People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
University of Echahid Hamma Lakhdar - El Oued
Faculty of Technology

A Master's Thesis presented to obtain the diploma of

Academic Master in Electrical Engineering

Discipline: Science and Technology

Specialty: Electrical control

Presented by:

Aymen Touati Brahim, Abdou Djamel Abd Nacer, Ghrib Elmouldi

A Study on Providing the Laboratory N°. 9 at University of El Oued using Photovoltaic Energy

Under jury members:

Pr. Youcef BEKAKRA…... **Supervisor**

Dr.Kechida Ridha………………………………………………*Chiaman*

Dr.Mahni Tidjani……………….. *Examiner*

Mémoire préparé au sein du Laboratoire d'Exploitation et de Valorisation des Ressources Energétiques Sahariennes

2023-2024

Dedication

To the owner of a fragrant biography and
of enlightened thought.
They were the first to be credited with our
obtaining higher education
(Our dear parents) , may God give them
long life.
To the one who put us on the path of life
and soothed us,
She took care of us until we
Let's get old.
(Our dear mothers, God bless them.).
To our brothers and sisters and to all our friends
To all our honorable teachers:
Who didn't hesitate to reach out to us?
I dedicate this research to you.

Thanks

We thank Almighty God for
grant us the will and courage
complete this dissertation.
We would like to express my framer
Dr. Youcef Bekakra

Patience and valuable advice.
Our thanks to our parents for
their support.
We would also like to thank all my
friends who have helped me from far or near
carrying out this work

List of symbols

LED = Light-Emitting Diode.

PV = photovoltaic.

GPV = Photovoltaic generator.

DC = Direct Current.

AC = Alternative Current.

K = Boltzmann coefficient (1.38.10-23 J/K).

Wh/day = Watt-hour per day.

Voc = Open circuit voltage.

Isc = Short Circuit Current.

Pmax = maximum Power.

E = radiance (W/m^2).

Um = maximum voltage.

Im = maximum Current.

T = Temperature of (°C).

G = radiance (G).

MPPT = Maximum Power Point Tracking.

P&O = perturber and observer.

ملخص:

تعد الطاقة من أهم العناصر الأساسية والضرورية للحياة، نظرا للزيادة المستمرة في الطلب عليها ، فقد أصبح من الضروري البحث عن مصادر بديلة لإنتاجها وذلك من خلال استغلال الطاقات المتجددة ومن أهم المصادر استعمالا الطاقة الشمسية بسبب مزاياها العديدة.

في هذه الأطروحة، قمنا بعمل دراسة نظرية حول تزويد المخبر رقم 9 التابع لقسم الهندسة الكهربائية بكلية التكنولوجيا بجامعة الوادي بالطاقة الشمسية وقمنا بعمل محاكاة لنظام الألواح الشمسية بواسطة MATLAB/SIMULINK الذي مكننا من مراقبة النظام الكهروضوئي ودراسته.

الكلمات المفتاحية:النظام الكهروضوئي، المحول الرافع، آلية التحكم MPPT, التصميم ,المحاكاة.

Abstract:

Energy is one of the most essential and essential elements of life, as demand for it continues to increase, it has become necessary to seek alternative sources of production through the exploitation of renewable energies. One of the most important sources is the use of solar energy because of its many advantages.

In this thesis, we did a theoretical study on the solar power supply of Laboratory No. 9 of the Department of Electrical Engineering – Faculty of Technology- at the University of El Oued, and we did a simulation of the solar panel system by MATLAB/SIMULINK which enabled us to observe and study the photovoltaic system.

Key words: Photovoltaic, boost Converter, MPPT, Modeling, Simulation.

Résumé :

L’énergie est l’un des éléments les plus essentiels et essentiels de la vie, car la demande pour elle continue d’augmenter, il est devenu nécessaire de rechercher des sources alternatives de production par l’exploitation des énergies renouvelables. L’une des sources les plus importantes est l’utilisation de l’énergie solaire en raison de ses nombreux avantages.

Dans ce mémoire, nous avons effectué une étude théorique sur l’alimentation solaire du Laboratoire N°. 9 du Département de Génie Electrique - Faculté de Technologie - de l’Université d’El Oued, et nous avons fait une simulation du système de panneaux solaires par MATLAB/SIMULINK qui nous a permis d’observer et d’étudier le système photovoltaïque.

Mots-clés : Photovoltaïque, Convertisseur boost, MPPT, Modélisation,Simulation.

Figure Lists

Chapter I: Generality about Photovoltaic System

Figure (I.1) : Different renewable energy families..4
Figure (I.2) : Photovoltaic effect………………………………………..…………………..7
Figure (I.3) : Different types of the photovoltaic cell...8
Figure (I.4): Characteristics of series-connected solar cells..10
Figure (I.5) : characteristics of parallel-connected solar cells..10
Figure (I.6): Autonomous systems..11
Figure (I.7): Network-coupled Systems……………………………………………………………11
Figure (I.8) : wind energy (hybrid system)…………………...12
Figure (I.9) : Fixed photovoltaic systems...13
Figure (I.10) : System with solar tracker..13

Chapter II: Calculate of the required power in Laboratory n°. 9

Figure (II.1) : General plan for solar installation..16
Figure (II.2) : Inside Image of the Laboratory n°. 9……………………………………………16
Figure (II.3) : poles of the motor..17
Figure (II.4) : Nameplate the motor..17
Figure (II.5) : poles of the motor 18
Figure (II.6) : Nameplate the motor..18
Figure (II.7) : Nameplate the AC...18
Figure (II.8) : Air conditioner AC..18
Figure (II.9) : Interior Lights...19
Figure (II.10) : Three-phase squirrel cage motor..20
Figure (II.11) : Three-phase squirrel cage motor (nameplate)..20
Figure (II.12) : DC shunt wound machine……………………………………………..….21
Figure (II.13) : DC shunt wound machine (nameplate)..21
Figure (II.14) : single-phase transformer..22
Figure (II.15) : Three-phase synchronous machine...22
Figure (II.16) : Three-phase Induction Machine1...23
Figure (II.17) : Three-phase Induction Machine2...23
Figure (II.18) : Three-phase Squirrel cage motor..24
Figure (II.19) : DC Machine Polyexcitation...24

Chapter III: Modeling and Simulation of PV System

Figure (III.1) : Cell, module and PV panel...30
Figure (III.2) : Characteristic I = f (V) and P =f (V) of a solar panel for different radiance at a constant temperature equal to 25 ° C………………………………………………………31
Figure (III.3) : Characteristics P=f (V) of a solar panel for different temperatures with radiance equal constant 1000w / m^2..31
Figure (III.4) : Block diagram of a Boost converter...32
Figure (III.5) : Elementary photovoltaic conversion chain associated with a control MPPT..33
Figure (III.6) : Principle of the P&O technique………………………………………….....34
Figure (III.7) : Algorithm of the P&O method...34

Figure (III.8) : three-phase DC/AC inverter………………………………………..………..35
Figure (III.9) : Simulation scheme of the global system in Matlab……………………………..35
Figure (III.10) : Voltage simulation results for influence of radiance and temperature constant (T = 25 °c)..36
Figure (III.11) : Current simulation results for influence of radiance and temperature constant (T = 25 °c)..36
Figure (III.12) : Power simulation results for influence of radiance and temperature constant (T = 25 °c)..37
Figure (III.13) : Voltage simulation results for influence of temperature and radiance constant (G = 1000w/m^2) 37
Figure (III.14) : Current simulation results for influence of temperature and radiance constant (G = 1000w/m^2) 38
Figure (III.15) : Power simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..38
Figure (III.16) : Voltage simulation results for influence of radiance and temperature constant (T = 25 °c)..39
Figure (III.17) : Current simulation results for influence of radiance and temperature constant (T = 25 °c)…………………………………………………………………..……………...40
Figure (III.18) : Power simulation results for influence of radiance and temperature constant (T = 25 °c)..40
Figure (III.19) : Voltage simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..41
Figure (III.20) : Current simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..41
Figure (III.21) : Power simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..42
Figure (III.22) :Voltage simulation results for influence of radiance and temperature constant (T = 25 °c)..43
Figure (III.23) : Current simulation results for influence of radiance and temperature constant (T = 25 °c)…………………………………………..………………………………...43
Figure (III.24) : Power simulation results for influence of radiance and temperature constant (T = 25 °c)..44
Figure (III.25) : Voltage simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..44
Figure (III.26) : Current simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..45
Figure (III.27) : Power simulation results for influence of temperature and radiance constant (G = 1000w/m^2)..45

Tables:

Table (I.1) : Different types of cells with their characteristics..9

Table (II.1) : Calculate of the Total Power...25

Contents

General Introduction……………………………………………..……………………..1

Chapter 1: Generality about Photovoltaic System

I.1.Introduction...4

I.2. The History of Solar Energy..4

I.3. Definition and History of Photovoltaics..5

I.4. Principle photovoltaic..6

I.5. The Photovoltaic Cell...6

I.6. Principles of Operation of a Photovoltaic Cell..................................6

I.7. Photovoltaic effect..7

I.8. Type and Efficiency...8

I.8.1. Efficiency of a cell..9

I.9. Photovoltaic cell association...10

I.9.1. Serial association of cells…………………………..…........10

I.9.2. Parallel association of cells……………………………..……10

I.10. Applications of photovoltaic systems…...10

I.10.1 Autonomous Systems..11

I.10.2. wind energy (hybrid system)...11

I.10.3. Grid Connected Systems...12

I.11. Types of PV systems..12

I.11.1. Fixed systems...12

I.11.2. System with solar tracker...13

I.12. Advantages and disadvantages of photovoltaic energy…………....13

I.12.1Advantages ……………………………………………………..13

I.12.2.Disadvantages..14
I.Conclusion..14

Chapter 2: Calculate of the required power in Laboratory n°. 9

II.1.Introduction……………………………..………………………..............16
II.2.Description of the Laboratory n°. 9 ………….……………….............16
II.3. Direct Current (DC) Motor………………..…………………….....17
II.4. Alternating Current (AC) Motor……………………………………17
II.5. Air Conditioner AC……………………….………………………...18
II.6. Interior Lights…………………………..…………………...18
II.7. Three Phase Squirrel cage induction Motor……..……………….....19
II.8. DC Shunt Wound Machine…………………….…………………20
II.9. Single Phase Transformer……………………………………...21
II.10. Three-Phase Synchronous Machine………………………………..22
II.11. Three-phase Induction Machine………...…………...…………22
II.12. Three-Phase Squirrel Cage Motor………………..……………..23
II.13. DC Machine Polyexcitation ………………………………24
II.14. Calculate of The Total Power…………………………….…...…24
II. Conclusion……………………………………………….…...26

Chapter 3: Modeling and Simulation of PV System

III.1. Introduction...28
III.2.Calculation of the required number of modules……………………...28
III.3. Number of serial modules..28
III.4. Number of parallel modules..29
III.5.System elements...29
III.5.1. Photovoltaic generator..29

III.5.1.1. Characteristic of a photovoltaic module......................................30

III.5.1.2. Influence of radiance...30

III.5.1.3. Influence of Temperatur..31

III.6. DC-DC Converter (Boost)..32

III.6.1. MPPT control definition...32

III.6.2. Technique Perturber and Observer (P&O).......................................33

III.7. DC-AC Inverter...34

III.8. Simulation results...35

III.8.1. Results of PV module...35
III.8.2. Results of boost converter..39
III.8.3. Results of inverter..43
III. Conclusion...46

General Conclusion……………………………………………………….47

References……………………………………………......……………48

General Introduction

Energy production has been a major challenge for years as the energy needs of industrialized societies continue to increase. Moreover, developing countries will need more and more energy to carry out their development; much of the world's energy production is provided by fossil sources. Global electricity consumption in recent decades has been strongly linked to the development of industry, transport, and communications. Today, much electricity is produced from non-renewable resources such as coal, natural gas, oil, and uranium. Their rate of regeneration is extremely slow on a human scale. This will lead to a non-zero risk of depletion of these resources in the short term.

