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Entitled

A study of a 1 KW photovoltaic installation inside the university pole of M'sila

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Thanks

In the name of god the most Merciful

After obeying God then with the learner's mother, our study career, and thank God for that.

We want to take this opportunity to first thank the supervisor, Dr. Mohamed SALMI for his kind treatment and his good manners because we do not forget his precious time and his numerous information and gave us the positive points of his experience in his educational career, Thank you very much.

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- Dr. Djedid TALOUB, Teaching at the University of M'sila to have agreed to examine our work
- To thank Us Mr. Djamal FRIDJA, Teaching at the University of M'sila to have granted the honor to us to assist with us jury.

Thank us the jury for granting us the honor of attending us jury of defense.

Dedication

I dedicate this humble work

To the only person who counts very for me

My mother to provide all the means of supports of love

Of encouragement and hope for the end of this memory

My brothers and my Sister for your unfinished assistance

All my friends and all those which are expensive to me

GUESSABI KHAOULA

Dedication

I dedicate this memory

To my very dear mother and my dear father

Who gives for me the assistance, courage and the force has

My brothers and my sisters without exception

All the friends who study with me and known

BEN ZOUAD NACER

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List of Symbol

PV: Photovoltaic

GSA: German Space Agency

I_c : Solar constant

I_0 : Current average value

N: Number of the day in the month

L: Longitude

a: Azimut

h: Height

TS: Solar time in the day

W: Time angle

δ : declination

j: Number of the day of the year

w_l : Hourly angle at sunrise

w_c : Hourly angle at sunset

d: Length of the day

TL: Legal time

TCF: Colander time

C: Difference (determined by each country)

TU: Universal time

1-Iref: Difference in longitude

ET: Time equation

S: Actuel duration

S_0 : Maximum duration of sunshine

N: Negative doping

P: Positive doping

I_{cc} : Short circuit current

I_{ph} : Current photo

G: Electron hole

L_n, L_p : Diffusion length

V_{OC} : Circuit –open voltage

K: Boltzmann constant

T: Temperature

P_m : Maximum power

P: Power measured at PV cell terminals

V: Voltage measured at PV cell terminals

I: Intensity measured at PV cell terminals

I_m : Maximum intensity measured at PV cell terminals

V_m : Maximum voltage measured at PV cell terminals

P_I : Ideal maximum power

P_0 : Power of the solar radiation incident

DC: Direct current

AC: Alternative current

UPS: Inverter

A: Cable strength in ohms

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Introduction

Introduction

Introduction

As Algeria has enormous potential for solar energy. For years, our country has been committed to exploiting this renewable energy by wanting to go far in this field, following the world trend in the exploitation of renewable energies. It depends on scientific research in Algerian universities in cooperation with international skills.

Researchers in this field have emphasized the advantages of renewable energies such as its properties, its reasonable impact on a language of operating time and above all that it is inexhaustible.

For this, we had the idea of the practical work of solar energy by applying new simulations in this area. From there, we can ask the following question: how to simulate a photovoltaic system chain through new software which is polysun?

The objective of this research work is to allow all students, including graduates, to quickly understand the concepts of photovoltaic system, to provide models, to control and to optimize this application using polysun software.

The realization of this subject arrives within the framework of the research works which are made by the team of renewable energies, which are doctoral students and masters, directed by Dr. SALMI

Our research is divided in to three chapters:

The first chapter is an introduction; it defines everything about solar energy in Algeria.

The second chapter studies theoretically on photovoltaic systems and presensation of polysun. In the third chapter, we present the simulation results of the polysun of our photovoltaic installation of 1KW.

Finally, we end with a conclusion of the work carried out as well as the main results.

Chapter I

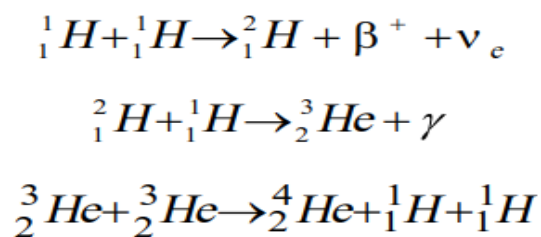
Fundamentals of solar energy

1-1- Origin of solar energy

Solar energy comes from the fusion of hydrogen into helium in the nucleus of our star. Two cycles were invented by astrophysicists to describe the steps leading to this fusion.

a- Proton-Proton cycle

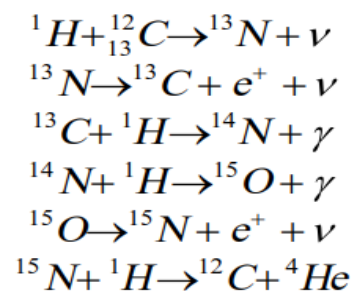
The proton-proton cycle provides 90% of the solar energy. The nuclear reactions to this cycle are governed by the following equations (1.1):



The notation ${}^1_1\text{H}$ represents the nucleus of the hydrogen atom 1, i.e. a proton (electromagnetic radiation).

b- carbon cycle

The Carbon cycle provides the remaining 10% of the solar energy was discovered by Hans Bethe and Carl von in 1938. Reactions involving carbon and nitrogen form a cycle; This latter remains repetitive as long as the presence of hydrogen remains: The series of transformations is represented by the following reactions(1.2): [1]



This cycle can be schematized by the diagram

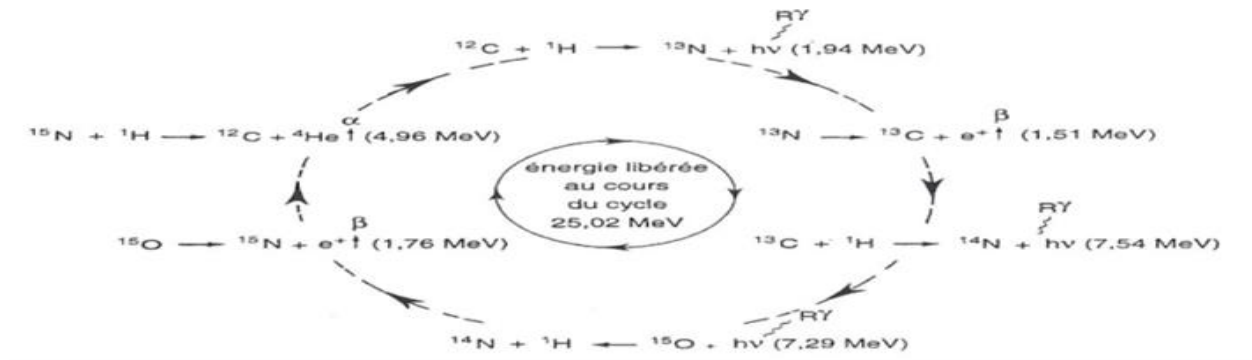


Figure (1.1) Carbon cycle diagram

1-2- Sun is

The sun is the source of life; but it is a small part of the universe in our solar system. It plays a very crucial role for us here on Earth. Our sun was formed about 4.5 billion years ago. It is composed of about 91% of hydrogen the sun's fuel, 8.9% helium and 0.1% of other heavier elements such as carbon and nitrogen. Due to the extreme temperatures of the sun, these elements remain in a phase that is similar to the gas plasma [2].

At the center, the temperature of 15 million $^{\circ}\text{C}$ combined with the powerful gravity of the sun, fuses the hydrogen molecules together to create helium called thermonuclear fusion. It transforms every second 700 million tons of hydrogen, and releases energy in the form of radiation, electricity and solar wind equals $4 \cdot 10^{26}$ W. Its speed of light 299292 km/s; comes the earth in 8 mn called the astrological unit; the distance between the sun and the earth is 150 million kilometers and its mass is $2 \cdot 10^{30}$ kg [1].

1-2-1-Sun properties

Table (1.1) shows the main physical properties of the sun [3].

Characteristics	Volume
mass	$1.989 \cdot 10^{30}$ Kg
diameter	$1.392 \cdot 10^9$ m
Average density	1410 Kg /m^3

Radiated power	$3.83 \cdot 10^{26} \text{ W}$
Temperature Surface	5770 K°
Speed of movement	$216 \text{ Km} \cdot \text{s}^{-1}$

Tableau (1.1) :Properties of the sun

1-2-2- Key Sun Features

The sun can be divided into six layers: the crown, the chromosphere, the photosphere, the convective zone, the radiative zone and the nucleus which are atoms; but there exists three major regions

A) Inland: where energy is created by thermonuclear reaction and which is inaccessible to investigations, because the radiation emitted in this region is several million and the pressure one billion atmosphere.

B) Photosphere: The thickness is about 300 Km which is responsible for almost all the solar radiation we receive.

C) Chromosphere and solar crown: where the material is much diluted, which explains that although the temperature is very high (1 million degrees) the radiation emitted is very low [4].

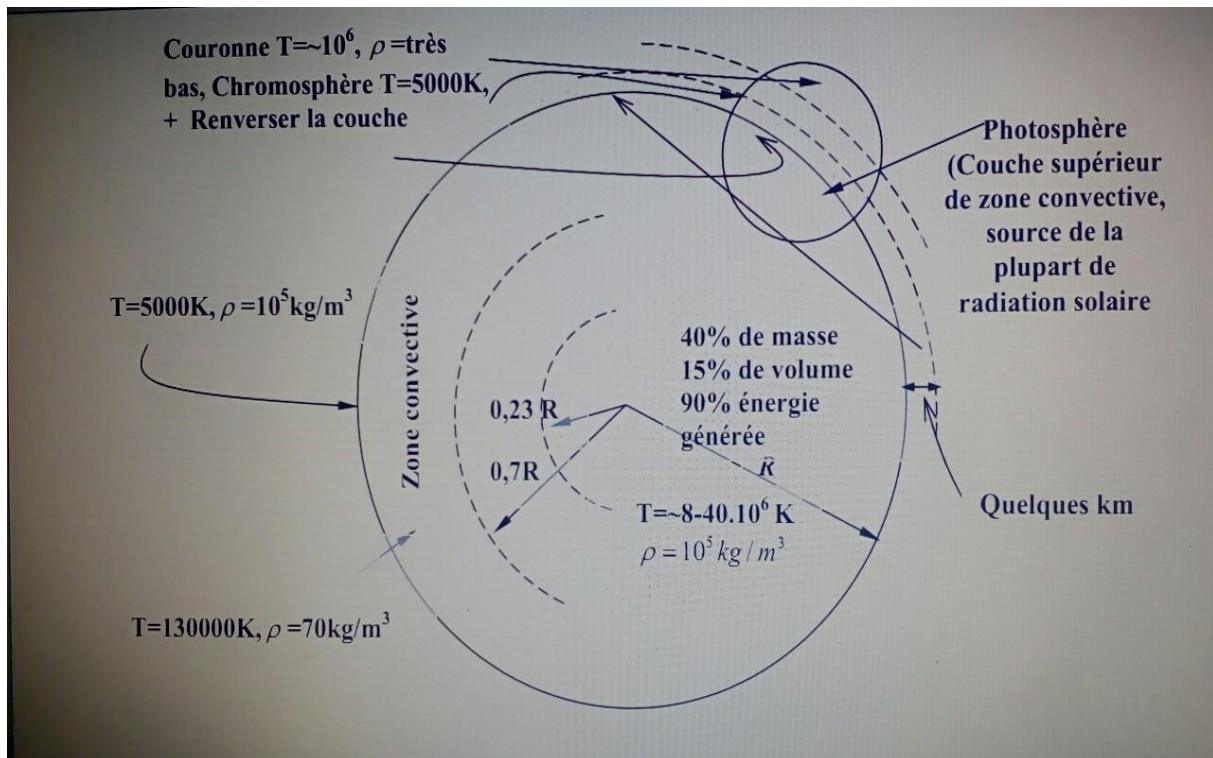


Figure (1.2) :Sun structure

1-2-3-Solar constant

The average solar flux on a plane perpendicular to the direction of the rays, placed outside the Earth's atmosphere, is called the IC solar constant. ..

