. Inverters comparison

In the table IV.2 we compare the inverters used in our study and the project of company.

Table IV.2 : Inverters comparison

	Study work	in the project of company
Number of inverter used In this system	2(10KW,5KW)	2(10KW,5KW)
The brand	Inverter 10KW :Layer Inverter 5KW :Huawei Technologies	Inverter 10KW :Deye Inverter 5KW :Solax
Model Type	Inverter 10KW :Layer_GC234 Inverter 5KW :Huawei_SUN2000 _5KTL_M1_380V	Inverter 10KW :SUN-10K -SG04LP3-EU Inverter 5KW : X3-5.0-S
Produce type	Inverter 10KW:hybrid	Inverter 10KW:hybrid

IV.2.3. Battery comparison

Table IV.3 represent a comparison of the studied and project battery

Table IV.3 :Battery comparison

	Study work	in the project of company
number of battery used inthis system	4	12
The brand	Master Energy	Master Energy
Type	Gel	Gel
number of batteries in series	4	4

Figure 1.IV:the battery used in the project.

IV.2.4. Other comparison

Table IV.4:Other comparison

	Study work	in the project of company
Module area	85m^2	85m^2
The section of the cable	4mm^2	4mm^2

Nb. of modules	52
Module area	85 m²
Nb. of inverters	2
Nominal PV Power	15.1 kWp
Nominal AC Power	15.0 kWAC
Pnom ratio	1.005

Figure IV.2: global system summary in our study

IV.3. Comment on the comparison results

The increase in the number of batteries in the system installed in the company , which is estimated at 8 additional batteries, is due to the company's desire to avoid the possibility of a problem with the four batteries and thus in anticipation of any malfunction.

IV.4. Conclusion

In this chapter, we made a general comparison between the elementspropertiesinthe solar system that we used in our simulation with the PVsyst, and the properties of the components of the solar system installed in the Gas and Electricity Distribution Company in M'sila.(batteries, inverters, cable,and solar panels,…).

So we concluded that two important things must be mentioned when installing a solar system

First - Choosing equipment with good characteristics that are available in the market because it plays an important role in the efficiency of the solar system.

Secondly - the need to study the system by sizing of all the elements involved in it, and this is to obtain the desired amount of electrical energyand reduce losses.

General Conclusion

The general objective of our work is a study,sizing and simulate of photovoltaic system in the gas and electricity distribution company of M'sila by PVsyst software, in order to calculate and analyze various performance parameters ofPhotovoltaic system such as: loss, and efficiency of the system.

In the first chapter , we presented the definition of the main renewable energy for our thesis "Solar Energy"and photovoltaic solar energy by describing the principle of the photovoltaic effect, the structure of cells and thecharacteristics ,In addition we presented the photovoltaic system in its two types (stand-alone and connected to the network), and at the end we talked about the basic elements of the photovoltaic system, including batteries, inverters, and regulators, especially MPPT regulators.

In the second section, we presented the PVsyst and its options - we also explained the methods and simulation steps of our solar system studied by this program.

In the third chapter we analyzed and evaluated various PV system performance parameters over a 12-month period (from 1 January to31 december).we have calculated the different efficiency (final efficiency, reference,field, inverter, module and system efficiency), losses such as: lossessystem and network capture, as well as capacity factor and performance ratio. The different curves of these last parameters have been provided and analyzed tounderstandthe behavior of the system, and detect the causes that can affect negatively on system performance. These results demonstrate that the PV system is affected by these parameters: irradiationsolar, temperature and wind. Temperature has a deleterious effect on panel operation, when theincreased cell temperature, the current also increased on the other hand the voltagedecreases, this leads to a decrease in the maximum power available and of courseaffects on module and inverter operation. High temperature and causeby the increase of solar irradiation, and the winds can relieve the temperature high so the efficiency of the module and the inverter are affected by the temperature andthe solar irradiation and the efficiency of the system depends on these two efficiencies.

In the last chapter, we compared the results obtained from the simulation and the system installed at the electricity and gas distribution company in M'sila.

In the end, we say that we are satisfied with the prototype of the company of electricity and gas distribution in M'sila.

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Abstract: in this project we have done a study and a sizing of a grid connected PV system using hybrid grid inverter by a PVsyst software ,also our work consists in sizing a photovoltaic installation connected to the network located in M'sila gas and electricity distribution company to supply a load for 15kw, firstly we have studied his project needed the book conditions ,in addition we have used the sizing of the characteristics of the locate, the latitude, the temperature, the solar irradiation and the roof of company which takes into account the technical characteristics of each component . Furthermore, the implementation of the project has been studied by the load of client, the sizing of all the system (modules numbers, chooper and inverters etc ..) and all equipments and accessory.

As conclusion, the completion of the project through this program has compared the results obtained with the project realized on the PV system implemented within the company of electricity and gas distribution.

Résumé: dans ce projet, nous avons réalisé une étude et un dimensionnement d'un système PV connecté au réseau utilisant un onduleur de réseau hybride par un logiciel PVsyst, également notre travail consiste à dimensionner une installation photovoltaïque connectée au réseau située dans la société de distribution de gaz et d'électricité de M'sila pour alimenter un charge pour 15kw, dans un premier temps nous avons étudié son projet nécessaire aux conditions du livre , de plus nous avons utilisé le dimensionnement des caractéristiques du local, la latitude, la température, l'ensoleillement et le toit d'entreprise qui prend en compte les caractéristiques techniques de chaque composant. De plus, la réalisation du projet a été étudiée par la charge du client, le dimensionnement de tout le système (numéros de modules, chooper et onduleurs etc..) et de tous les équipements et accessoires.

En conclusion, la réalisation du projet à travers ce programme a permis de comparer les résultats obtenus avec le projet réalisé sur le système PV mis en place au sein de la Société de distribution d'électricité et de gaz.

ملخص:في هذا المشروع ، قمنا بدراسة وتحديد حجم النظام الكهروضوئي المتصل بالشبكة باستخدام محول الشبكة الهجين بواسطة برنامج PVsyst ، كما يتمثل عملنا في تحديد حجم التركيب الكهروضوئي المتصل بالشبكة الموجودة في شركة توزيع الغاز والكهرباء المسيلة لتزويد الحمل لـ 15kw ، أولاً قمنا بدراسة مشروعه الذي يحتاج إلى شروط الكتاب ، بالإضافة إلى أننا استخدمنا تحجيم خصائص الموقع وخط العرض ودرجة الحرارة والإشعاع الشمسي وسقف الشركة الذي يأخذ في الاعتبار الخصائص التقنية من كل مكون. علاوة على ذلك ، تمت دراسة تنفيذ المشروع من خلال حمل العميل ، وتحجيم كل النظام (أرقام الوحدات ، والعاكسات والمحولات ، إلخ ..) وجميع المعدات والملحقات.

في الختام ، أدى استكمال المشروع من خلال هذا البرنامج إلى مقارنة النتائج التي تم الحصول عليها مع المشروع المحقق على نظام الطاقة الكهروضوئية المنفذ داخل شركة توزيع الكهرباء والغاز.