More so as demand continues to grow and is now higher than supply, resulting, for example, in a sharp fluctuation in the world price of oil. There are several types of renewable energy sources: hydropower, geothermal energy, wind energy, biomass energy, and photovoltaic energy. Today, renewable energies are gradually becoming full-fledged energies, competing with fossil energies in terms of cost and production performance. However, their system for converting energy into electricity often suffers from a lack of optimization, which still makes them overpriced systems with significant deficiencies in efficiency and reliability.

To this end, although there is more and more research proving the viability of sources such as photovoltaic (PV) or wind energy, many are reluctant to install these systems on a large scale, both in mass production and in private households. Although photovoltaic energy had been known for many years as an attractive alternative to or complement to conventional sources, it can generate electrical energy ranging from a few milli watts to a megawatt electricity supply because of its many advantages.

• The production of this renewable electricity does not emit greenhouse gases, but the environmental impact of the system's production had be reduced.

• Since sunlight is available everywhere and almost inexhaustible, photovoltaic energy can be exploited both in the mountains, in a remote village, and in the center of a large city, as well as in the south and the north.

• Photovoltaic electricity had be produced as close as possible to its place of consumption, in a decentralized manner, directly at the user's disposal, making it accessible to a large part of the world's population.

• This work aims to establish a model to simulate the decrease in electrical power efficiency produced by a panel caused by material alteration over time.

The drafting of our brief consists of three chapters:

• In the first chapter, we presented generality about photovoltaic systems, the construction of photovoltaic cells, and the photovoltaic effect and operating principle.

• In the second chapter, we calculate the total capacity of electrical equipment used in laboratory n°. 9 with a profile of each.

• In the third chapter, modeling and simulation by MATLAB SIMULINK of every element of the realized system PV are studied, including the boost converter and orders MPPT "P&O".

We will conclude this work with a general conclusion[34].

Chapter 01 :

Generality about photovoltaic system

I.1.Introduction:

Because of population expansion and technological advancements, the world's energy consumption has been rising significantly in recent years. Fossil resources are running out, though. There fore, in order to satisfy the demand for power worldwide, it is imperative to explore alternative solutions that are based on renewable energy. Algeria possesses vast untapped resources, including solar, wind, and hydropower. The many types of renewable energy are depicted in Figure (I. 1).

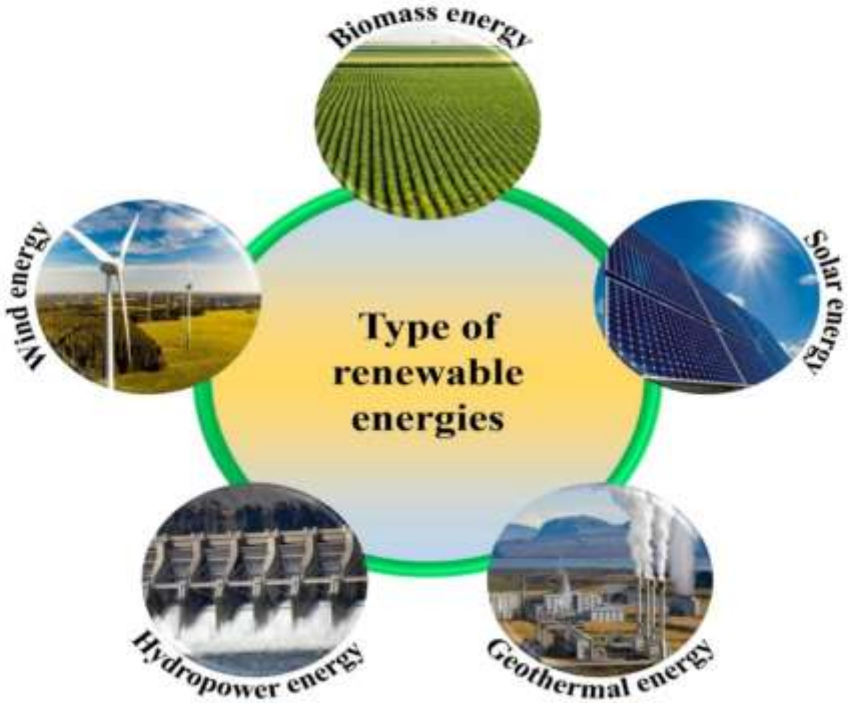


Figure (I. 1): Different renewable energy families.

In this chapter, we will begin by defining solar energy, followed by building photovoltaic cells, the photovoltaic effect, and the operating principle. Next, we will present the different types of photovoltaic cells. Finally, the pros and cons of photovoltaic energy.

I.2.The History of Solar Energy:

1. The history of solar energy is extensive, dating back thousands of years. When it came to creating structures that could capture heat and sunshine, the Greeks were innovators. During the 19^{th} century, interest in turning solar energy into electricity increased as technology developed. One of the most important renewable energy sources in the contemporary period, solar energy has seen remarkable advancements in generating and energy storage technology in recent decades.

2.19th Century: The photovoltaic effect was discovered by Alexandre Edmond Becquerel in 1839, and it serves as the basis for the process of turning solar light into electrical power.

3. 20th Century: Solar energy technology made major strides in the 20th century.

Using silicon as the material, Bell Labs researchers created the first modern solar cell in 1954, based on the photovoltaic effect. The goals of further research and studies were to lower the cost and increase the efficiency of solar cells.

4. The 1970s and beyond: Following the oil crisis of the 1970s, interest in solar energy and other renewable energy sources has grown. Solar technology has advanced significantly, lowering the cost and raising the efficiency of solar power generation.

5. Today: Due to efforts made in recent years, solar electricity has become more widely available worldwide.

These are some of the key points in solar history and show how this technology has evolved and changed over the ages.

I.3.Definition and History of Photovoltaics:

A solar cell is a thin, round, or polygonal piece of crystalline material, most commonly silicon. When light hits this wafer, it knocks electrons loose. If the positive and negative contacts of the cell are connected to a device, it allows electricity to flow. This current is collected by electrodes on the top and bottom of the cell. This process is called the photovoltaic effect, which means using light particles (photons) to create electricity (voltage) [1].

Some dates in the history of photovoltaics:

1839: The photovoltaic effect is discovered by French physicist Edmond Becquerel. This effect allows for the conversion of light energy into electricity.

1875: Werner Von Siemens presents a paper on the photovoltaic effect in semiconductors to the Berlin Academy of Sciences.

1954: Three American researchers, Chapin, Pearson, and Fuller (not Prince), create the first practical solar cell.

1958: The first satellites powered by solar cells, with an efficiency of 9%, are launched into space.

1973: The first house powered by solar cells is built at the University of Delaware.

1983: The first car powered by solar energy travels 4,000 kilometers in Australia [2].

I.4.principle Photovoltaic:

Currently in widespread use, photovoltaic conversion can be simply defined as the process of converting photon energy into electric energy by means of materials absorbing light. A photon that has been absorbed by a substance transfers some of its energy to an electron by impact, thereby drawing the electron out of the substance. The latter, which had been in a stable state at a lower energy level, then changes to a higher energy level, causing an electrical imbalance in the material and producing an electron-hole pair with the same electrical energy.In general, the electron-hole pair converts its electrical energy into thermal energy to swiftly return to equilibrium. The main goal of photovoltaic sensors in the form of cells is to recover all or part of the electrical energy, even though the electrical phenomenon is secondary to the thermal phenomenon (including heating of the material by sun rays). Or power plants. For instance, solar cells that combine an N-doped semiconductor material with a P-doped semiconductor make this conceivable [3].

I.5.The Photovoltaic Cell:

To move from the photovoltaic effect to practical application, it is necessary to find materials that make it possible to optimize the two essential phases of this principle: 1. Absorption of incident light 2. Collection of electrons on the surface PV cells are made from semiconductor materials that are capable of conducting or transporting electricity. More than 90% of solar cells manufactured today are made from crystalline silicon, a semiconductor. One side of the cell is n-doped (for example, phosphorus). The other is p-doped (for example, boron). Metallic electrodes are placed on both sides to collect electrons and create an electrical circuit [4].

I.6. Principles of Operation of a Photovoltaic Cell:

A photovoltaic cell, typically made from silicon, is a semiconductor device. It consists of two layers: a P-doped region and an N-doped region. This creates a PN junction, which acts as a potential barrier. When photons (light particles) strike the semiconductor, they are absorbed. This absorption transfers the photon's energy to the atoms within the PN junction.

This energy boost excites electrons, causing them to jump out of their orbits and creating "free" electrons (negative charges) in the N-doped region. Simultaneously, "holes" (positive charges) are formed where the electrons were previously located in the P-doped region.

This movement of electrons and the creation of holes leads to a voltage difference between the two layers. This potential difference can be measured between the positive and negative terminals of the cell.

The term "photovoltaic" originates from the Greek words "photo" meaning light, and "voltaic," derived from the Italian physicist Alessandro Volta, known for his contributions to the field of electricity.

A solar cell usually produces less than 2 watts at less than 0.5 volts. A panel can be created by a series association of multiple modules or by a parallel association of multiple modules. A module is created by a series of associations of numerous cells.
Solar energy. An assembly may be made into a panel by adding two diodes: one in series to stop reverse currents and another in parallel, which is called a bypass diode. This diode only acts if a group of cells becomes imbalanced. It does this by limiting the reverse voltage across the assembly and lowering the production loss that results [5].

I.7. Photovoltaic effect:

The term "photovoltaic" comes from the prefix "photo", which means light or clarity, and the suffix "volt", which refers to Alessandro Volta, a pioneer in the field of electricity. Alexandre Edmond Becquerel made the discovery of the photovoltaic effect in 1839. Photons are absorbed by semiconductor materials to produce an electrical potential, which is the photovoltaic effect. Photovoltaic cells use solar radiation to continuously generate electricity that may be used to power devices or recharge batteries [6].

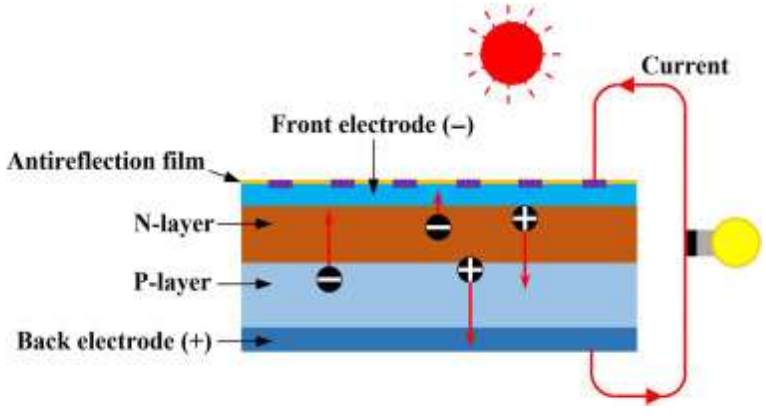


Figure (I. 2): Photovoltaic effect.

I.8.Type and Efficiency:

- Efficiency and varieties of photovoltaic cells: There are several kinds of solar cells, also known as photovoltaic cells, and each form of cell has a specific cost and efficiency. But regardless of their nature.
- Their efficiency is still just 8–23% of the energy they are given. Currently, there are three primary cell types. Figure 3 presents the different types of the photovoltaic cell.
- **Monocrystalline cells:** Due to their intricate manufacturing process, they are the most efficient but also the most costly.
- **Polycrystalline cells:** are less expensive to manufacture, have an easier design, and have a lower yield.
- **Amorphous cells:** They are inexpensive and need very thin silicon layers, but their yield is poor. They are frequently found in small consumer goods like timepieces and solar calculators [7].