The current average value is $I_0 = 1367 \text{ W/m}^2$

This value is the average for the year of alien flux.

Indeed, the trajectory of the Earth around the sun being elliptical, it follows a seasonal variation of +/- 1.6% of the distance to the sun and thus, a variation of this flux .The following equation gives the corrected value of the solar constant.

$$I_c = I_0 (1 + 0.033 \cos ((360/365) N)) \quad (1.3)$$

N: is the number of the day in the month [4].

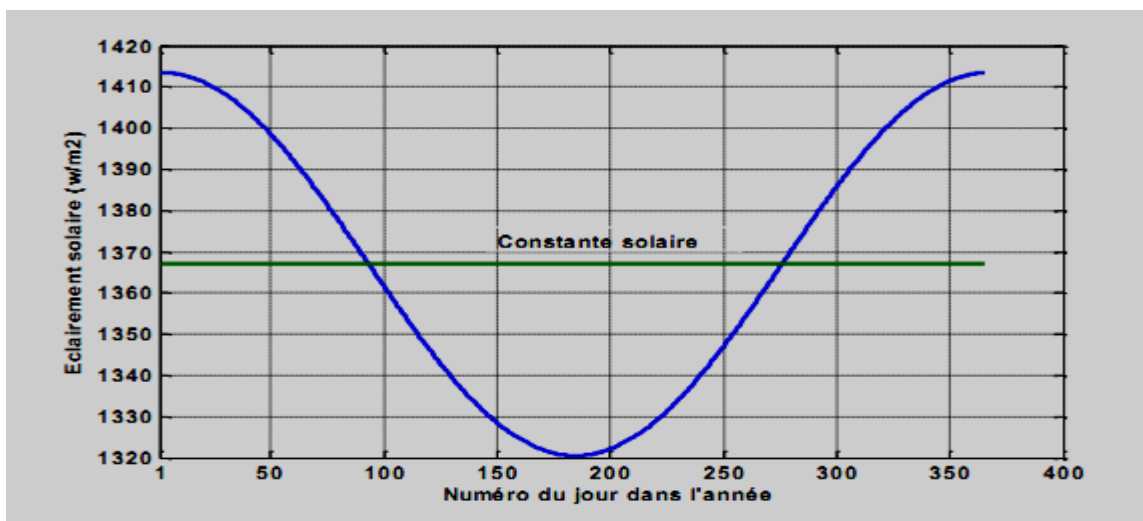


Figure (1.3): Variation of solar radiation and solar constant in year

1-3-Influence of the atmosphere

1-3-1-Definition of the atmosphere

The earth is enveloped by a layer of air from the atmosphere. Seen from space the atmosphere looks like a blue halo.

1-3-2-Composition of the atmosphere

The atmosphere is composed of a mixture of particles spaced apart, among other things; it contains 78% of the nitrogen, a gas that can be fixed by bacteria before being absorbed by plants. Then it is composed of 21% of dioxygen, which is a gas useful for breathing, and a small amount of carbon gas, which is used by green plants to photosynthesize water vapor and solid particles, as well as dust or pollen [5].

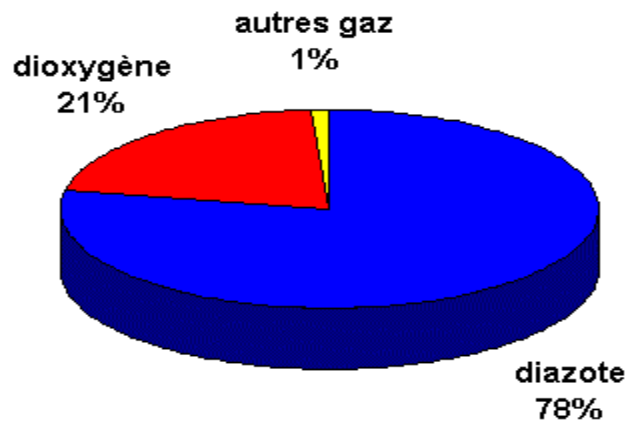


Figure (1.4): Circle defining the composition of the atmosphere

1-3-3-Atmosphere Structure

The atmosphere is divided into five layers .and the characteristics of each of them are illustrated in figure (1.5).

1-Troposphere: The first layer is between 0 and 15 Km high, it is a layer where all the weather phenomena, such as cloud formation, precipitation and storms, take place. The more you go up in the troposphere, the colder it becomes.

2-Stratosphere: At the 2nd level between 15 and 50 Km, the number of air particles decreases in this layer. The stratosphere is formed by the ozone layer. Here too, the temperature decreases as we rise.

3-Mesosphere: At. The 3rd level, between 50 and 80 km in high, the air particles are very rare and it is the coldest level of the atmosphere. The temperature decreases as you go up and it reaches the minus 80°C at the top.

4-Thermosphere: 4th level is between 80 and 500 Km high, it absorbs most of the sun's rays and the temperature is very high, it can reach 1800 C°. It is in this layer that the northern lights will form. Meteorites that enter the atmosphere burn when they arrive in that layer. It then shows a trail of light that is interpreted as shooting stars.

5- Exosphere: 5th layer or also called the layer space, located beyond 500 Km of height. One cannot measure the temperature and it is in this layer that most satellites are placed [6].

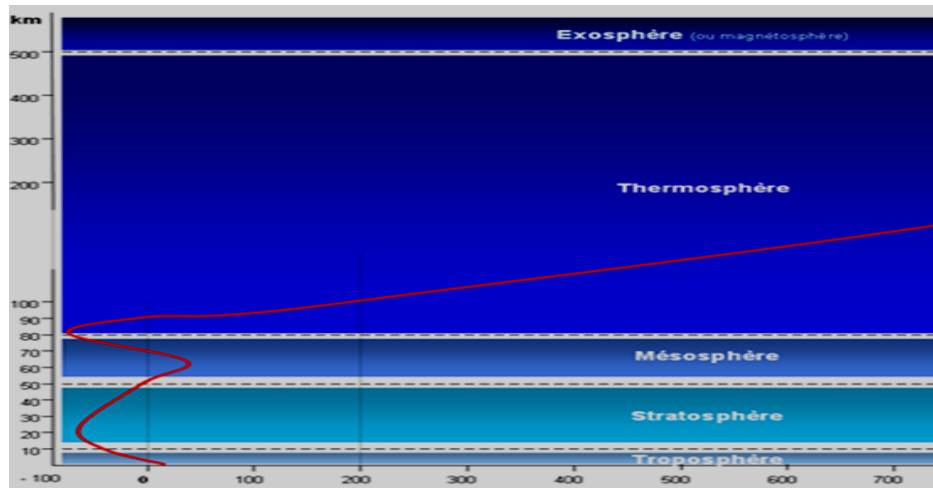


Figure (1.5): Different layers of the atmosphere (red temperature)

1-3-4-Role of the Atmosphere

Without atmosphere, life on earth would not have been possible. The atmosphere is a kind of protective cocoon.

The ozone layer stops the ultraviolet rays sent by the sun. Without this layer, life on earth would be impossible because we would be burned by the rays of the sun. The atmosphere also protects us from the bombardment of meteorites. Most of these meteorites disintegrate by burning in the atmosphere and give birth to the shooting stars [7].

1-3-5- greenhouse effect

The atmosphere is transparent and permits light to pass, but it acts as a giant greenhouse that allows the earth to maintain more or less stable temperatures. The greenhouse effect is a natural phenomenon on that is due to the presence of the atmosphere and that prevents all infrared rays from getting lost in space .Some of these rays remain trapped in the atmosphere, which helps to maintain constant temperatures [8].

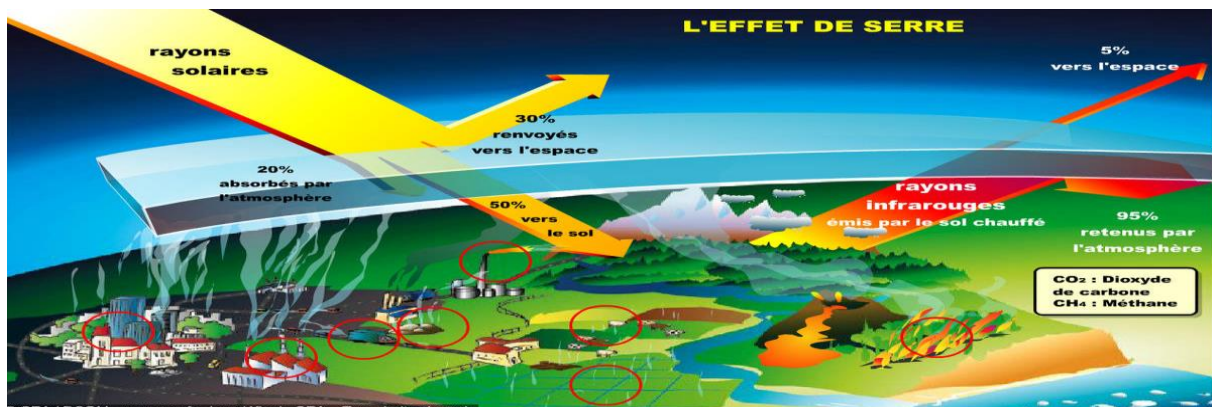


Figure (1.6): Greenhouse effect phenomén

1-3-6-Absorption of the atmosphere

When radiation flows through the atmosphere, it is partially or completely absorbed by its composing molecules, then gives energy to the atmosphere.

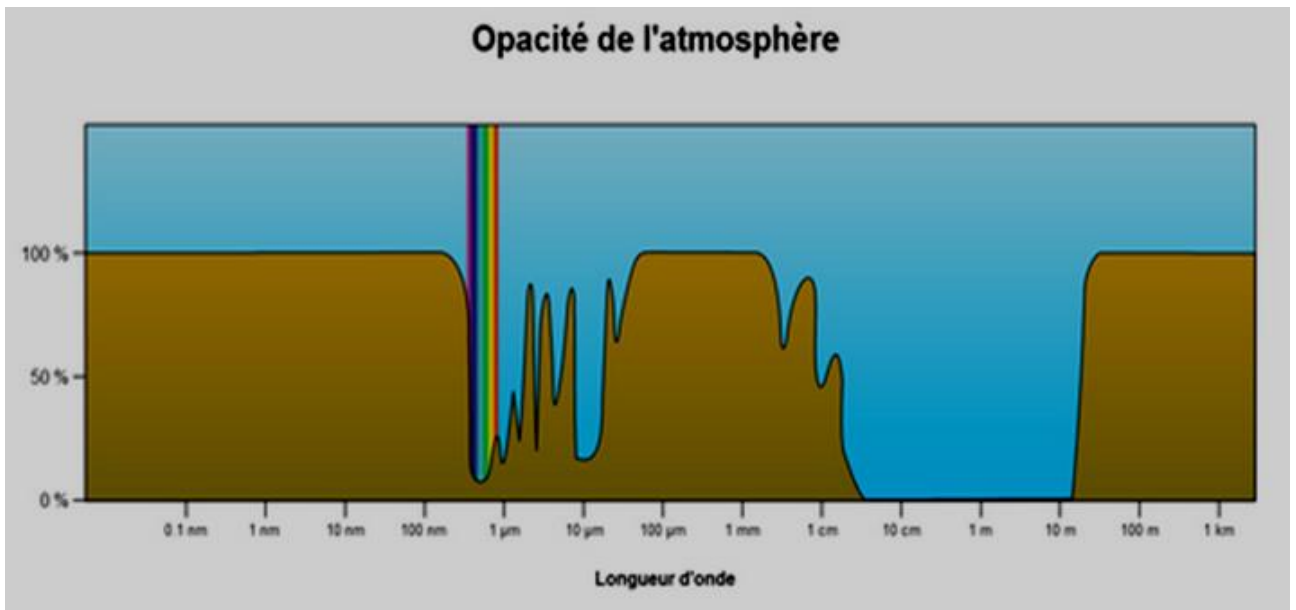


Figure (1.7): Opacity curve of the atmosphere

- Gamma radiation, X-rays and ultraviolet radiation are completely absorbed by ozone.
- Visible radiation and near infrared are very little absorbed by the atmosphere.
- Infrared and thermal infrared radiation is mainly absorbed.
- Far infrared radiation is absorbed by water vapor and carbon dioxide from the atmosphere.
- Radio waves are not absorbed [9].

1-3-7-Solar radius scattering phenomenon

Radiation can interact with particles and molecules present in the atmosphere as obstacles to the spread of energy. When the radiation is not absorbed, it can be partially diverted in all directions. This is the phenomenon of atmospheric diffusion, the nature of which depends on several parameters:

- The wave length of the radiation
- density and size of atmospheric particles and molecules
- The thickness of the atmospheric layer to be crossed.

There are three types of broadcasting: the diffusion of Rayleigh and the diffusion of Mie, Diffusion of selective.

a-broadcaste of Rayleigh

The diffusion of Rayleigh is due to the gaseous molecules present in the atmosphere (O_2 , N_2 , CO_2 , water vapor ...) or fine dust particles. It occurs when the size of the diffusing molecules

is much lower than the wave length of the radiation. The diffused intensity is then inversely proportional to the power 4th of the wave length of the incident radiation. The diffusion of Rayleigh is therefore a selective phenomenon that occurs on everything for the shortest wavelengths of the spectrum (purple, blue). It affects the high atmosphere and explains the blue color of the sky during the day. The shortest (blue) wave lengths of solar radiation are more diffused than the larger (red) wavelengths, so the sky appears blue to the observer. At dawn or dusk. On the other hand, when the sun is low on the horizon, the thickness of the atmospheric layer crossed by radiation is much greater than during the day. The short wavelengths are fully scattered, only the largest wave lengths (red) are seen, and the sky appears red orange in the direction of the sun.

b- Dissemination of Mie

When the size of the particles is of the order of magnitude or greater than the wave length of the radiation, Rayleigh's diffusion no longer occurs and gives way to Mie's diffusion. Water droplets, ice crystals, or aerosols in the atmosphere (dust, smoke) layer are the main carriers of Mie's diffusion. Much less selective than Rayleigh diffusion, Mie diffusion is inversely proportional to the wavelength of the incident radiation. Rather, it occurs in the lower layers of the atmosphere (which contain more aerosols) and gives the color of the sky a washed blue and yellowish appearance, with all wave lengths being diffused in the same way.

c- Non-selective diffusion

Non-selective diffusion occurs when the size of atmospheric particles is much larger than the wave length of radiation. It is due in particular to water droplets found in clouds and mists. Non-selective scattering affects all wave lengths, which explains the white color of clouds [10].

e- Albedo

This is the fraction of an incident radiation broadcast or reflected by an obstacle. As this term is generally reserved for the ground or clouds, it is an average value of their reflectance for the radiation in question and for all possible angles of impact [11].

1-4- Coordinate System

1-4-1-Geographical coordinates

It is the angular coordinates (L and Ft) that allow the identification of a point on the earth as shown in Figure (1.8), such as:

-Longitude L , is counted positively to the east and negatively to the West, from the Greenwich Meridian. [12].

-The latitude, so that you can spot the angular distance of any point on the equator. It varies from 0° to 90° in the northern hemisphere and from 0° to -90° in the southern hemisphere

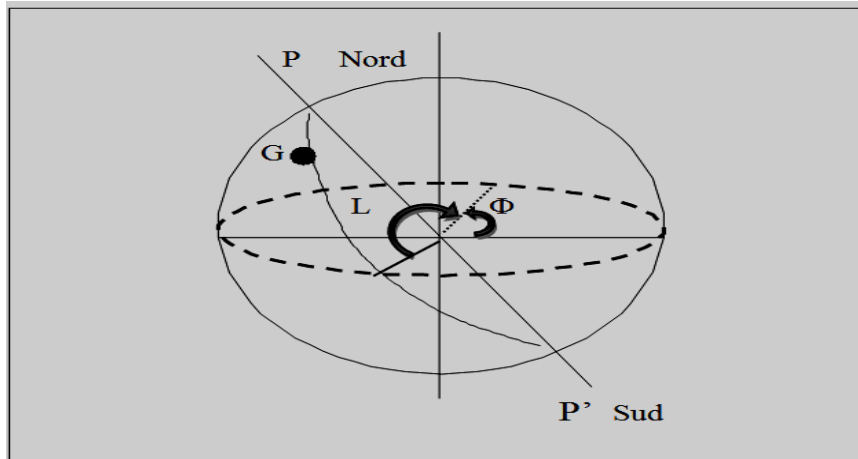


Figure (1.8) : Geographical coordinates

1-4-2-Horizontal Coordinate

The horizontal coordinates are characterized in the celestial sphere by two angles:

- The azimuth a , it's the angle made by the projection of the direction of the sun on the horizontal plane with direction south. It is counted from 0° to 360° from West to east, or from 0° to 180° from south to West.

- The height h , it's the angle that the direction of the sun makes with its projection. It is 0° to 90° towards the zenith and 0° to -90° towards the nadir.

Sometimes the complement of the h angle is called zenithal distance:

$Z + h = 90^\circ$ (Figure 1.9)

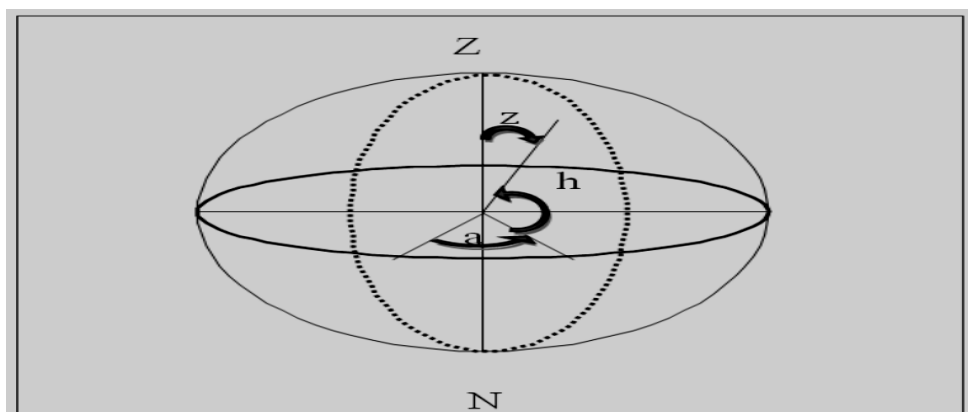


Figure (1.9): Horizontal coordinates.

These two angles are dependent on

- The latitude L of the place.
- TS solar time in the day
- Date-y (the number of the day of the year).

The latitude L and the date j are used to determine the path of the sun in the sky and the time TS gives the time taken by the earth to take a tour on it self. One day was divided into 24 hours and the TS solar time was defined by setting TS = 12 hours when the sun is at maximum height (the sun is at its "Zenith") [12].

The time angle ω also defined by:

$$\omega = 15^\circ (\text{TS} - 12) \quad (1.4)$$

ω is counted positively in the afternoon.

The height h of the sun can then be deduced from the relationship:

$$\text{Sin} (h) = \text{sin} (L) \text{sin} (\delta) + \text{cos} (L) \text{cos} (\delta) \text{cos} (\omega) \quad (1.5)$$

And azimuth has through the relationship:

$$\text{Sin} (a) = \frac{\text{cos} (\delta) \text{sin} (\omega)}{\text{Cos} (h)} \quad (1.6)$$

1-4-3- Time Coordinates

In Figure 1.10, the hourly coordinates in the celestial sphere are identified by:

- The declination strike is the angle made by the equator plane with that of the ecliptic. It varies over the year from $+23^\circ 27'$ to $-23^\circ 27'$ and determines the uneven duration of days.
- Time angle ω : it is determined by the regular rotation of the earth around its axis.

It is counted positively in the retrograde direction from 0° to 360° [12].

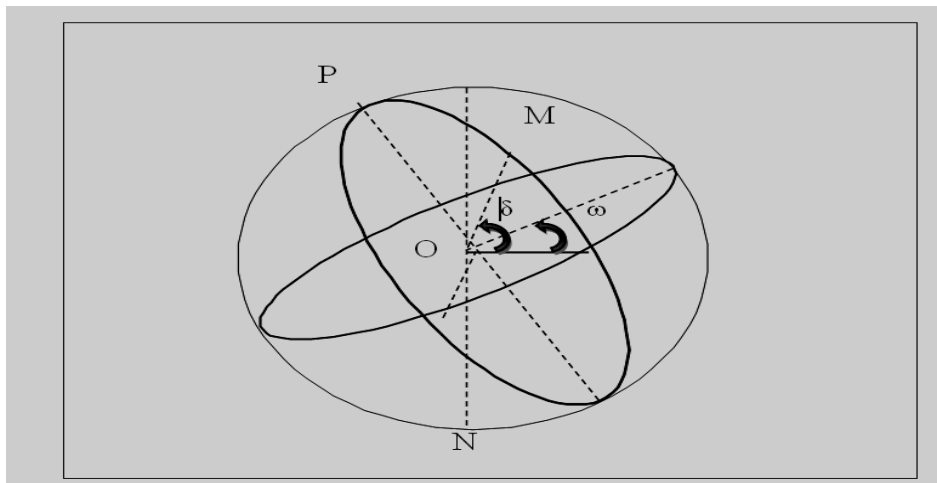


Figure (1.10): Time coordinates.

1-5- earth Movements

The trajectory of the earth around the sun is an ellipse whose sun is one of the hotspots, the plane of this ellipse is called the ecliptic. The eccentricity of this ellipse is low, which means that the earth-to-sun distance varies only $\pm 1.7\%$ from the average distance of 150 million Km (149475.106 Km).

The earth also revolves around itself around an axis called the pole axis. The plane perpendicular to the axis of the poles and passing through the center of the earth is called the equator. The movements of the earth around its axis and around the sun are illustrated on the figure (1.11)

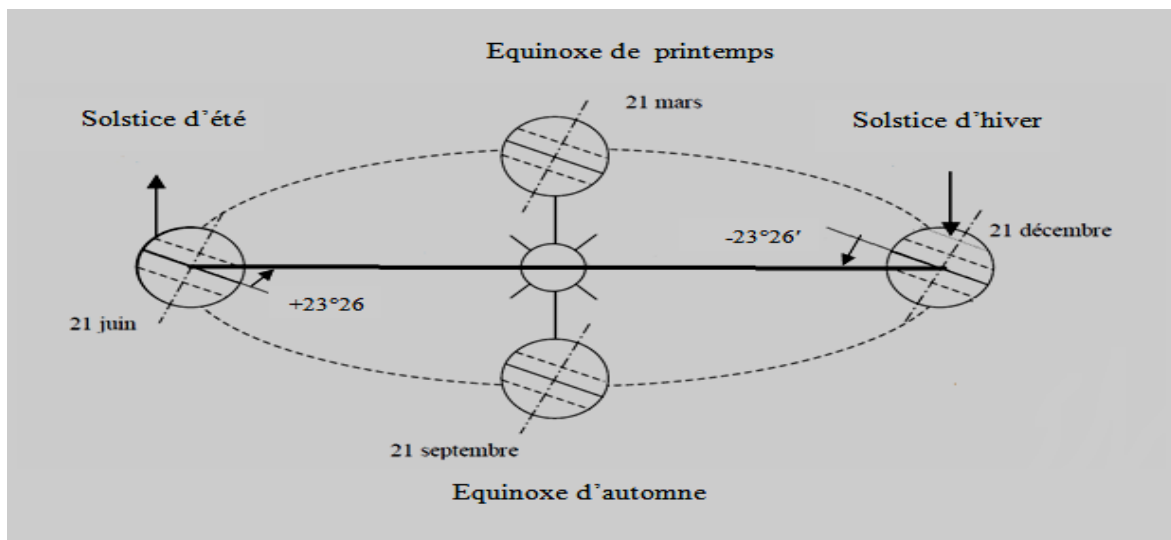


Figure (1.11): Schematization of earth movements of around the sun.