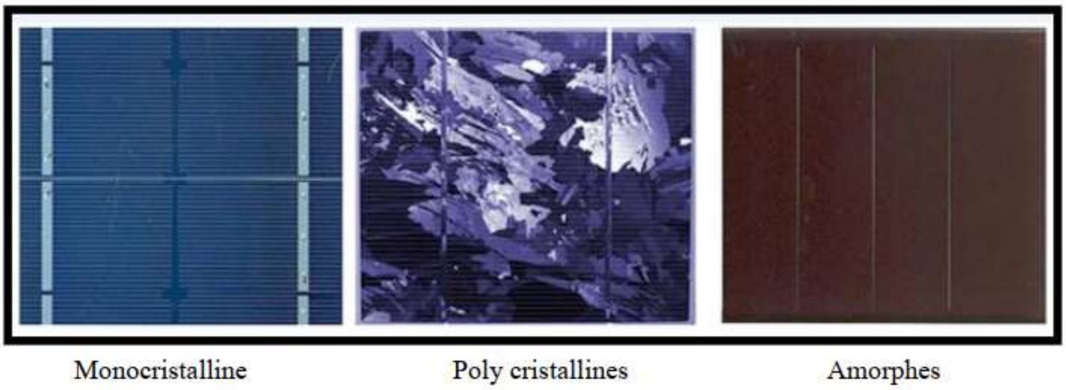


Figure (I. 3): Different types of the photovoltaic cell.

I.8.1.Efficiency of a cell:

The following table (I.1) presents the different types of PV cells and their characteristics [8]

Technology	Monocrystalline	Polycrystalline	Amorphous
Cell and module			
Features	Very good performance: 14 to 20%. Lifetime : important (30 years) Manufacturing cost: Pupil. Power: 100 to 150 WC/m^2 7 m^2/ KWP. Low yield under Low radiance. loss of yield with the elevation of the Temperature. Manufacturing: elaborate From a block of molten silicon which has solidified forming a single crystal Uniform blue color.	Good performance: 11 to 15%. Lifetime : important (30 years) Manufacturing cost: cheaper than monocrystalline panels Power: $100Wp/m^2$.8 m^2/ KWP. Low yield under low radiance. Loss of yield with increasing temperature. Manufacturing: made from electronic grade silicon which when cooled	Low yield: 5 to 9% Lifespan: quite long (20 years) Manufacturing cost: inexpensive compared to other technologies Power: 50 WC/m^2 16 m^2/KWP Correct operation with low illumination. Not very sensitive to high temperatures. Can be used in flexible panels. Larger panel surface area than other silicon panels.
Market share	%43	%47	%10

Table (I. 1): Different types of cells with their characteristics.

I.9. Photovoltaic cell association:

I.9.1.Serial association of cells:

The amount. As an example, the serial connection of three separate cells is shown in Figure (I. 4).

Generator current PV is equal to a single cell's current, but the output voltage rose since it was the sum of the voltages of all the cells in the chain in this example, cell GPV.

Figure (I. 4): Characteristics of series-connected solar cells.

I.9.2.Parallel association of cells:

As an example, the parallel connection of three separate cells is shown in figure (I. 5). In this instance, the voltage is still equal to that of a single cell, but the current of the group of cells is equal to the sum of the current of each cell [9].

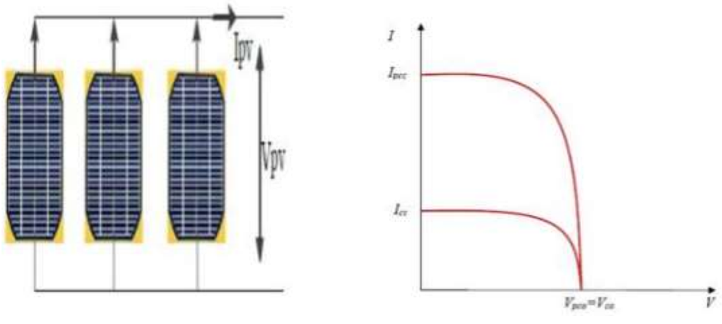


Figure (I. 5): characteristics of parallel-connected solar cells.

I.10.Applications of photovoltaic systems:

I.10.1.Autonomous Systems:

An autonomous photovoltaic system is one that runs without reliance on the grid or any other energy source. This method is typically utilized in remote locations. An installation of this kind has to be able to provide electricity during the night or in inclement weather. As a result, batteries must be used to store a portion of the solar modules that are produced every day. One or more solar modules, a charge regulator, one or more batteries, and maybe an inverter make up this arrangement [10].

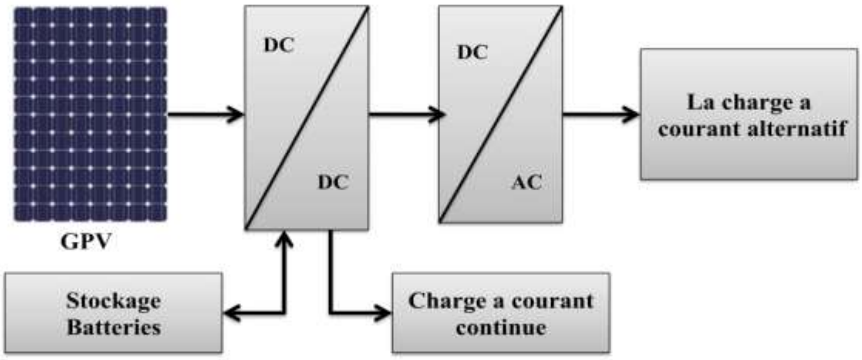


Figure (I. 6): Autonomous systems.

I.10.2.wind energy (hybrid system):

As seen in figure (I. 7), this hybrid electric power generation system integrates and runs two renewable energy sources (wind and photovoltaic) for energy production.

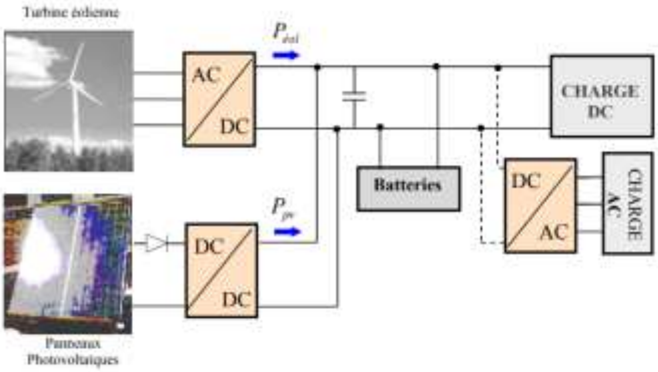


Figure (I. 7): wind energy (hybrid system).

A photovoltaic subsystem with a DC/DC converter is part of the hybrid system, enabling it to consistently use the maximum power point. An electrical generator powered by wind power. A continuous bus is linked to two power sources. Batteries provide for storage. An inverter is used to link an alternating or continuous load to be fed. Controlling the size of the system's many components is essential, as is optimizing the size of the generators photovoltaic, wind turbine, and storage battery capacity in this kind of setup. An installation's size should be arranged as follows identifying the profile of consumer load. Measurements of the solar and wind power generators. Measurements of the storage batteries [11].

I.10.3.Grid Connected Systems:

In general, installations that are linked to a distribution plant or the electrical grid offer the best option for producing electricity from solar energy in terms of both energy and cost. These facilities are made up of linked solar modules with one or more inverters that are wired into the electrical network. The solar module's direct current is converted by the inverter into an alternating current that is compatible with the electrical grid. A system linked to the network is demonstrated [12].

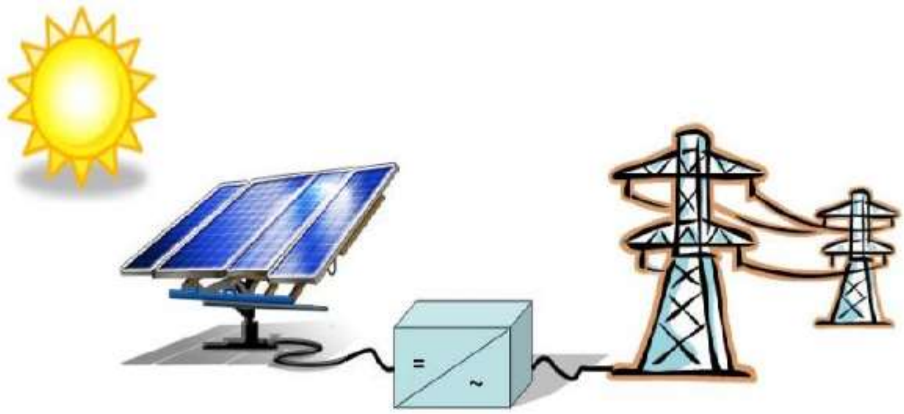


Figure (I.8): Network-coupled Systems

I.11.Types of PV systems:

I.11.1.Fixed systems:

The most traditional arrangement involves installing the modules on permanent supports in a set location. However, certain permanent supports let the orientation angle be readjusted in accordance with the seasons. Metallic components utilized in production.

The modules (stainless steel, aluminum anodized, and galvanized steel) cannot be altered by supports in a physical or chemical sense [13].

Figure **(I. 9):** Fixed photovoltaic systems.

I.11.2.System with solar tracker:

Devices for tracking the sun depending on the installation location, a single axis (east to west) or two axes can improve the generation of electrical energy by 20 to 40%.The USA is the primary market for these materials in network-coupled systems. Both for solar pumping and local electricity [14].

Figure (I. 10): System with solar tracker.

I.12. Advantages and disadvantages of photovoltaic energy

I.12.1.Advantages:

- Self-sufficient energy, provided by free and renewable solar radiation as fuel.
- Clean and non-polluting photovoltaic energy that doesn't release greenhouse gases or waste.
- Produces the necessary energy.

- Lessens susceptibility to power outages.
- Easy system extension; installation size can be increased subsequently to monitor load requirements.
- The sale of excess production allows for the amortization of investments and generates income.
- Minimal maintenance.
- Noiseless.

I.12.2.Disadvantages:

- The manufacture of photovoltaic panels is high-tech, requiring enormous research and development and therefore costly investments.
- The efficiency of photovoltaic panels is still low.
- Requires an additional system (batteries) for household installations.
- The cost of investing in a photovoltaic installation is expensive [15].

I.Conclusion:

In this chapter, we provide an overview of the history of solar energy as well as an overview of photovoltaic systems. And we explored the principle of a photovoltaic cell and its types. We also discussed the pros and cons of a photovoltaic cell. In the next chapter we will calculate the total energy of the laboratory around which our study is centered.

Chapter 02 :

Calculate of the required power in Laboratory n°. 9

II.1.Introduction:

In this part, we present an insight into laboratory n°. 9 of the Department of Electrical Engineering at the University of El Oued and measure the total power of the devices in this laboratory.

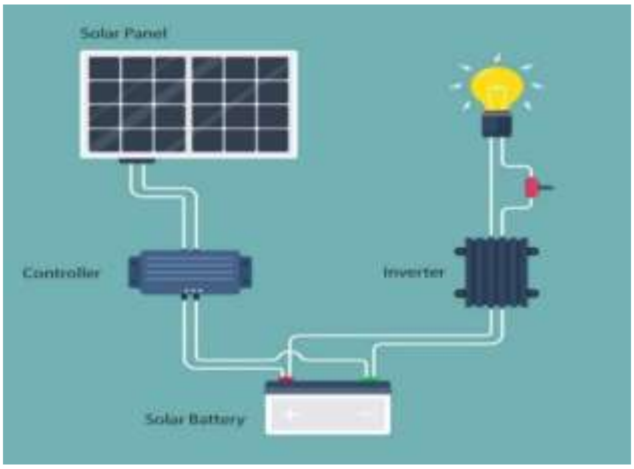


Figure (II. 1): General plan for solar installation.

II.2.Description of the Laboratory n°. 9:

Laboratory n°. 9 is an informant of the Department of Electrical Engineering of the University of El Oued. It is considered one of the most prominent laboratory in the university and the South as a whole because of the equipment it contains, which has made it easier for students to do several experiments and work smoothly and efficiently.

Figure **(II. 2)**: Inside Image of the Laboratory n°. 9.

We have the devices in the lab, as well as the power and current for each device.

II.3.Direct Current (DC) Motor:

DC power systems are not very common in contemporary engineering practice. However, DC motors still have many practical applications, such as automobiles, aircraft, and portable electronics, in speed control applications. An advantage of DC motors is that it is easy to control their speed in a wide range of directions. DC generators are quite rare. Most DC machines are similar to AC machines, i.e., they have AC voltages and currents within them. DC machines have DC outputs just because they have a mechanism converting AC voltages to DC voltages at their terminals. This mechanism is called a commutator; therefore, DC machines are also called commutating machines [16].

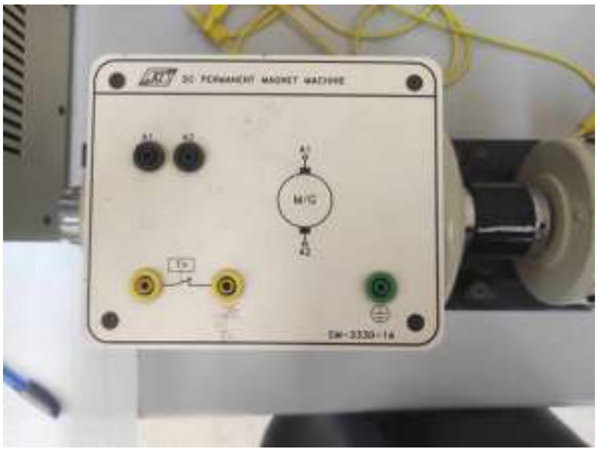


Fig (II. 3): poles of the motor.

Fig (II. 4): Nameplate the motor.

Rated Current: 2.7A Rated Power: 400W

II.4.Alternating Current (AC) Motor:

AC motors are electric motors that rotate by using power from a commercial AC power supply. They are easy to handle and have features that can be configured at a low cost. They are widely used to power various devices. A three-phase synchronous machine is an electromechanical energy conversion device that operates at a constant speed known as the synchronous speed. This speed is determined by the rotating magnetic field produced by the AC supply to the stator. The machine can be a generator, converting mechanical energy to electrical energy, or a motor, converting electrical energy to mechanical energy [17].

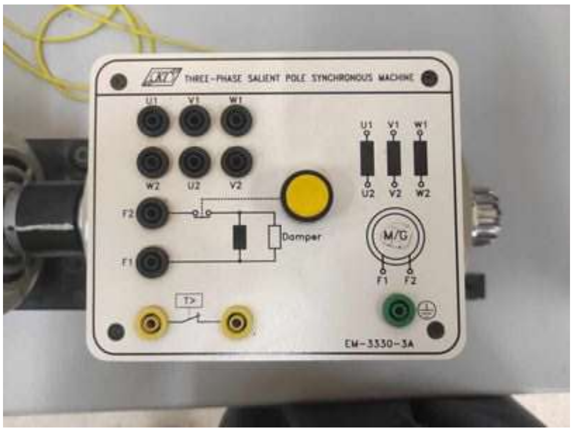


Fig (II. 5): poles of the motor.

Fig (II. 6): Nameplate the motor.

Electrical Power: 300 W. . Current: 1.7 A.

II.5. Air Conditioner AC:

An air conditioner is a device that controls indoor temperature, humidity, and air quality by cooling and sometimes heating the air in a confined space. It works by extracting heat from the indoor air and transferring it outside, thereby lowering the indoor temperature. Air conditioners typically consist of a compressor, condenser, evaporator, and expansion valve or metering device. They are widely used in residential, commercial, and industrial settings to provide comfort and improve air quality, especially during hot weather [18].

Fig (II. 7): Nameplate the AC.

Fig (II. 8): Air conditioner AC.

Applied Electrical (Voltage): 220 - 240 Vdc

Electrical Power: 1650W

II.6. Interior Lights:

An electric lamp, commonly known as a light bulb, is a device that produces light when electricity flows through a filament or gas. It's a fundamental source of artificial light, replacing traditional methods like candles. There are various types, including incandescent, fluorescent, LED, and halogen lamps, each with unique characteristics and applications. Electric lamps illuminate homes, streets, and workplaces, playing a vital role in modern society. Ongoing technological advancements promise greater energy efficiency and longevity in the future [19].

Fig (II. 9): Interior Lights

Applied Electrical (Voltage): 220 - 240 Vdc

Electrical Power: 75 w

II.7. Three-phase squirrel cage induction Motor:

The asynchronous machine, often known as an induction machine, is an electric alternating current (AC) machine with no connection between the stator and rotor. Cage machines or squirrel cage machines are other names for devices with a "squirrel cage" rotor. Today, there are various uses for asynchronous machines, including in industry (machine tools), domestic appliances, and transportation (metro, trains, and ships). Although it was just intended to be a motor at first, power electronics have allowed it to be used more and more as a generator. A start-up mechanism is necessary for asynchronous machines to run on single-phase electricity. Only three-phase current systems can power asynchronous motors for power applications beyond a few kilowatts [20].

Fig (II. 10): Three-phase squirrel cage motor.

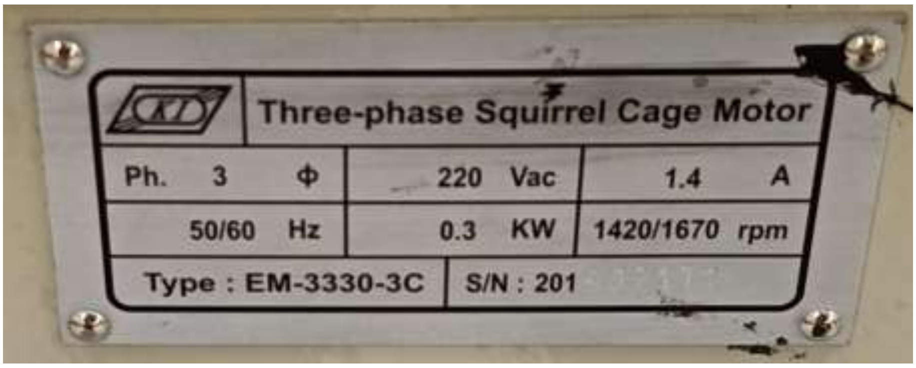


Fig (II. 11): Three-phase squirrel cage motor (nameplate).

Rated Current: 1.4 A Rated Power: 300W

II.8. DC Shunt Wound Machine:

On the same power supply, the field winding and winding induction are linked in parallel (bypass). The armature current determines the torque. This kind of motor can function as a generator. The winding releases the voltage in the ramp to reduce the motor's initial current intensity. To marginally lower the flux and speed values of this kind of motor, a variable resistor is linked in series with the inductor circuit. The armature and inductor share the same power source, but decreasing the voltage also causes the flux and torque to decrease, making it difficult to control the speed [21].

Fig (II. 12): DC shunt wound machine.

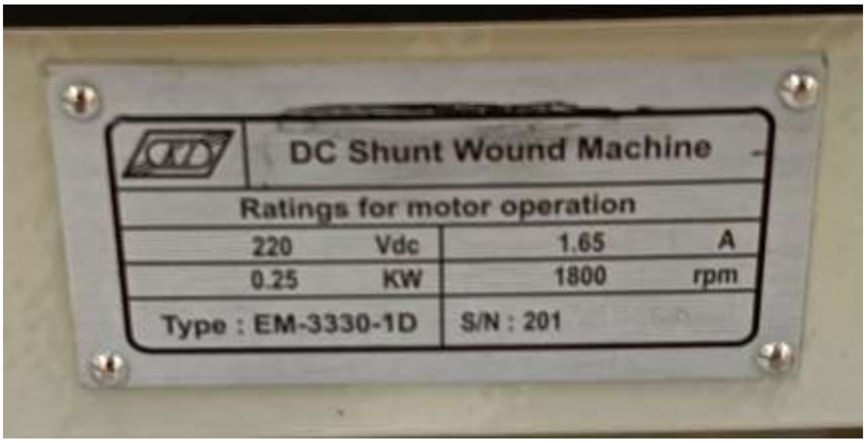


Fig (II. 13): DC shunt wound machine (nameplate).

Rated Current: 1.65 A Rated Power: 250W

II.9. Single-Phase Transformer:

It allows you to transfer the electrical power from a "primary" circuit to a "secondary" circuit. As a result, it functions both as the second air circuit's generator and principal circuit. The transformer is a static device that permits the adjustment of certain quantities (voltage, current) in an alternating manner without altering their frequency. In most cases, the voltage and current fluctuate in magnitude, but the power is mostly maintained. To adjust the receiver (load) to a network, its function is to vary the amplitudes of the alternating electrical magnitudes (currents and voltages) at a constant frequency. A static device called an electrical power transformer transfers electrical energy between circuits without requiring a direct electrical connection. Additionally, it uses mutual induction between two windings to accomplish this. It can transfer electricity from one circuit to another without changing the frequency, but at varying voltage levels depending on the situation [22].

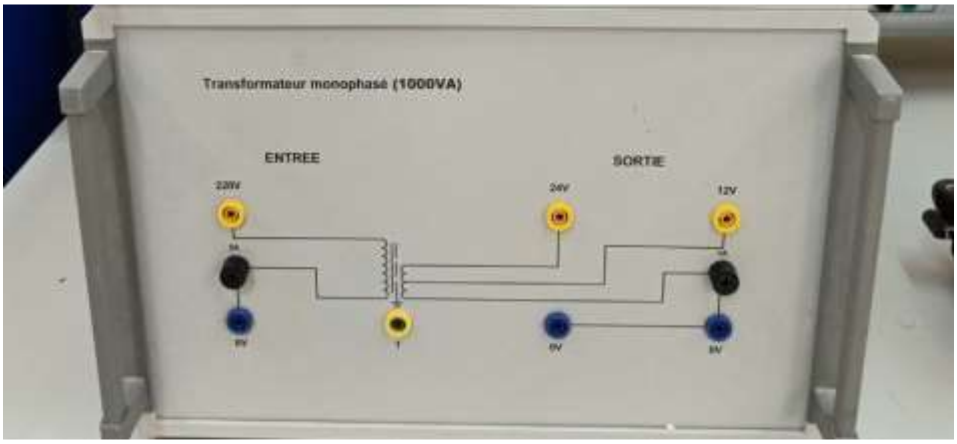


Fig (II. 14): single-phase transformer.

P = 1000 * 0.8 = 800 W

II.10. Three-Phase Synchronous Machine:

A three-phase synchronous machine matches the grid frequency to power a three-phase system. The gadget generates alternating current at the network's frequency and voltage. These devices are commonly used in electrical power generation and industrial situations that require precision and grid stability [23].

Figure (II. 15): Three-phase synchronous machine.

Rated Current: 3.8 A   Electrical Power: 1200 W

II.11. Three-Phase Induction Machine:

A three-phase induction motor is a type of electric motor that converts three-phase AC electrical power into mechanical energy. They are widely used in industry due to their robustness, reliability, and relatively low cost [24].

Figure (II. 16): Three-phase induction machine1.

Figure (II. 17): Three-phase induction machine 2.

Electrical Power: 3000W

II.12. Three-Phase Squirrel Cage Motor:

A common kind of electric motor in both commercial and industrial settings is the three-phase squirrel cage motor. There are three primary phases of an engine: reverse, straight, and single phases. Because the engine's cage, which carries its name, is made of conductive metal rods like copper or aluminum, a powerful magnetic field may be produced when the engine is operating. The three-phase cage engine requires less maintenance and operates with great efficiency and stability [25].