The angle formed by the direction of the sun with the equatorial plane is called "declination", it varies during the year between -23.45° and $+23.45^\circ$, it is zero at equinoxes (March 21 and September 21), maximum at summer solstice (June 21) and minimum at Winter solstice (December 21). The declination value can be calculated by the relationship:

$$ET = 23.45 \sin [0.980(j + 284)] \quad (1.6)$$

Where I is the number of the day of the year [12].

1-5-1-Seeming motion of the sun

The apparent motion of the sun seen by fixed observer at a latitude L point north of the equator is shown in figure (1.12)

At solar noon, the angle of the direction of the sun with the vertical of the place is equal to (L- strike).

The day time is 12 h at equinoxes, it is less than 12 h between September 21 and March 21 and more than 12 h between March 21 and September 21 [12].

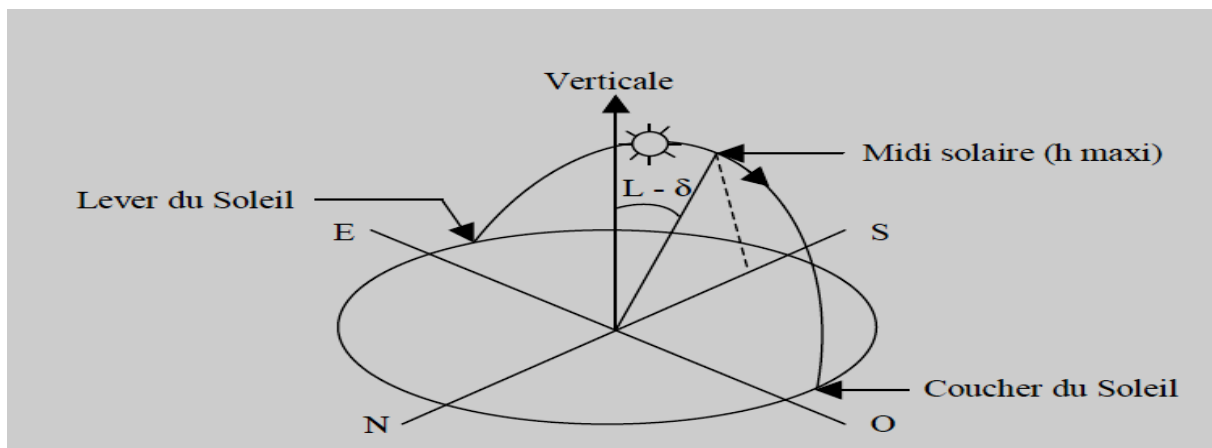


Figure (1.12): Seeming movement of the sun observed at a latitude point.

1-5-2- Time and day

a- Duration of day:

The module ω the hourly angle at sunrise is obtained by writing $\sin (h) = 0$ Which leads to [12]:

$$\cos (\omega) = - \text{Tang} (L) \text{Tang} (\delta) \quad (1.7)$$

Sunrise time is therefore of value:

$$(TS) 1 = 12 - \frac{\omega_1}{15} \quad (1.8)$$

The hourly angle ω_c at sunset is the opposite of the hourly angle at sunrise, so we have $\omega_c = -\omega_1$ and the length of the day:

$$d = 2 \frac{\omega_1}{15} \quad (1.9)$$

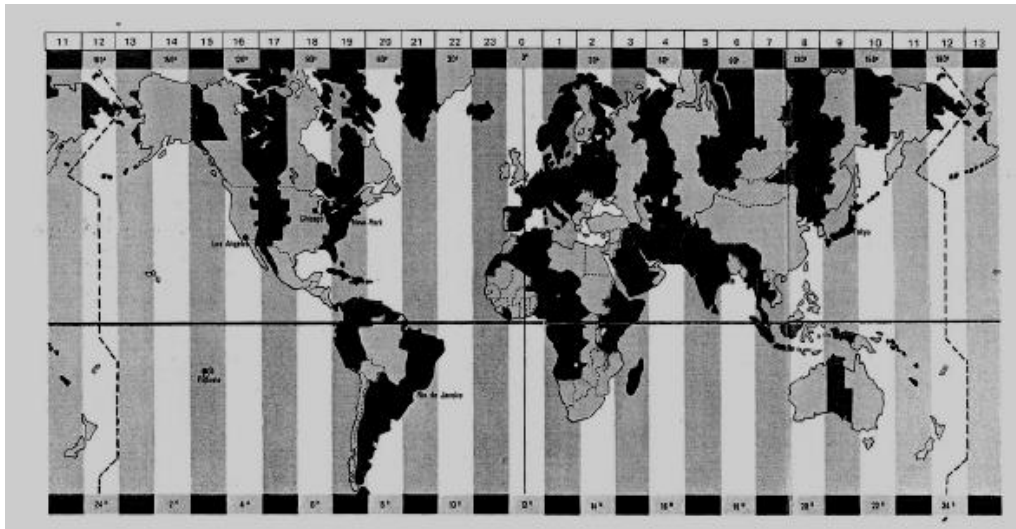
b- Relationship between legal time and solar time

Relationship related to the movement of the sun use TS solar time, which is generally different from TL (Watch time) statutory time of the location. This difference is related to:

- The difference (determined by each country) between the legal time TL and the calendar time TCF of the hourly beam in which it is:

$$C = TL - TCF \quad (1.10)$$

- The calendar time TCF of the hourly beam is equal to the universal time TU (Greenwich Meridian Solar Time) plus the hourly time value shown in Figure (1.13)



Figure(1.13): Hourly offset from Greenwich meridian.

- The difference in longitude ($l - l_{ref}$) between the place in question and the place of reference to legal time (usually the center of the beam).

The TS solar time is finally calculated by the formula:

$$TS = TL - C + ET + \frac{l_{ref} - l}{15} \quad (1.11)$$

15

The maximum correction due to the time equation is in the order of 16 mn. The first approximation may not be taken into account. The annual variations in declination and time equation are shown in Figure (1.14).

The problem is often to determine the C difference between TL and TCF at a given location, as follows:

It is possible to know TL and TU.

Hence $(TL - TU)$.

- The difference $(TL - TU)$ can be read on the figure (1.13).

- On en déduit $C = (T_L - T_U) - (T_{CF} + T_U)$.(1.12) [12].

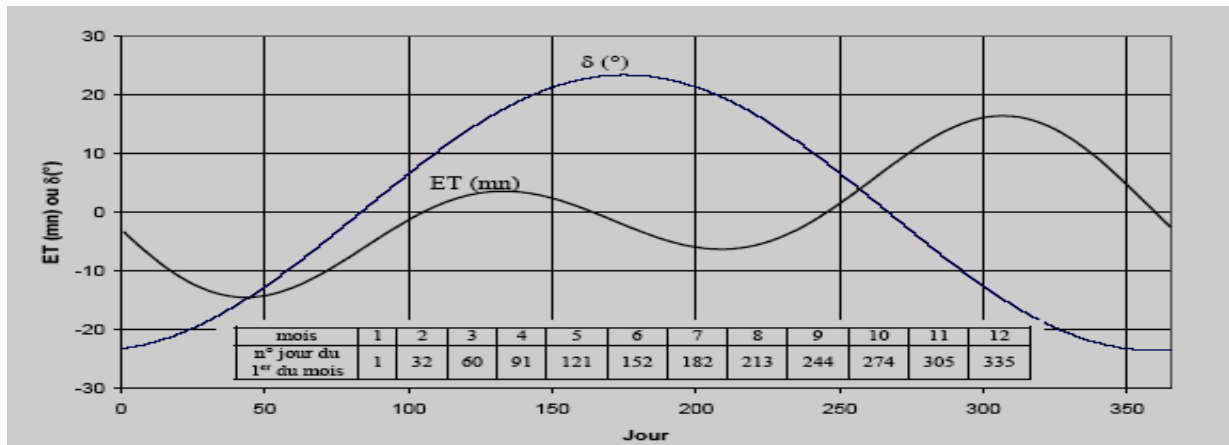


Figure (1.14): Time equation (ET) and declination as a function of the day of the year.

1-5-3- Time and sunshine

a- Sunny duration

Depending on the weather conditions, the sky can be more or less covered with clouds during a day. These cover the sun, totally or partially, preventing radiation from reaching the ground directly. It is said that cloud cover is more or less important depending on weather there are many or few clouds.

The actual duration of sunshine or sunshine S is the time during which, during a day, direct sunlight reached the soil of the site. Direct radiation is the radiation that reaches the earth's surface without having under gone a deviation since its emission by the sun [12].

b- Rates of sunshine

By clear sky without clouds, the ground receives direct sunlight for the duration of the day, or more precisely for the maximum sunshine duration S_0 . The ratio between the actual duration and the maximum duration of sunshine S_0 is referred to as sunshine or sunshine: [12].

$$\sigma = \frac{S}{S_0} \quad (1.13)$$

1-6- Solar deposit

1-6-1- Definition

The solar field is a set data describing the evolution of the solar radiation available during a given period. It is used to simulate the operation of a solar energy system and to make the most exact dimensioning possible given the demand to be satisfied. It is used in fields as varied as agriculture, meteorology, applications and energy public safety [1].

1-6-2- Solar deposit in Algeria

Algeria offers a very high solar field, ranking it among the three countries with the best solar fields in the world. The rate of solar irradiation in the northern Algerian Sahara, the Adrar region in particular, is around 1200 kWh /m².an. However, the best rates of solar irradiation in Europe are on the order of 800kWh/m².an limited to the southern part of Europe. Following a satellite assessment. The German Space Agency (GSA) concluded that Algeria represents the most important solar potential of the entire Mediterranean basin, i.e. 169,000 TWh/yr for thermal solar, 13.9 TWh/yr for Photovoltaic solar. The Algerian solar potential is the equivalent of 10 large natural gas deposits that have reportedly been discovered at Hassi R'Mel. [13]

1-6-3- Solar potential in Algeria

Algeria has one of the largest solar deposits in the world. The duration of sunshine on almost the entire national territory exceeds 2000 hours annually and reaches 3900 hours (highlands and Sahara). The energy received daily on a horizontal surface of 1m² is in the order of 5kWh over most of the national territory, i.e. close to 1700kWh/m²/year in the north and 2263kWh/m²/year in the south of the country. The following table summarizes the solar potential in Algeria.

Regions	Coastal region	High Plateaux	Sahara
Area (%)	4	10	86
Average sunshine time (hours/year)	2650	3000	3500
Average energy received (kWh/m ² /year)	1700	1900	2650

Tableau 1.2: Characteristic of solar potential in Algeria

Figure 1.15 shows the potential for different months of the year

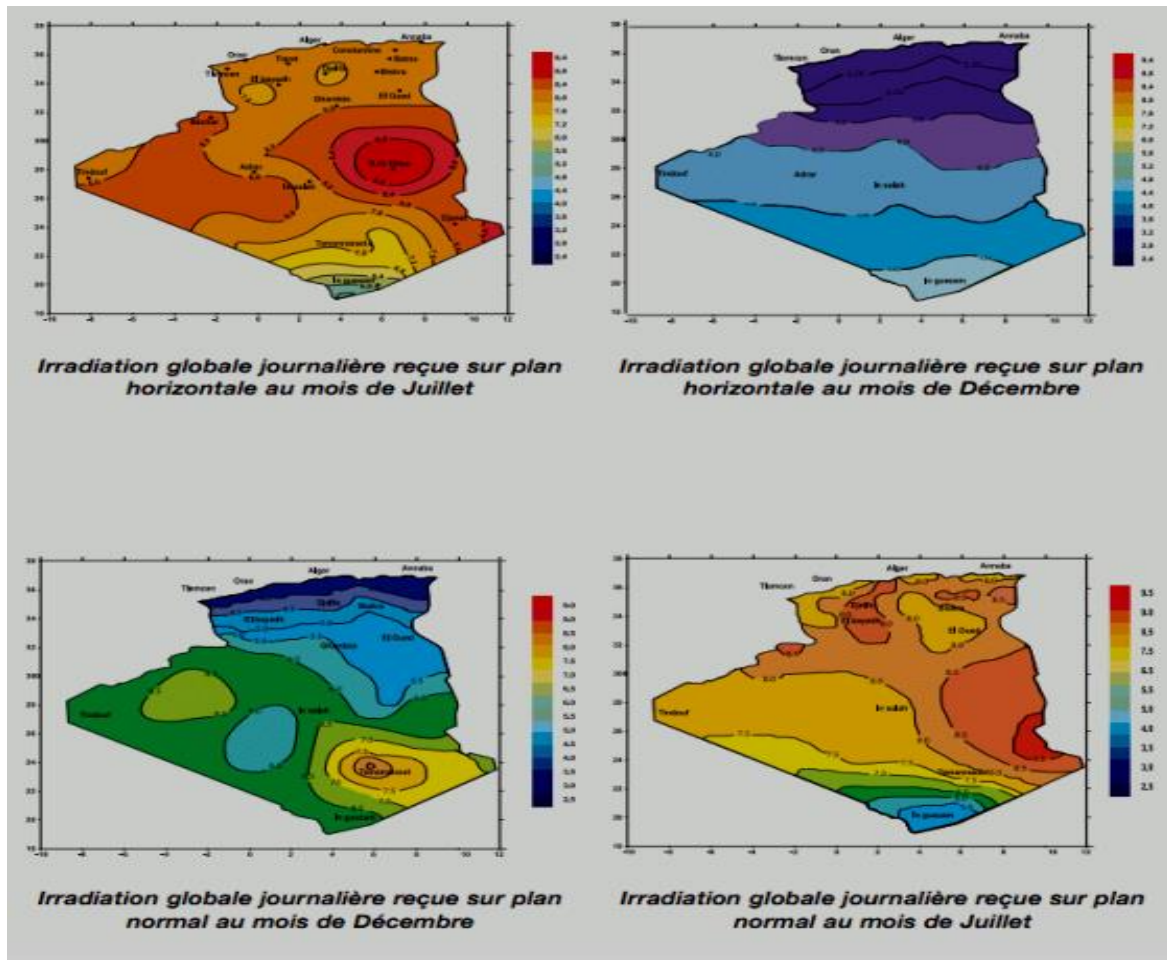


Figure (1.15): Daily global irradiation in Algeria

1-7- Solar energy exploitation in Algeria

Indeed, Algeria is one of the world's largest solar energy reserves. This energy put the equivalent of 10 times global consumption. The Algerian gouvernement decided to launch a long-term renewable energy program of 22,000 MW in 2011. By 2030, the program in question provided for a capacity of 12,000 MW exclusively for the internal market. The aim was to save as much as possible natural gas for export.

The realization of projects using photovoltaic energy are:

- Electrification of more than 1000 homes
- Electrification of 15mosques
- Electrification of 15 schools
- Electrification of 20 security posts [15].

Chapter II

Simulation of a system statement by software polysun

2-1-PV cell

2-1- 1-Definition

A PV cell is an electronic component of a semiconductor material that is used to release their electrons through energy (light) that produces electricity through sun exposure.

2-1-2- History of the PV effect

1839: photovoltaic effects discovered by Edmond Becquerel

1877: first PV cell in selenium

1922: Einstein wins Nobel Prize in Physics for his work on the photo-electric effect

1954: first silicon PV cells with higher yield (4.5% to 6%)

1955: first commercialization of PV 14 MW cells

1958: satellite with PV cells. [16]

2-2- Photovoltaic effect

2-2-1-Definition

The photovoltaic effect is a physical phenomenon specific to certain materials called semi-conductors that produce electricity when exposed to light. It was discovered in 1839 by the French physicist Alexander Edmonde Becquerel.

The photovoltaic effect in summer might have been used until the early 1960s when it has undergone significant development due to its space applications.

Photovoltaic electricity is now widely used, particularly in the field of electricity injection [16].

2-3- Solar cell operating principle

The operation of a photovoltaic cell is as follows: the "grains" of light called photons move a few electrons from the metal by penetrating very slightly into silicon. Since the semiconductor metal only allows the electrons to move in one direction, the electrons moved by the light must pass through the outer circuit to return to their place, which generates a current.

The cells produce electricity every day even if the sky is cloudy: in that case, the performance is simply lower. The cells are assembled in the form of photovoltaic panels, which are embedded on or in the roofs of dwellings, as illustrated in the figure below ;

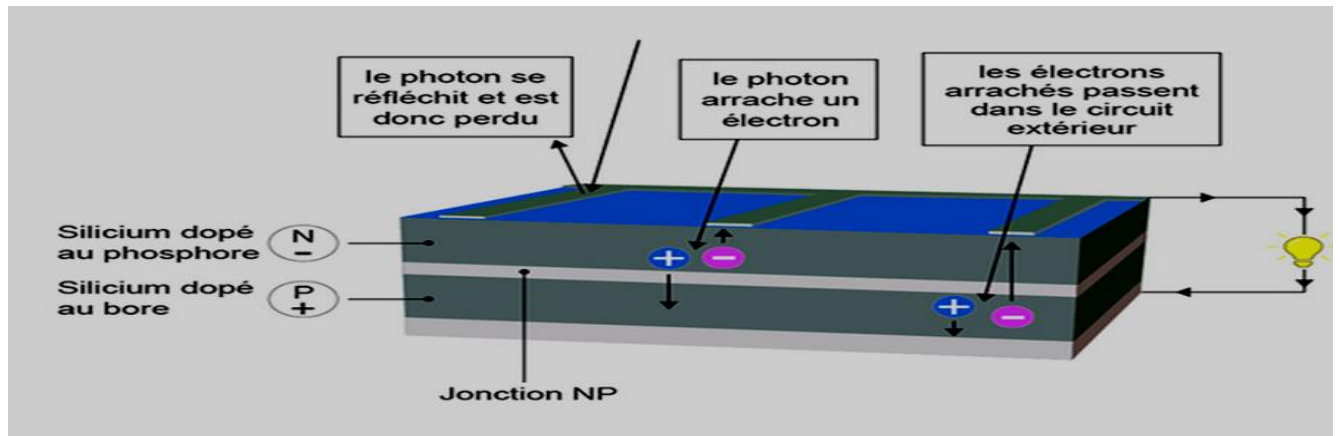


Figure (2.1): Principle of the photovoltaic cell

2-4- Different cell manufacturing technologies

- Silica

Silica is a chemical compound called also silicon dioxide, a chemical formula SiO_2 . Silica is the most common element in the earth's crust after oxygen. It represents 100 percent of the crust mass.

Silica is a hard mineral. In nature, it is found in large quantities in:

Detric sedimentary rock

Metamorphic rock

Magmatic rock

- Extraction and purification

This reaction occurs in an arc furnace because it requires melting the silica. The temperature of the oven can be up to 3000C° . In reality, the silicon silica reduction reaction results from a large number of intermediate chemical reactions. The oven power can go up to 30MW, in order to initiate chemical reactions. After this operation, silicon is obtained in liquid form. Its purity is 98%.

- Getting ingots

Once the purification step is complete, the crystallization stage of liquid silicon comes. The product from this stage is a solid silicon ingot. There are two methods of crystallization. The 1st gives polycrystalline silicon and the 2nd gives single crystalline silicon.

- Getting Wafers

Cylindrical or parallel silicon ingots obtained after the solidification stage are then sawn into thin plates of 200 micrometers thickness, which are called "wafers". The cutting of the ingots is carried out by a wire saw [18].

- Doping and the P-N junction

Doping is a method of achieving the P-N junction. This consists of introducing impurities into an intrinsic crystal to modify these electrical properties. The doped semiconductor is then called the "extrinsic semiconductor". There are two types of doping:

-Type N Doping: N-type doping consists of the addition of a Phosphore atom within the crystalline structure of silicon. The Phosphorus with 5 electrons on its outer electronic layer will associate with 4 silicon atoms, leaving an electron free: the effect of this addition is to give the crystalline structure a negative overall load.

-Type P Doping: Type P doping consists of adding a Bore atom to the crystalline structure of silicon. The Bore with 3 electrons on its outer electronic layer will associate with 4 slicium atoms, leaving a hole free: This addition has the effect of giving the crystalline structure a positive overall load [19].

2-4- 1- Different technologies of PV cells

a- Silicium monocristallin

Single crystalline silicon is the result of melted silicon cooling. Once solidified, it turns into a uniform crystal that is cut into thin slices to form the photovoltaic cell. The color of This material is blue, without traces of crystals or other.

1) Benefits

Very good yield about 25% (150 W/m^2)

Long life (-/+ 30years)

2) inconvenience

High cost

Low performance under low illumination

b- Silicium poly cristallin

To obtain poly crystalline silicon, we melt the silicon in a square elongated metal mold, called longotiere. The color of this type is blue and strewn with patterns left by the crystals. This particularity allows us to easily recognize this photovoltaic cell

1) Benefits

Good yield about 10 or 15 % (100 W/m^2)

Lifetime (- /+30 years)

Cheaper than monocrystalline

2) Inconvenience

Low efficiency under low light

c-Silicium amorphous

The amorphous silicon is obtained from silicon gas. This gas is sprayed on a support, glass, soft plastic or metal, thanks to a vacuum blasting process. These photovoltaic cells are dark gray.

1) benefits

Flexible or rigid,

Cheap compared to other cell types,

Less sensitive to high temperature.

2) inconvenience

Very low yield 7% (60 W/m^2)

Requires a larger surface to achieve the same yield as thick cells

d- Multi-junction

The multi-junction cell consists of different layers of semiconductor materials that convert each solar radius, regardless of exposure. The layers are stacked, forming the multi-junction photovoltaic cell. For the time being, only spacecraft are equipped with such equipment.