Figure (II. 18): Three-phase Squirrel cage motor

Electrical Power: 1500W

II.13. DC Machine Polyexcitation:

The DC machine polyexcitation is a rotary electrical machine that can function as either a generator or a motor. It's characterized by its various excitation methods, making it versatile and offering excellent performance properties.

Electrical Power: 1500w

Figure (II. 19): DC Machine polyexcitation.

II.14.Calculate of the Total Power:

After we know the equipment in this laboratory, we will calculate the total power in the following table:

Devices	Number	Power in watts/ day	Total power in watts/ day	Operating time in hours	Power required in watt-hours
(DC) motor	1	400	400	5	2000
(AC) motor	1	300	300	5	1500
Air conditioner AC	2	1650	3300	8	26400
Interior lights	20	18	360	8	2880
Three-phase squirrel cage induction motor	1	300	300	5	1500
DC shunt wound machine	1	250	250	5	1250
Single-phase transformer	3	800	2400	5	12000
Three-phase synchronous machine	1	1200	1200	5	6000
Three-phase induction machine	2	3000	6000	5	30000
Three-phase squirrel cage motor	2	1500	3000	5	15000
DC Machine Polyexcitation	2	1500	3000	5	15000
TOTAL	36	10918	20510	61	113530

Table (II. 1): Calculate of the Total Power.

II.Conclusion:

In conclusion, this section provided a valuable overview of laboratory n°. 9 of the Department of Electrical Engineering at the University of El Oued. This research focused on assessing the energy usage of laboratory devices. This knowledge is required to improve energy utilization, ensure the efficient operation of laboratory equipment, and identify the number of solar panels and appropriate devices to supply this laboratory with solar energy.

Chapter 03:

Modeling and Simulation of PV System

III.1.Introduction:

Modeling is a crucial process that involves creating various models to evaluate the characteristics of each component of the installation and its parameters. In a photovoltaic energy system, the goal is to operate close to maximum power point tracking (MPPT). Digital simulation used to understand the behavior of these components and their interactions. By simulating the system's performance, we can track the energy conversion steps and identify detailed losses across the system. In this chapter, we calculated the number of panels needed to power Laboratory n°. 9 and then studied the modeling and simulation of the photovoltaic system with a "boost" converter using a numerical inspector for "P&O" MPPT.

III.2.Calculation of the required number of modules:

First, we have to calculate the required power from the solar panels, so we have the total energy required per day: 113530 Wh/day.

- Power required from the solar panels = total energy required per day / effective sunshine hours * system efficiency.

Power required from the solar panels = 113530 / 5*1.3 = 29518 w = 29 kW.

- Number of solar panels required =

Power required from the solar panels / output power of the solar panels.

Number of solar panels required: 29530 / 445 = 66 panels.

III.3.Number of serial modules:

We assume a certain number of sequential panels, for example, 3.

So calculate the power output of one string (series) of solar panels.

Power output of one string = power rating of a single panel × number of panels in series.

Power output of one string (series) = 445W × 3 = 1335W = 1.335 kW.

III.4.Number of parallel modules:

Total power output = power output of one string × number of parallel strings.

By substituting the values, we get 29 kW = 1.335 kW × number of parallel strings. Solving for the number of parallel strings, we get:

Number of parallel strings = 29 kW / 1.335 kW.

Number of parallel strings ≈ 21.72 ≈ 22.

Therefore, to generate the required power of 29 kW using solar panels with the given panel parameters (Voc = 90.5V, Isc = 6.21A, and P = 445W), the configuration should be 3 panels in series and 22 parallel strings.

III.5.System elements:

III.5.1.Photovoltaic generator:

A photovoltaic module consists of a set of elementary photovoltaic cells mounted in series and in parallel [26].

they produce electricity from the moment they are exposed to solar radiation, do not pollute, have no moving parts, require virtually no maintenance, and produce no noise [27].

If a cell (under radiance) not connected to an external circuit, it has a voltage called open circuit voltage (Vco), which is highly temperature-dependent. On the other hand, the maximum current PV reached when the terminals of the cell are short-circuited. The short circuit current, denoted Isc, and then referred to as being highly dependent on the level of radiance, denoted E. To produce more power, several cells had be assembled to create a complete photovoltaic module (energy generator). Thus, the serial connection of identical cells makes it possible to increase the voltage of the whole, while parallel allows for an increase in the current. Serial or parallel wiring is possible and often used to obtain an overall PV generator with the desired characteristics to theoretically adapt photovoltaic energy production to demand [26].

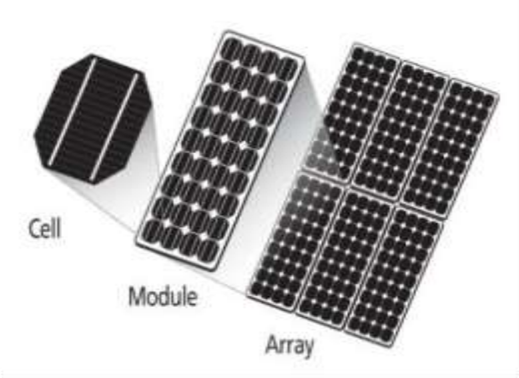


Figure (III.1): Cell, module and PV panel.

III.5.1.1.Characteristic of a photovoltaic module:

Here is the description of the parameters of a module:

1. **Maximum Power (P max)**: Maximum electrical power that the module can provide in the standard condition (25 ° C and a radiance of (1000 W/m ²).

Characteristic I (V): Curve representing the current I delivered by the module in function of the voltage at the terminals.

2. **Open circuit voltage (Vco)**: Voltage at the terminals of the module in the absence of any current, for "full sun" radiance.
3. **Short Circuit Current (Isc):** Current delivered by a short circuit module for radiance "full sun".
4. **Optimum operating point (Um, Im):** When peak power is maximum in full sun, Pm = Um. Im.
5. **Maximum efficiency:** Ratio of optimal electrical power to power of incidental radiation.
6. **Form factor:** Ratio of optimum power Pm to maximum power what can the cell have: Vco. Isc [28].

III.5.1.2.Influence of radiance:

Figure (III.2) gives an example of the curves for different radiation levels:

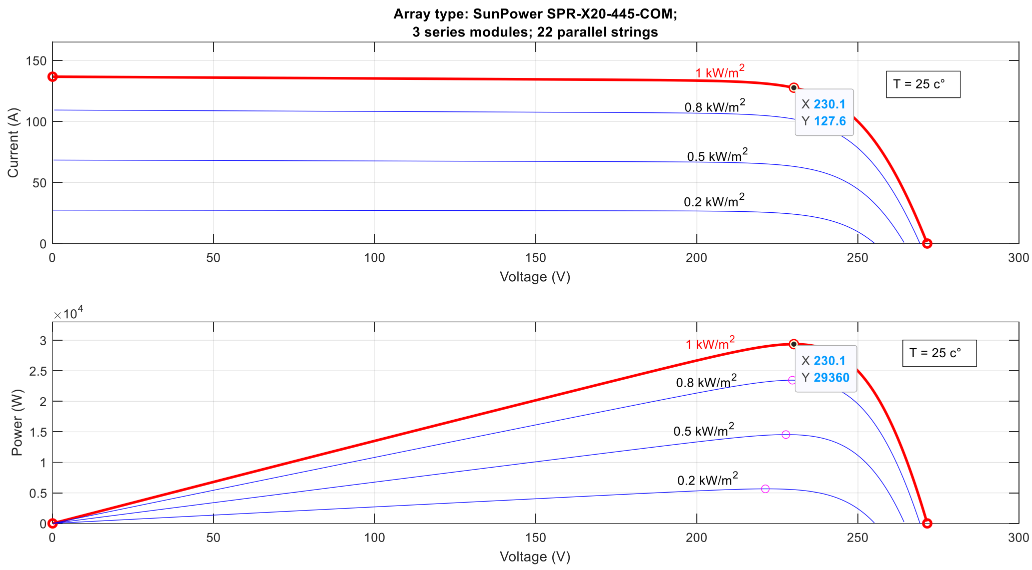


Figure (III.2): Characteristic I = f (V) and P = f (V) of a solar panel for different radiance at a constant temperature equal to 25 ° C.

It will be noted that the value of the short-circuit current is directly proportional to the intensity of the radiation. On the other hand, the open circuit voltage does not vary in the same proportions; it remains almost identical even at low radiance. Standard, internationally accepted irradiation-to-measure-response photovoltaic panels have a radiating intensity of 1000 W/m2 and a temperature of 25 °C.

III.5.1.3.Influence of Temperature :

Figure (III.3)shows current-voltage curves for different operating temperatures of the PV cell:

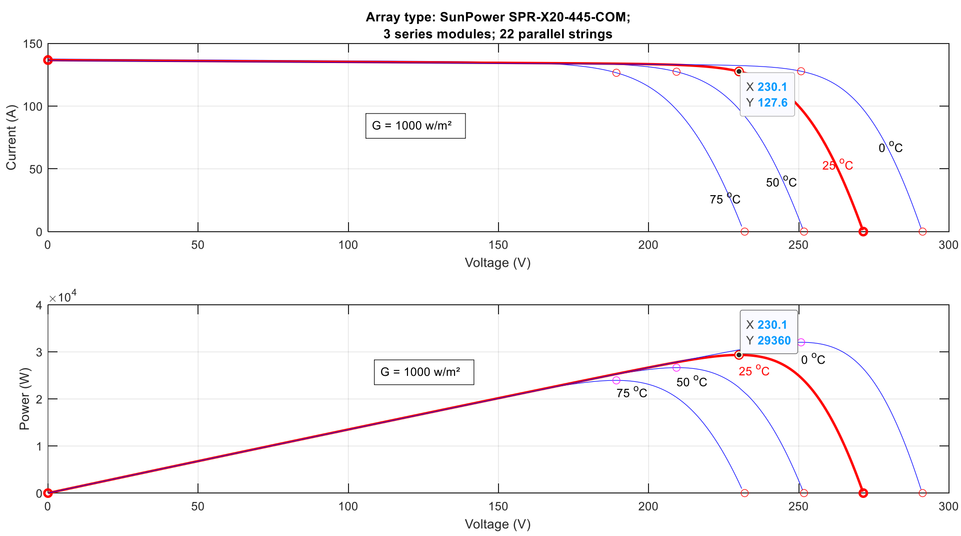


Figure (III.3): Characteristics P=f (V) of a solar panel for different temperatures with radiance equal constant 1000w / m ².

It will be noted that the temperature has a negligible influence on the value of the short-circuit current. On the other hand, the open circuit voltage drops quite sharply when the temperature increases, and consequently, the extractable power decreases. During the dimensioning of an installation, temperature variations at the site had be considered. It is important to know that the power of the panel decreases by about 0.5% with each degree of increase in the temperature of the cell above 25 °C.

III.6.DC-DC Converter (Boost):

It is a DC-DC direct converter. The input source is of the direct current type (inductance in series with a voltage source), and the output load is of the direct voltage type (capacitor in parallel with the resistive load). Switch K can be replaced by a transistor since the current is always positive and the switches must be controlled (when blocking and starting) [29]. Also known as "boost" or parallel converter, its basic schema is that of the figure (III.4). Its typical application is to convert its input voltage into a higher output voltage [30].

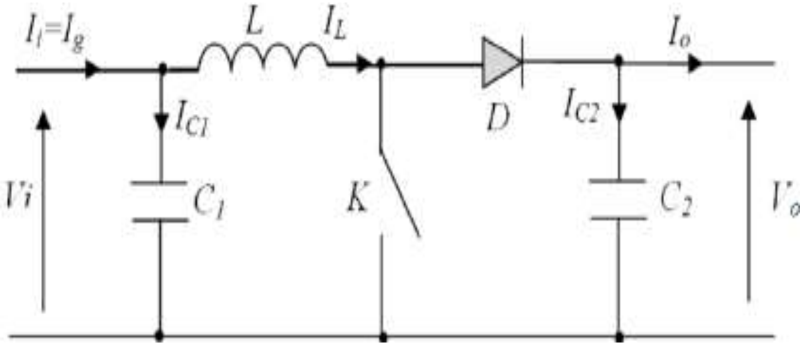


Figure (III.4): Block diagram of a Boost converter.