1) benefits

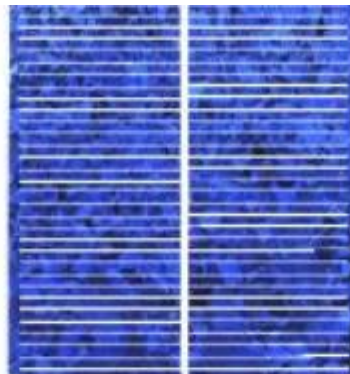
Uneven performance

2) inconvenience

No commercial application [20]



Monocrystalline cell



polycrystalline cell



amorphous cell

Figure (2.2): Different types of solar cells

2-4-2-Parameters characterizing photovoltaic cells

a- Short circuit current I_{CC}

The short circuit current is the current started by the short-circuit light cell at the outlet [21], if the two electrodes are short-circuit through an ammeter, the electrons drained by an internal field of the junction will give rise to a short current

-circuit I_{CC} which corresponds to the current photo I_{ph} generated by radiation, it defines the amount of peer electron hole generated G that crosses the junction without recombination between diffusion lengths L_n and L_p , given by the relationship (2.1) [22]:

$$I_{ph} = q \cdot G \cdot (L_n + L_p)$$

b- Circuit-open voltage V_{CO}

If the cell is left in an open circuit, the voltage measured at the electrode terminals is called open circuit voltage V_{CO} . This is the voltage that should be applied to the diode in the passing direction to generate a current equal to the current photo, it is given by the relationship (2.2) [22]:

$$V_{CO} = \left(\frac{kT}{q} \right) \cdot \ln \left[\left(\frac{I_{CC}}{I_o} \right) + 1 \right]$$

c- Maximum power P_m

Under fixed operating conditions (illumination, temperature, ambient air speed, etc.), the electrical power P available at the terminals of a photovoltaic cell is given by the following relationship [22] :

$$P = V \times I \tag{2.3}$$

P: Power measured at PV cell terminals

V: Voltage measured at PV cell terminals

I: Intensity measured at PV cell terminals

The power charged by a solar cell is maximum when the $V I$ product is maximum. Therefore, the equation is rewritten as follows:

$$P_m = V_m \times I_m \tag{2.4}$$

The power can be entered under curve $I (V)$ (Figure (2.3)) :

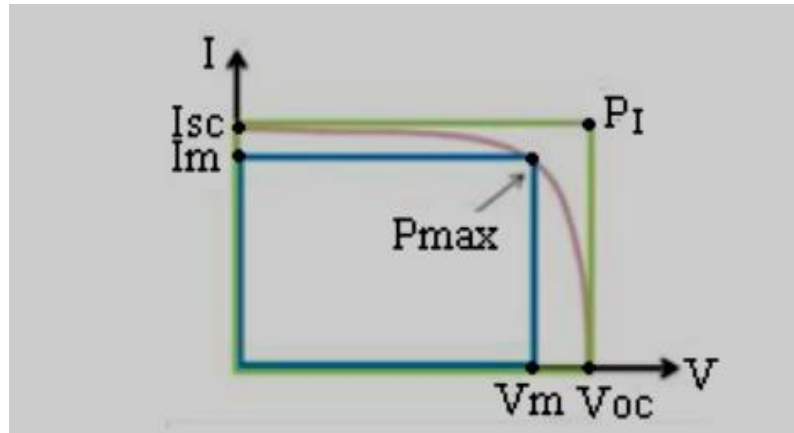


Figure (2.3): Maximum PV cell power

For an ideal solar cell, the ideal maximum power P_I would therefore correspond to the open circuit voltage V_{co} multiplied by the short circuit current I_{cc}

$$P_I = P_{\max \text{ idéale}} = V_{co} \times I_{cc} \quad (2.5)$$

Energy conversion performance [22]

The energy conversion efficiency is the ratio of the power generated and the power of the solar radiation incident P_o .

The maximum yield is the ratio of maximum power to power P_o :

$$\eta_m = \frac{V_m \times I_m}{P_o} \quad (2.6)$$

Connection of PVmodules

The combination of several cells forms a photovoltaic module, the PV cells are connected in series and in parallel to increase voltage and intensity of use.

Serial Association: the current remains the same but the voltage increases in proportion to the number of cells (modules).

Parallel association: In this case, the voltage remains the same but the current increases proportionally to the number of cells.

2-5- PV Solar System

2-5-1- Definition

In cloudy weather, photovoltaic solar panels generate electricity from diffuse sunlight. The

amount of energy that can be collected depends on the degree of sunlight. This energy can be stored in batteries, which can meet the needs during the night [23]. This operation from the horseback riding chain that composes the PV system its elements are (panels, regulator, inverter, batteries, cables, visible).

2-5-2- Different types of PV systems

a-Isolated System

These are systems that work 24 hours a day with solar energy converted to electric energy without the help of any other electric source, and this with several components, but the most important are the batteries that are most used in the market today are:

Lead-acideaccumulators and nickel-cadmium accumulare [24].

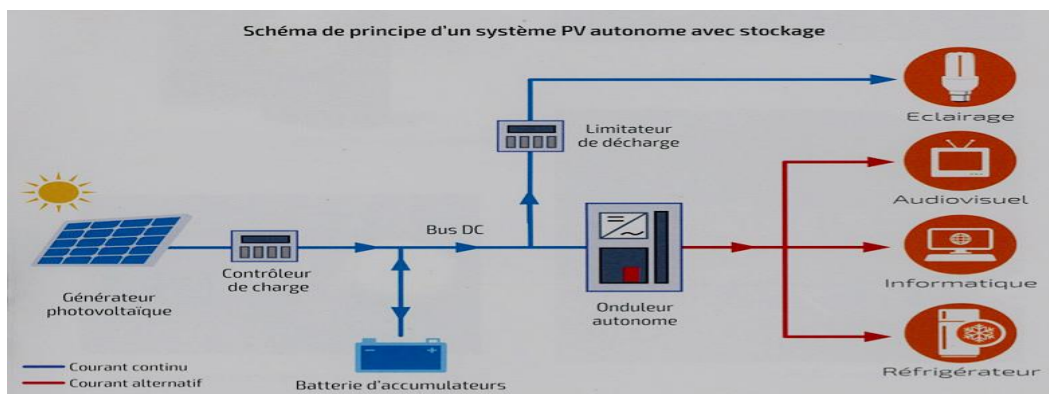


Figure (2.4): Photovoltaic installation for isolated site

b- System connected to the network

A photovoltaic system connected to the network is a system connected directly to the electrical network using an inverter. This type of system offers a lot of ease for the producer/consumer, since the grid is responsible for the balance between electricity production and consumption [24].

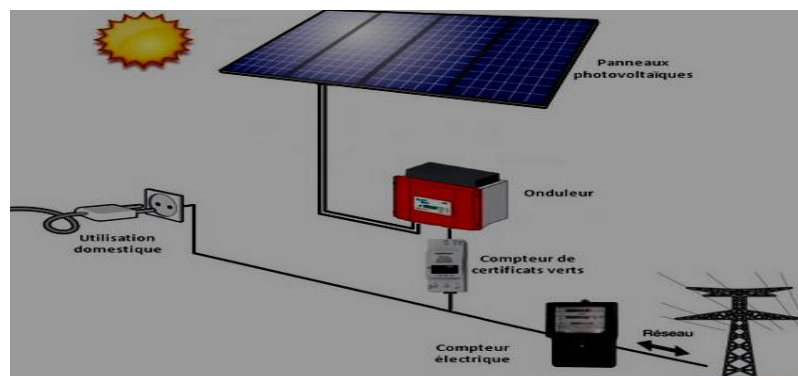


Figure (2.5): Diagram of a photovoltaic system injected into the network

c- Hybrid system

These are systems that combine different types of energy such as wind, diesel or cogeneration in addition to photovoltaic. This type of installation is used when the photovoltaic generator alone does not cover all the required energy [25].

d- Solar pumping

These water pumping systems are powered by energy. It is an autonomous system. The power generated by the solar module is used to operate the DC single-block centrifugal group for lifting water from the open well or the reservoir for minor irrigation and drinking water purpose the system requires a shadowless area for solar panel installation [23].

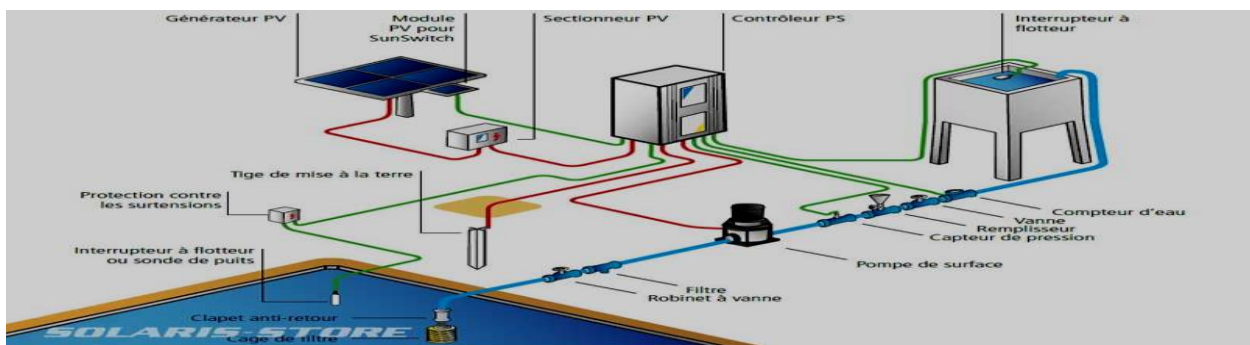


Figure (2.6): Diagram of a solar pump

2-6- Components of a photovoltaic system

2-6-1- Solar panel system

The solar panel is one of the main subsystems of any solar power system. The solar panel is formed by connecting solar "modules" in series and/or parallel. This network produces a continuous current in relation to the incident solar radiation. [23].

2-6-2- Load controllers

The regulation of the battery charge and the control of the energy produced by the photovoltaic generator is a critical function of the photovoltaic system. The most important functions of the load controllers are listed below:

- Prevents battery overload
- Prevents battery from unloading
- Provides load control functions
- Provides status information to system users
- Interfacing and controlling emergency energy sources

Turn PV energy to auxiliary load

Serve as cabling center [23].

2-6-3- Battery Design

The choice and dimensioning of the battery are essential to the overall reliability of the system. The battery serves as an energy buffer, storing the excess energy produced by the solar generator during the day and releasing that energy if necessary during and during the inoculation time periods, when the bay cannot take charge [23].

2-6-4- UPS

A photovoltaic network and battery produce DC current and voltage. If the load is driven by AC alternating current, a UPS can be used to convert DC to AC current. UPS available only can produce in single-phase or three-phase, 50 or 60 Hz and 117 or 220 volts [23].

2-6-5- Cabling

Power losses in DC systems are due to a drop in voltage. Care should be taken when selecting the size of the cable to be used. If a small cable is used, the voltage drop increases and in an off-grid or standalone system, this can have a major impact on the system where the battery voltage is lower than expected. The voltage drop can be calculated as follows:

V: is the drop of volt in the cable

I: the current in the cable

A: cable strength in ohms

Note that the strength depends on the length and cross section of the cable [26].

2-7-Polysun Software

2-7-1-Description

Poly Sun is a software that allows users to effectively simulate solar thermal, photovoltaic, geothermal systems. This manual provides users with complete operating instructions to take advantage of the wide range of functions provided by poly Sun. Available for Windows and Mac, is also available in 13languages.

Poly Sun is the ideal sales and planning tool. Available in 2 professional and design versions [27, 28, 29].

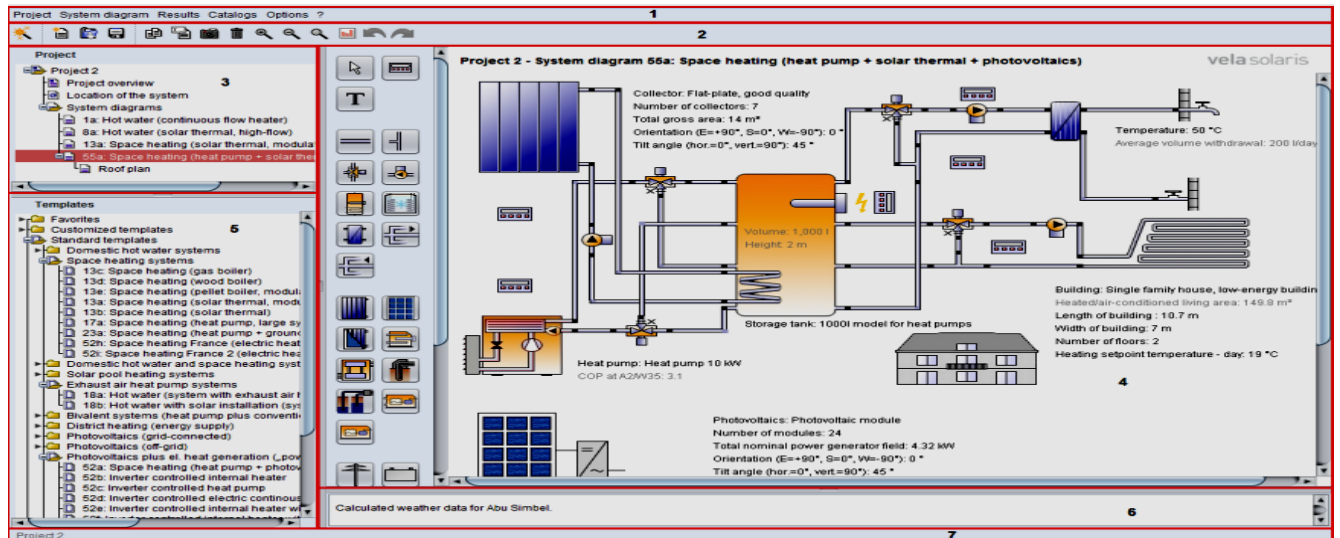


Figure (2.7) : Polysun interface

2-7-2- Basic polysun structure

Poly Sun is a simulation program with planning tools as follows:

a-Photovoltaic and electrical components

- PV Modules
- UPS
- Extern Grid
- Electric Consumers
- Batteries
- Electric mobility
- Generators
- Roof Planner
- Systems

b-Thermal and Conventional Solar Heating Systems

- Thermal solar sensors
- Hot water tanks
- Boilers
- General System Component
- Thermal Consumers
- Systems

c-Heat Pumps and Geothermal Systems

- Air/water heat pumps

- Water/water heat pumps
- Floor-source loops
- Floor-water loops
- Systems

Other Components and System

- Cooling system
- Ice storage tanks
- Co generators
- Air/water heat exchangers [29].

2-7-3- Global weather data included

a- Location

You can simply click on the location of the system, select the location in the database or map, but not all locations can be found on it when you give the locale name in the search option, you must search them manually on the map. There are 5 other options:

"Import weather data from meteonorme ver 6"

Calculate the meteonorme location weather data and the underlying measured weather data since (1986-2005) the irradiance parameters since (1996-2005).

"Import weather data from meteonorme ver 7.2"

Weather profiles available for more than 7500 locations, the location in this option must be chosen from the drop-down list.

If the location is to be chosen specifically on the map, the "webservice" option is recommended as it provides the most up-to-date data. However, to use the "webservice", the internet connection must be provided.

The "profiles" option allows you to import weather data from the file (with the CSV extension "comma separated values") which you can also measure.

The "external monthly values" option allows you to manually modify the available monthly values [29].

b-horizon

Use the slide commands to display a graphical representation of the sun position for the selected location for each hour and day of the year. The yellow curve represents the solar ecliptic of the selected day. The red line is the horizon that can be drawn in the graph by clicking on the graph or by entering the exact horizon points [29].

2-7-4-Wizard

The wizard is a useful and user-friendly tool located in the first button to the left of the icon bar, which helps the user to size the system according to the requirements step by step, the wizard opens automatically after the start of poly Sun.

- First choose a name for the project
- Then you will have to select "the location" of the system
- You can choose a corresponding model by choosing the required energy suppliers, in the drop-down menus saying "yes" or "no"
- You can define the type of energy provider,
- You can choose the most suitable model by double-clicking,
- When the template is selected, the wizard will open the new tabs,
- Once all your system settings have been set, press the "continue" button,
- In the next step of the wizard, you can set up the building model,
- The step of the wizard is to size the solar system you choose,
- By clicking on the "accept" button the settings are confirmed and the first simulation will be performed automatically,
- The results can be checked and the system can be optimized manually in the graphical user interface [29].

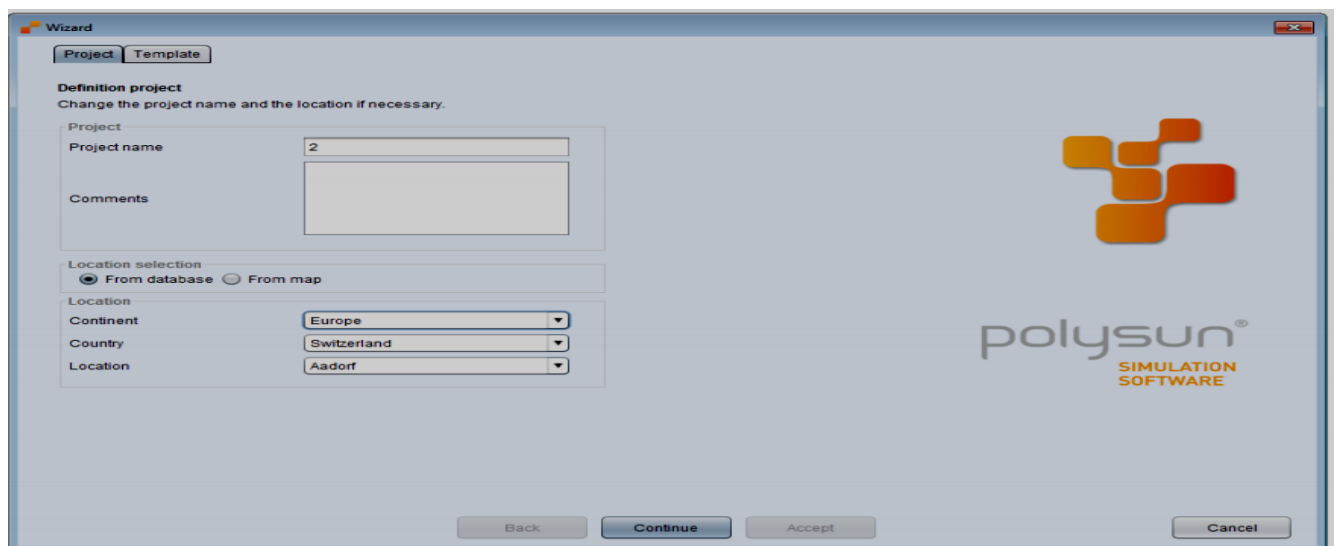


Figure (2.8): Defining a project in the wizard

Chapter III

Results

3-1- Meteorological data of the M'sila site

3-1-1- Geographical coordinates

The M'sila region is located between the states: Bordj Bou-Arreidj and Sétif in the North East, Médéa and Bouira in the North West, Batna in the East, Djelfa in the West and Biskra in the South East. It has 990 592 inhabitants over an area of 2300 Km², the semi-arid climate dry and cold is the main climate of the state [13].

We have indicated on the figure (3.1) the geographical map of M'sila using the polysun software.



Figure (3.1): Geographical map of the region of M'sila

3-1-2- Sun Trajectory

Knowledge of the apparent motion of the sun for a given point of the earth's surface is necessary for any solar application. The sun position is defined by two angles: solar height and azimuth.

The solar height: angle between the sun and the horizontal plane of the place,

The azimuth: angle with the direction of the south, counted negatively towards the east.

- Figure (3.2) shows that at azimuth (0°) the sunrise is 60° maximum

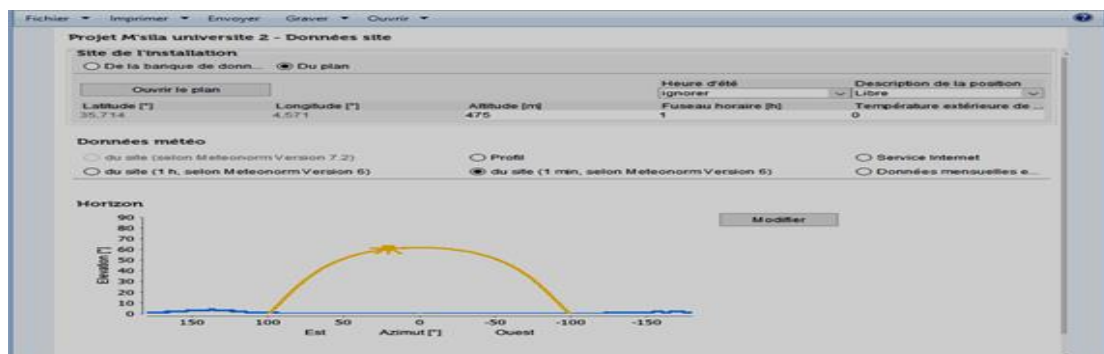


Figure (3.2): sun trajectory in M'sila

3-2- Photovoltaic Field

3-2-1- Electrical requirements

In this step after opening the project, we have to choose the photovoltaic components of our system from the model that is a bookmark in the favourites. In photovoltaic 50a, we can also choose a name for the roof plane, where we will find the main parameters of our system. Figure (3.3) shows the user electrical equipment by Polysun [29].



Figure (3.3): Users needs (electrical equipments)

3-2-2- Orientation of PV modules

The wizard: PV generator field from polysun. We can find more detailed information about the PV modules and their parameters, the type of modules can be chosen from the catalog [29]. The Figure (3.4) below shows the important parameters for the layout PV modules are as follows.

- Orientation 0°
- Inclinaison 33°
- Number of modules 4

And the minimum and maximum module temperatures 10 C° , 70 C° respectively, are important parameters for the configuration of the inverter. They can be inserted manually or calculated automatically using Polysun built-in algorithm.

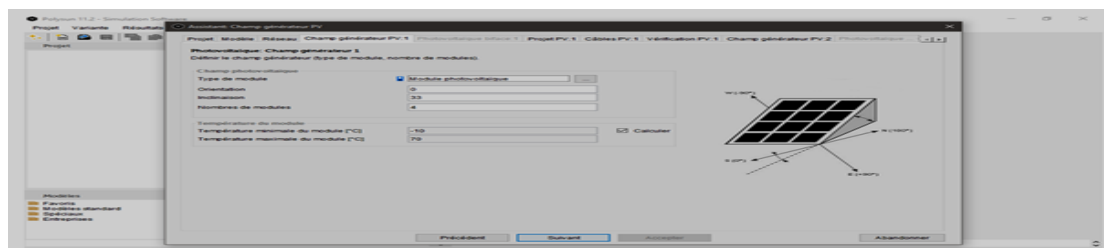


Figure (3.4): Orientation and tilt of the PV system

At the M'sila university pole site, the optimal inclination of 4 modules of 250 W for each one is 33°.

3-2-3- Automatic UPS layout

Polysun provides users with a useful inverter configuration tool; the UPS wizard provides the user with a list of possible configurations and gives a number of suggestions on the inverter /String configuration according to the system requirements. [29] The figure below shows the configuration of the inverter.

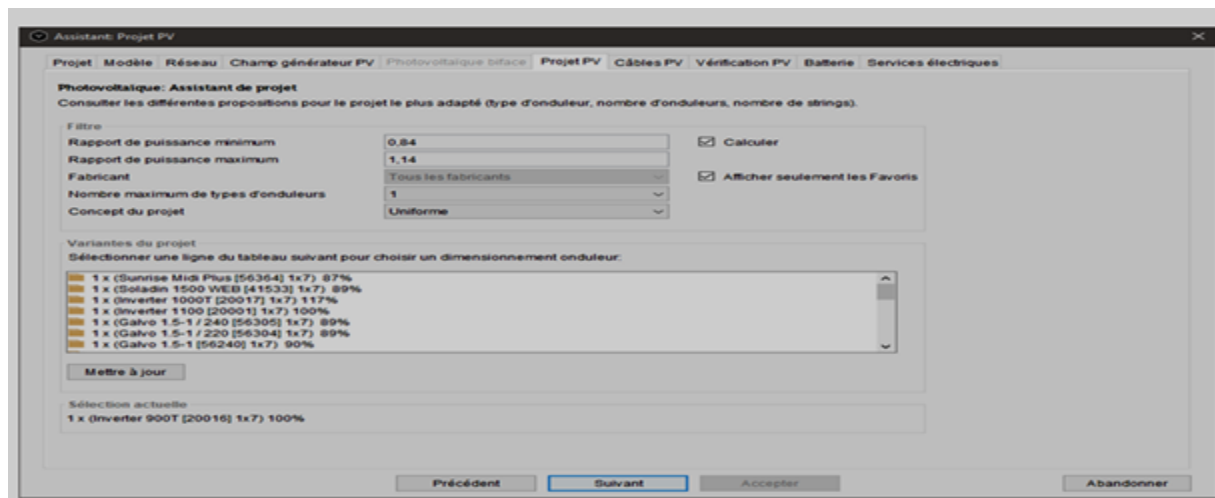


Figure (3.5): Inverter configuration

Polysun provides for all components of the system separate catalog in which the products are listed as a table with the relevant specific data. The catalogs include both examples of anonymous components as well as products available on the market for which an indication of the manufacturer or test institute is provided [29].