III.6.1.MPPT control definition:

In a photovoltaic system comprising a photovoltaic source and a load, searching for the optimal operating point using optimization techniques is an important step. This order technology had often named in the literature "Research of the Power Maximum Point" (Maximum Power Point Tracking, MPPT) [31]. By definition, an MPPT order, linked to an intermediate adaptation floor, allows a generative PV to permanently produce the maximum of its power. Thus, whatever the weather conditions (temperature and irradiation) and whatever the voltage of the battery, the control of the converter places the system at the maximum operating point.

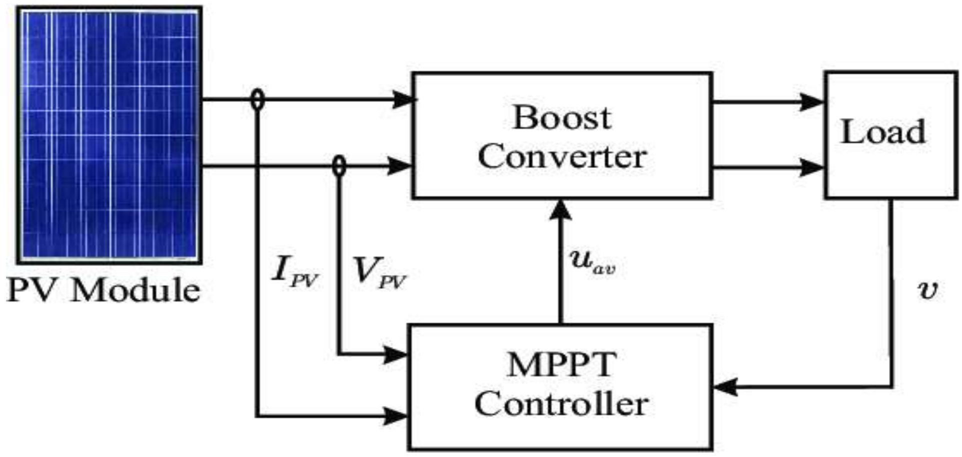


Figure (III.5): Elementary photovoltaic conversion chain associated with a control MPPT.

III.6.2.Technique Perturber and Observer (P&O):

There are several methods for obtaining the maximum power point tracking (MPPT) of a photovoltaic generator. The first uses of the MPPT date back to 1968. It had a kind of controller that will force the generator to work at its maximum power. Among the methods, we consider the so-called perturbation and observation (P&O). Very often exploited and quoted thanks to its simplicity. It had based on an algorithmic procedure to search for the maximum power point (MPPT) [32]. Its principle had based on the perturbation of the system by increasing or decreasing the voltage of the generator, or it acts directly on the duty ratio of the DC/DC converter, and then observation of the effect on the output power. Therefore, following a voltage perturbation, the power increases, and the direction of the perturbation had maintained. Otherwise, it had reversed to resume convergence toward the new MPPT .Figure (III.6) and Figure (III.7) introduce, respectively, the functioning principle and flowchart of the technology of the order MPPT of type P&O. The power at each instant had calculated thanks to the voltage and current values of the photovoltaic panel, which requires the use of two sensors.

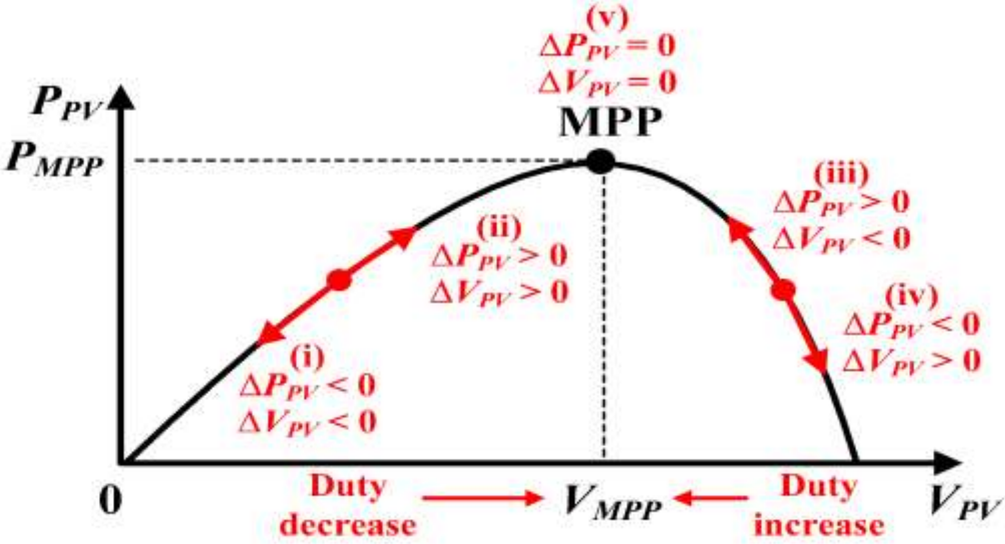


Figure (III.6): Principle of the P&O technique.

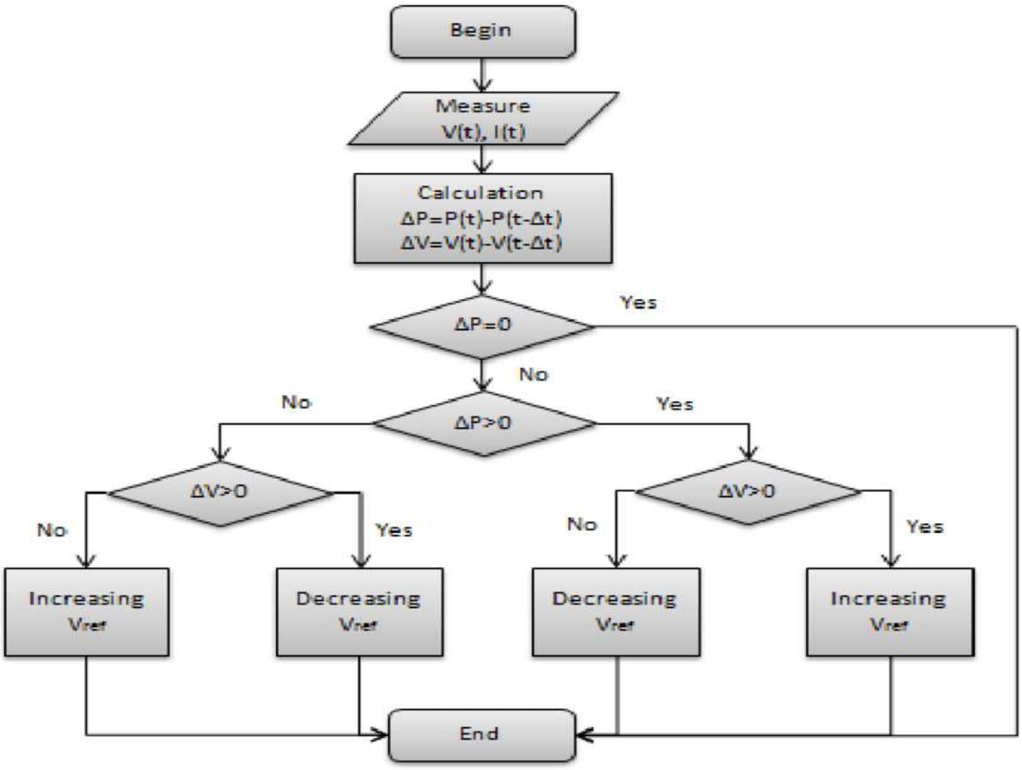


Figure (III.7): Algorithm of the P&O method.

III.7.DC-AC Inverter:

Inverters are static converters in power electronics. They has used in any electric system where the transformation of the DC voltage into the AC voltage is necessary. The solar inverter makes it possible to convert the direct current produced by the photovoltaic panels into alternating current identical to that of the electrical grid. **[33]**

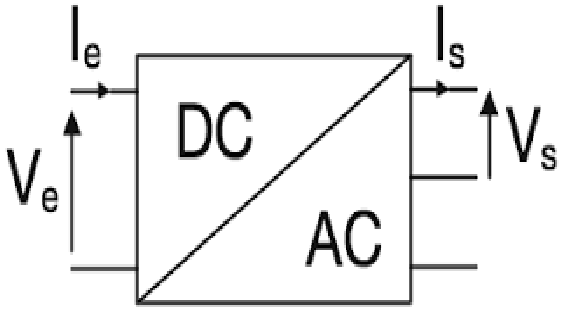


Figure: (III.8) three-phase DC/AC inverter

III.8. Simulation results:

This simulation models a PV system with a DC-DC converter for boosting the voltage from the PV array before it had converted into AC electricity by an inverter. The inclusion of temperature blocks and radiance suggests that the model may account for temperature effects and radiance on the system's performance.

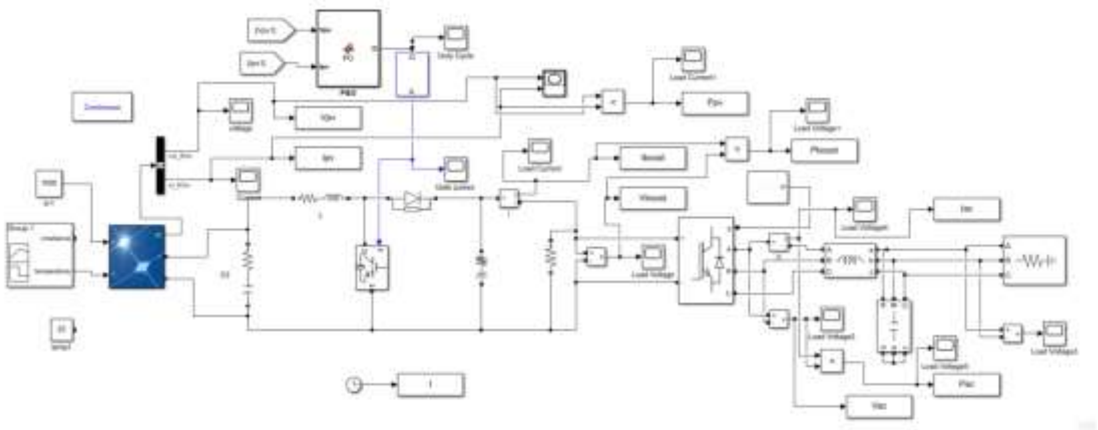


Figure (III.9): Simulation scheme of the global system in MATLAB.

III.8.1. Results of PV module:

a. Influence of radiance :

By varying the radiance (G) between (1000 w/m^2 at time 0 to 0.2 sec, 800 w/m^2 at time 0.2 to 0.4 sec, 500 w/m^2 at time 0.4 to 0.6 sec, and 200 w/m^2 at time 0.6 to 0.8 sec) the characteristic had given by the figure (III.10).