N° catalogue	Nom	Source des données	Fabricant
1	★ Module photovoltaïq...	Enecolo	Anonyme
60024	★ PV Mono 250	Vela Solaris	Anonyme
60029	★ PV Poly 250	Vela Solaris	Anonyme
60034	★ PV Thinfilm 250	Vela Solaris	Anonyme

Figure (3.6): Catalogue of different solar panels

3-2-4- PV installation diagram

Polysun calculates the loss factor (see Figure (3.7)) to achieve this value at nominal power, which defines DC cable losses at nominal power. The cable parameters that must be specified are:

- Cable type: with a suitable conductor diameter can be chosen from the catalogue.
- Current feed: defines how polysun will calculate current through this section of cable
- String, N string
- DC UPS, AC UPS
- N string: number of strings for current calculation, applicable only if current flow is set to N strings
- Length :(return) for unit
- By string
- By UPS
- By UPS and Phase
- Quantity: sets how polysun should calculate the total length of the cable section.
- Automatically calculates the number of strings and/or the number of inverters, - Enter the number of units manually.
- Number: of units of the specified length • Total length: of the section of the cable, as inserted in the calculation of the loss of cable [29].



Figure (3.7): Calculation of cable losses

3-3- Energy balance

3-3-1- Solar radiation

We know that the earth is not a more sphere therefore its rays are different which allows a change in the diffusion of the solar rays. "The Global radiation is the energy emitted by the sun on a surface on the ground". This radiation solar depends heavily on many parameters:

- Site latitude, season, time of day, and atmospheric weather conditions. It was noted that in the less winter sunshine is very low 160 W/m^2 as shown in figure (3.8) due to obstacles such as clouds and buildings.
- There is an increase between from 160 W/m^2 to 300 W/m^2 . The peak in the summer period up to 360 W/m^2 due to clear sky and the movement of the earth and the rate of summer sunshine is very long compared to the rate of winter sunshine.



Figure (3.8) Global solar radiation

3-3-2-Temperature

We know that the climate of M'sila is semi-arid. Since there is no snowfall, the interesting effect of solar monitoring on the temperature of the modules for snowmelt is not present. In the winter (11 Dec- 14 Feb.) is low between 5C° and 12C° In the spring season (Feb 14-Apr 30) and the fall season (Sept 12-Nov 26) is between 18C° and 20C° .

But during the summer season (30 Apr-28 May) the temperature increases to the maximum peak 40C° in July. As seen in Figure (3.9).

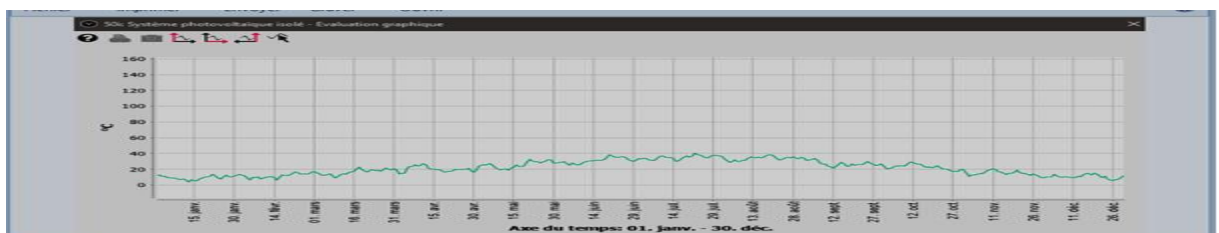


Figure (3.9): Average annual outdoor temperature

3-3-3-Energy Production

The level of electricity production is not stable and unpredictable but depends on the level of sunshine.

At least (1 Jan-30 Apr) the lowest production is 30W in 01 Jan and the highest is 230 W in 8 March. Production is medium and unstable. At least (30 Apr- 28 August) is at high production value up to 210W with a small disturbance.

At least (28 August-30 Dec.) the lowest production is 30W in 30 Dec. the highest production in 210W in 10 Oct.

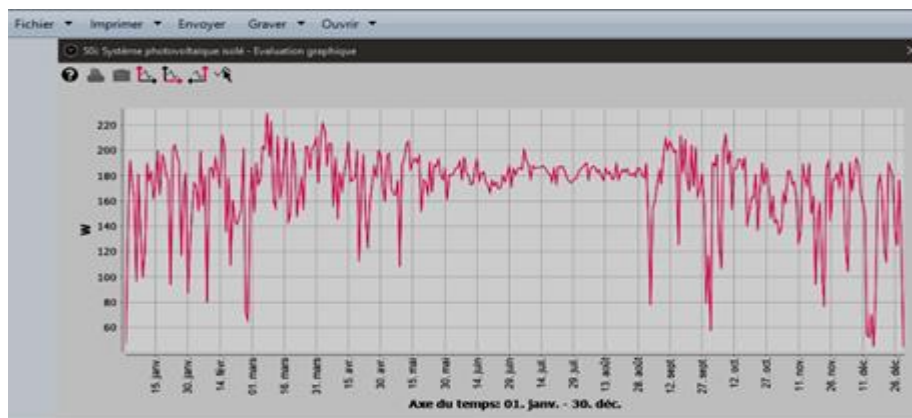


Figure (3.10): Average annual energy production

3-3-4-Energy consumption

There is a study on the maximum Peak of electricity consumption in Algeria. The study says that in Tuesday, 11 July 2017, the electrical power called the national network of 13,227 MW. In the figure (3.11) below, in note that in the month's (Dec, Jan, May) the consumption is very increased 250kWh compared to the other month's 200kWh-210kWh. This value is because the production is higher than the consumption one is less.

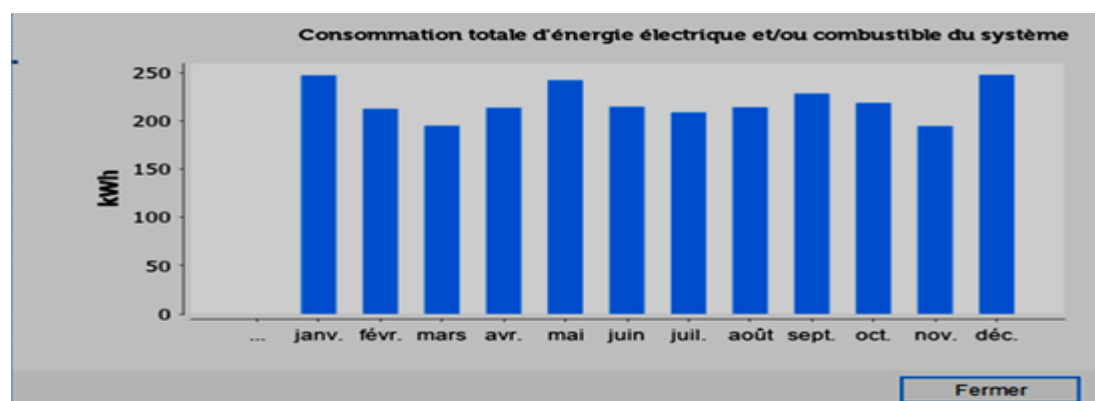


Figure (3.11): Annual balance sheet of energy consumed.

Conclusion

Conclusion

Conclusion

Today, Algeria is strongly called to be up to date thanks to its natural potential in the field of renewable energy including solar energy, which is known by advantages such as its cleanliness, its low cost of its exploitation for language of a lifetime in the production of electricity, in addition the great advantage of this energy is that it is inexhaustible.

The significance of this research is the improvement of solar energy by enhancing the installation of PV system linked with a preliminary study.

We presented in the in the proposal some vital information related to the geographical position with the sun and the atmosphere of the specific area.

In addition, we provided the basic principles of the photovoltaic systems and its component as our system is connected to the electrical communication.

We used the software of simulation polysun and elevated the production crystalline electricity by four modules poly of 250 W for each one, and the weather conditions on March 8th gave a maximum value equal to 230W.

The optimal Orientation of modules statement is 33° of slope and 0 of azimuth.

It was mentioned that in winter (11 Dec-14 Feb) the sunning is very weak 160 W/m².

We noticed an increase between (March 1st and 30 April) of 160 W/m² with 300 W/m² and the maximum value at the period of summer (May 15th – 13 Aug) up to 360 W/m².

The consumption of energy is very high in January, May and December with a value of 250 kWh.

We can say that we have achieved good results compared to what we discussed in theory. Where we had more ambition to do this work, and that's to do a comparative study seems to be the first parity simulation and practical installation of the photovoltaic system at the university pole M'sila, however, current conditions in the world in general and in Algeria in particular, which is the virus COVID19. But that does not prevent this work from being opened for further research.

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Abstract

Photovoltaic electricity is obtained by the direct transformation of sunlight into electricity, using photovoltaic system.

The aims of this work and describe the software that we used to estimate the electrical energy produced from solar energy within the university center of M'sila.

An estimated study of the energy supplied by a photovoltaic system, using polysun software was made for the M'sila site.

The estimate of the annual power of the energy supplied is equal to 230 kWh, was produced by the PV Poly 250 module which manufacturer by Anonymous from Vela Solaris company.

The significant increase is observed for the temperatures in the afternoon. The efficiency threshold for the best efficiency is basically 17.2 C° at 14:00 h.

Résumé

L'électricité photovoltaïque est obtenue par la transformation directe de la lumière du soleil en électricité, au moyen des systèmes photovoltaïques.

Le but de ce travail et décrit le logiciel qu'on a utilisé pour estimer l'énergie électrique produite à partir de l'énergie solaire au sein de pôle universitaire de M'sila.

Une étude estimative de l'énergie fournie par un système photovoltaïque, en utilisant le logiciel polysun a été faite de M'sila.

L'estimation de la puissance annuelle de l'énergie fournie est égale 230 kWh, était produite par le module PV Poly 250 qui fabricant par Anonyme de Vela Solaris entreprise.

Une augmentation significative est observée pour les températures dans l'après-midi. Le seuil d'efficacité pour la meilleure efficacité est fondamentalement 17.2C° à 14 :00h.

ملخص

يهدف هذا العمل إلى تقدير متوسط إنتاج الطاقة الكهربائية السنوي لمحطة كهروضوئية ، ثبتت في القطب الجامعي بجامعة محمد بوضياف بالمسيلة.

تمت هذه الدراسة باستخدام برنامج Polysun المختص في محاكاة الأنظمة الكهروضوئية التي تعمل على التحويل المباشر لأشعة الشمس إلى كهرباء . لإنتاج 1 كيلوات استخدمنا أربع لوحات شمسية من نوع متعدد البلورات سعة 250 وات التي تصنعها شركة Vela Solaris. قدرت الطاقة المتوسطة المنتجة بـ 230 كيلوات. كما لاحظنا زيادة معتبرة في درجة حرارة الألواح الشمسية عند الساعة الثانية 14:00 h ظهرا قدرت بـ 17.2 C° ، مما يدل على تأثير عمل الألواح بدرجة الحرارة.