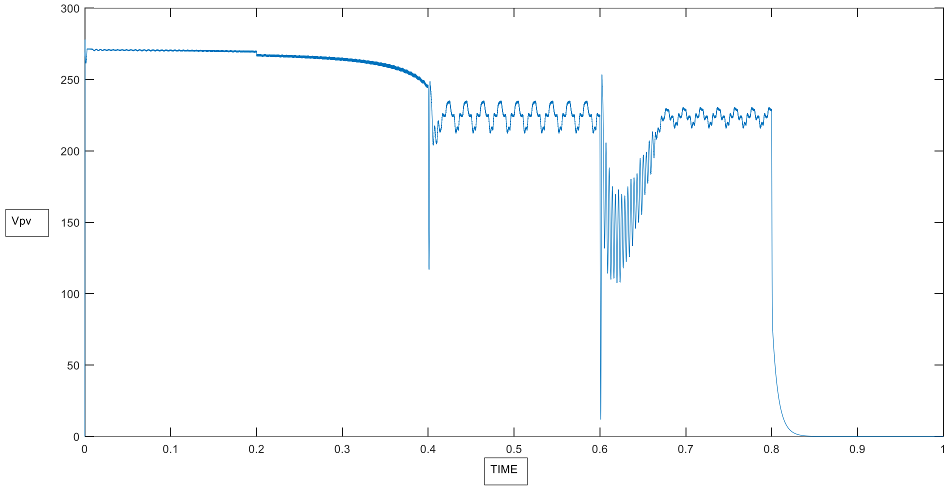


Figure (III.10): Voltage simulation results for influence of radiance and temperature constant

(T = 25 °c).

The graph demonstrates that solar irradiance has a positive correlation with the output voltage of a PV module. Higher irradiance levels lead to higher voltage output.

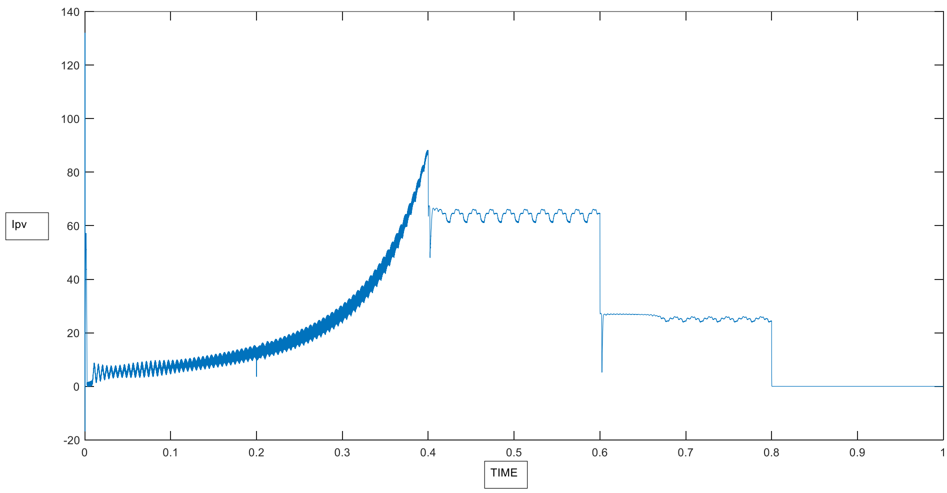


Figure (III.11): Current simulation results for influence of radiance and temperature constant

(T = 25 °c).

The diagram reinforces the concept that radiance intensity has a positive impact on a solar panel's ability to generate electricity.

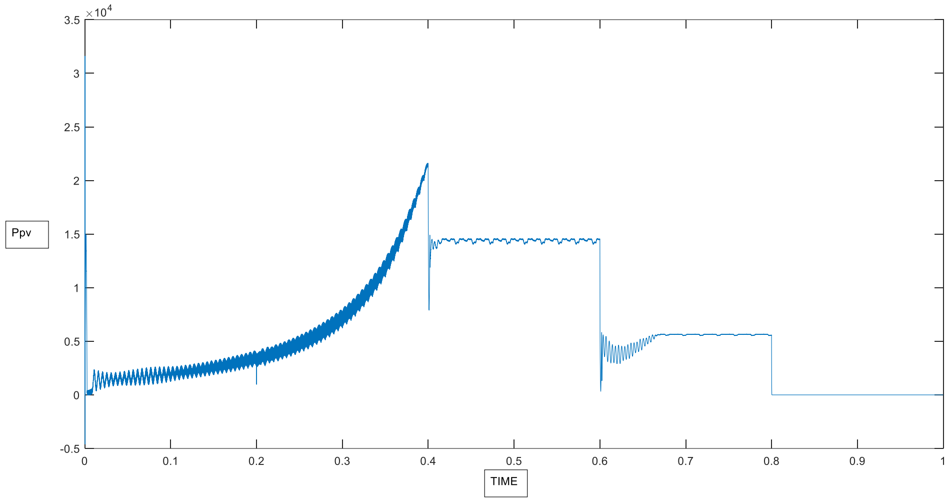


Figure (III.12) Power simulation results for influence of radiance and temperature constant

(T = 25°c).

Generally, the amount of irradiance that hits a solar panel will affect the amount of power it produces. More irradiance usually means more power output. The exact relationship between irradiance and power output will vary depending on the specific solar panel and other factors, such as temperature.

b. Influence of Temperature :

By varying the temperature (T) between(75°c at time 0 to 0.2 sec, 50°c at time 0.2 to 0.4 sec, 25°c at time 0.4 to 0.6 sec, 0°c at time 0.6 to 0.8 sec) the characteristic had given by the figure(III.13).

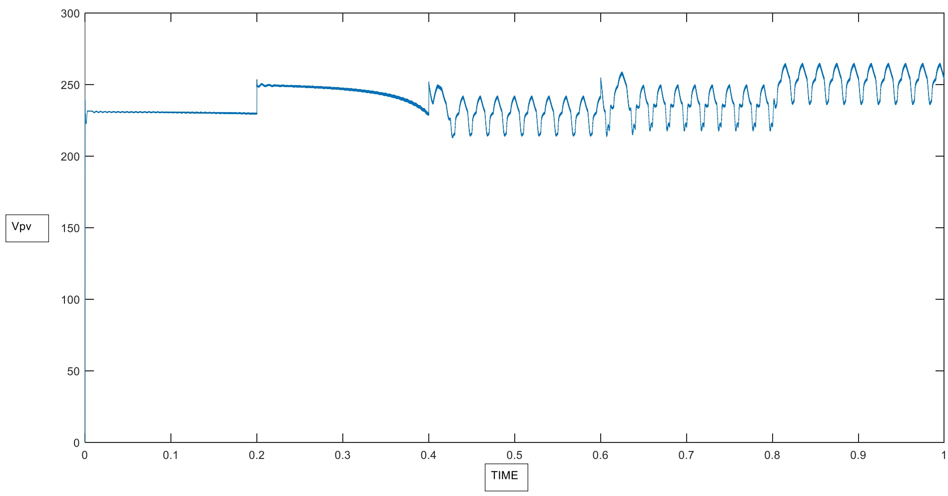


Figure (III.13): Voltage simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The blue line in the graph shows that the output voltage of the solar panel decreases as the temperature increases. This is because solar panels are less efficient at converting sunlight into electricity when they are hot.

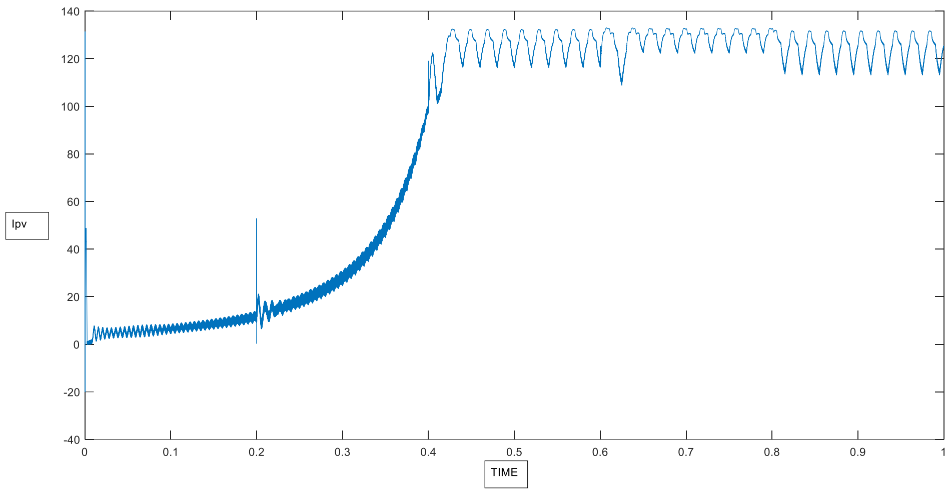


Figure (III.14): Current simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The curve on the graph shows that the output current of the PV module increases slightly as the temperature increases. This is because as solar panels heat up, the silicon atoms within the solar cells vibrate more, which can loosen electrons and allow for more current flow.

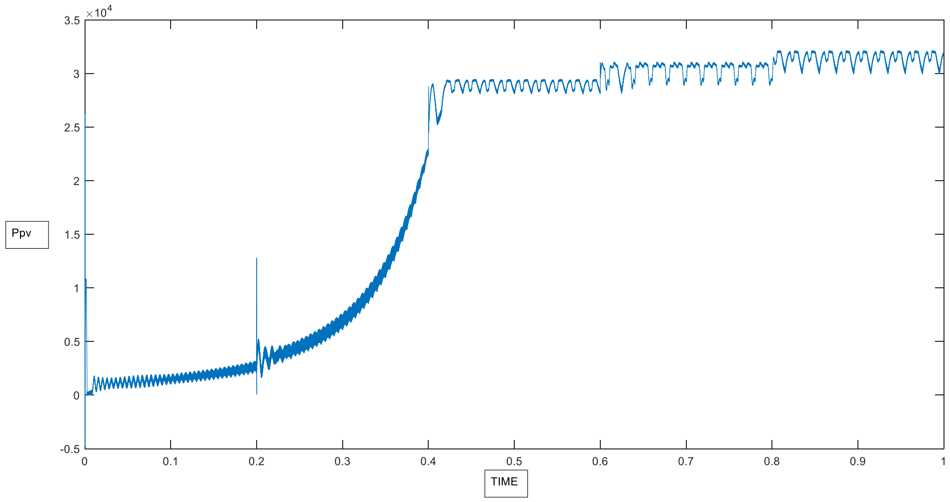


Figure (III.15): Power simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

As the temperature increases further, the output power begins to decrease. This is because solar panels are less efficient at converting sunlight into electricity when they are hot.

III.8.2. Results of boost converter:

a. **Influence of radiance :**

By varying the radiance (G) between(1000 w/m^2 at time 0 to 0.2 sec, 800 w/m^2 at time 0.2 to 0.4 sec, 500 w/m^2 at time 0.4 to 0.6 sec, and 200 w/m^2 at time 0.6 to 0.8 sec) the characteristic had given by the figure(III.16).

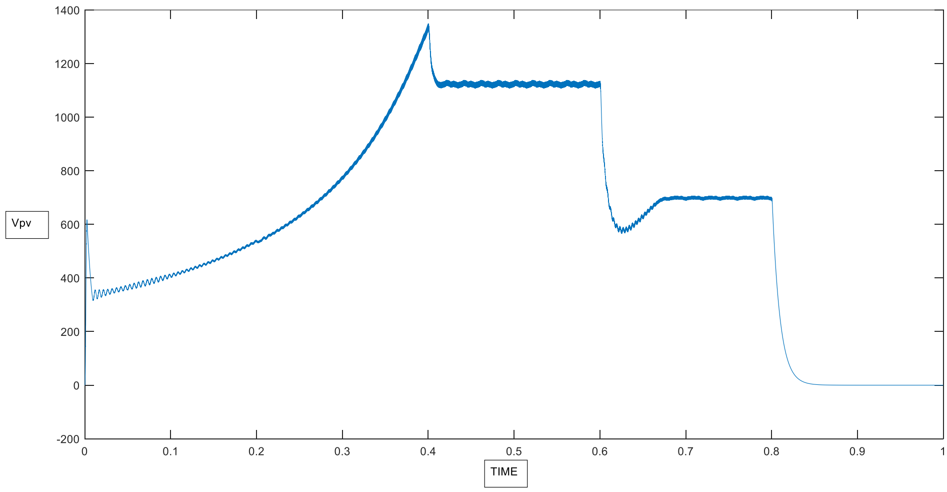


Figure (III.16): Voltage simulation results for influence of radiance and temperature constant

(T = 25 °c).

The curve depicts how the output voltage decreases as the radiance or irradiance level decreases. At higher radiance levels (towards the left side of the x-axis); the PV module generates a higher output voltage, which then drops gradually as the radiance decreases.

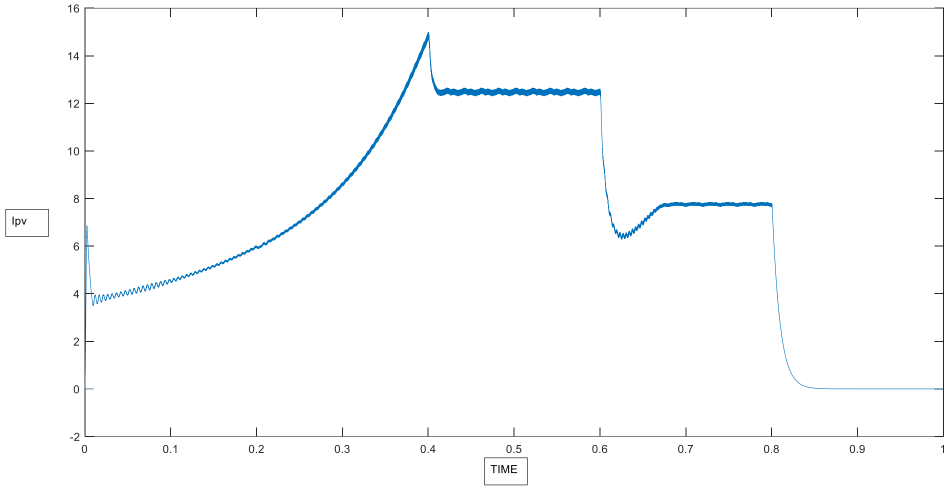


Figure (III.17): Current simulation results for influence of radiance and temperature constant

(T = 25°c).

The sharp increase in current is likely the result of the boost converter had been turning for the first time or due to a sudden increase in sunlight hitting the PV module. This resulted in a temporary surge in the output current. After the initial surge, the current decays gradually over time.

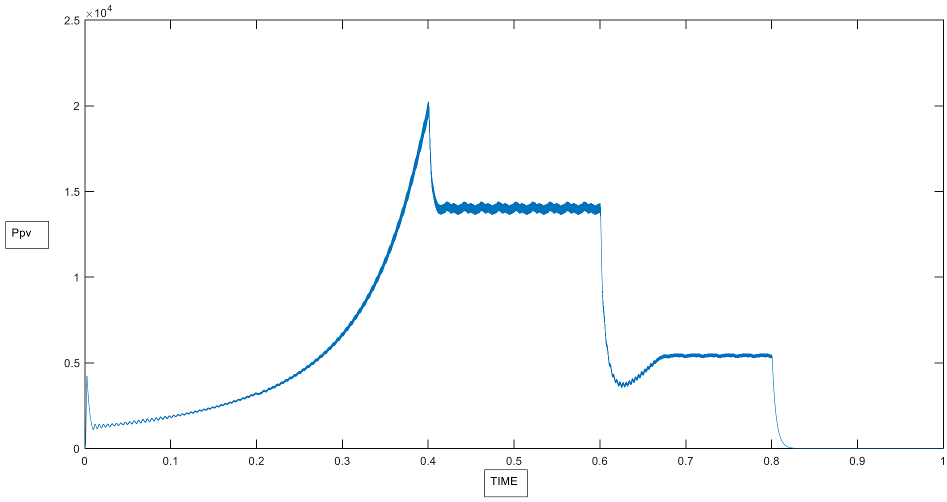
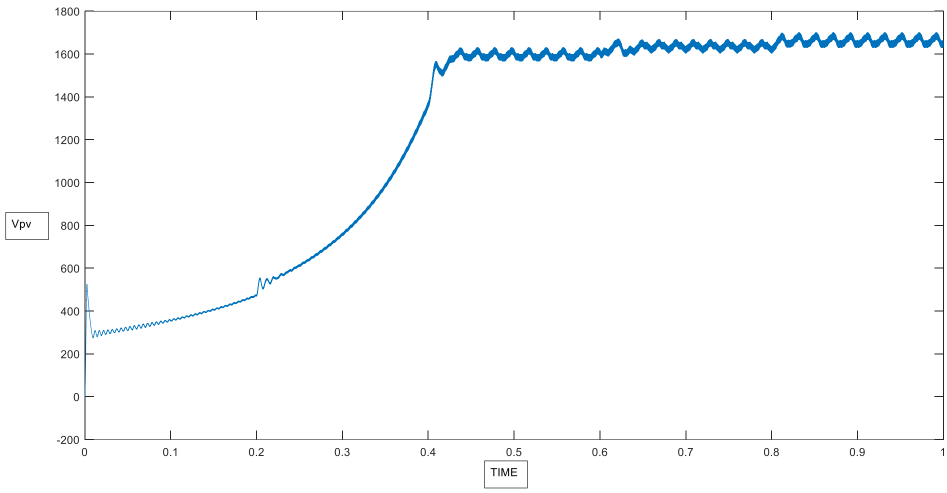


Figure (III.18): Power simulation results for influence of radiance and temperature constant

(T = 25°c).

The sharp first peak indicates a quick rise in power production, which had most likely caused by a rapid burst of sunlight reaching the PV module. This happens when the clouds clear and the system is first exposed to direct sunlight. Following the initial power increase, the output progressively drops over time.

b. Influence of Temperature :



By varying the Temperature (T) between(75°c at time 0 to 0.2 sec, 50°c at time 0.2 to 0.4 sec, 25°c at time 0.4 to 0.6 sec, 0°c at time 0.6 to 0.8 sec) the characteristic had given by the figure(III.19).

Figure (III.19): Voltage simulation results for influence of temperature and radiance constant (G = 1000w/m²).

The curve has a gradually decreasing shape, indicating that the output voltage from the PV module decreases over time. This behavior is characteristic of the temperature effect on PV modules.

As the temperature of the PV module increases due to continued exposure to sunlight, the voltage output decreases. This is because the voltage of a PV module has an inverse relationship with temperature, governed by its temperature coefficient.

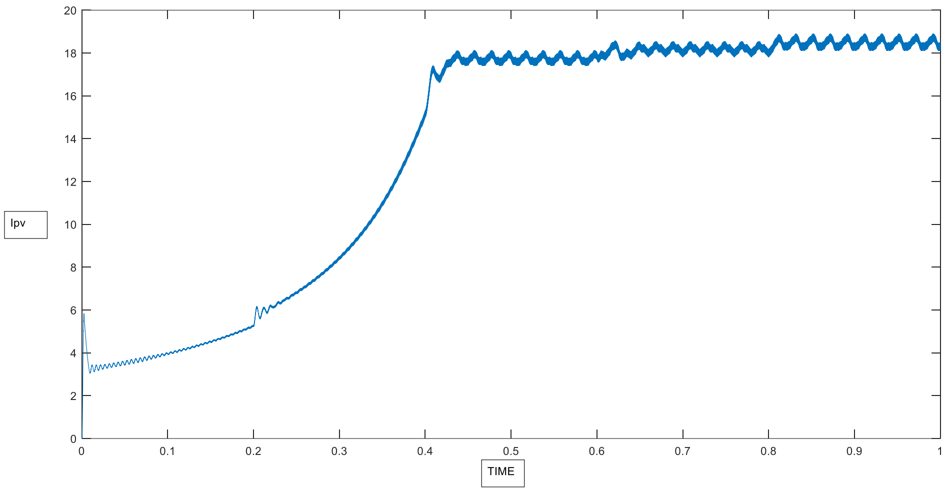


Figure (III.20): Current simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The shape of the curve suggests that as the temperature increases (likely due to solar heating); the output current of the PV module initially increases, reaches a maximum, and then decreases as the temperature continues to rise further. This behavior is consistent with the typical temperature dependence of solar cell performance, where moderate temperature increases can improve output but excessively high temperatures degrade performance.

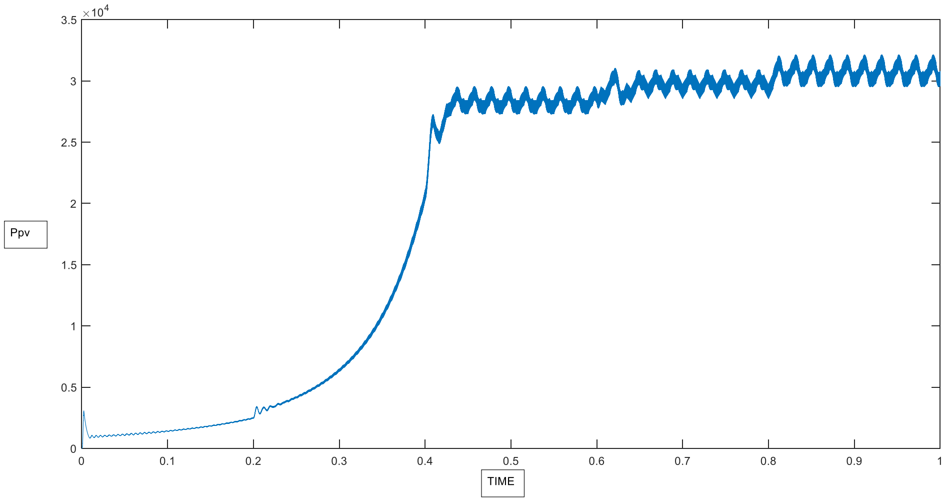


Figure (III.21): Power simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The diagram shows that the output power of the PV module is lower at higher temperatures. This is because solar cells are less efficient at converting sunlight into electricity when they are hot.

The boost converter can help mitigate this effect by increasing the output voltage from the PV module.

III.8.3.Results of inverter:

a. Influence of radiance :

By varying the radiance (G) between(1000 w/m^2 at time 0 to 0.2 sec, 800 w/m^2 at time 0.2 to 0.4 sec, 500 w/m^2 at time 0.4 to 0.6 sec, 200 w/m^2 at time 0.6 to 0.8 sec) the characteristic had given by the figure(III.22).

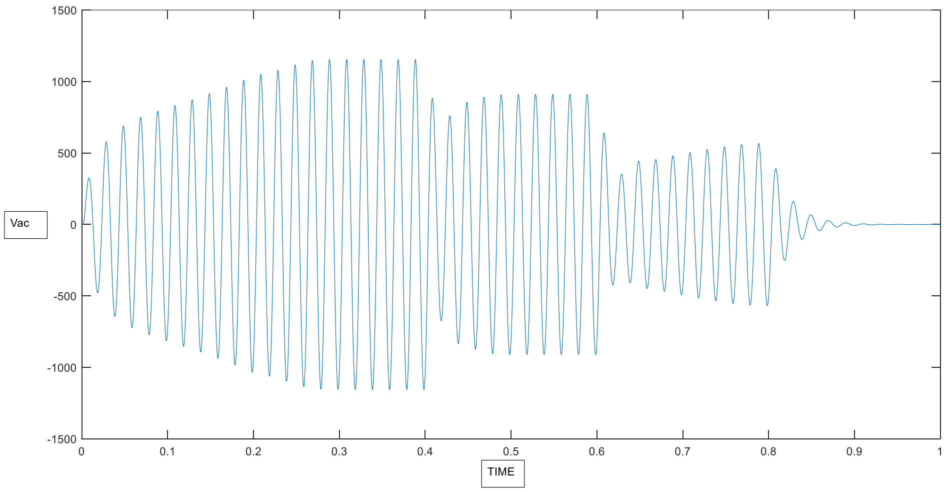


Figure (III.22): Voltage simulation results for influence of radiance and temperature constant (T = 25°c).

We can see a fluctuation in the voltage output over time, which had likely caused by changes in irradiance levels. Generally, higher irradiance levels will result in a higher output voltage from the PV module.

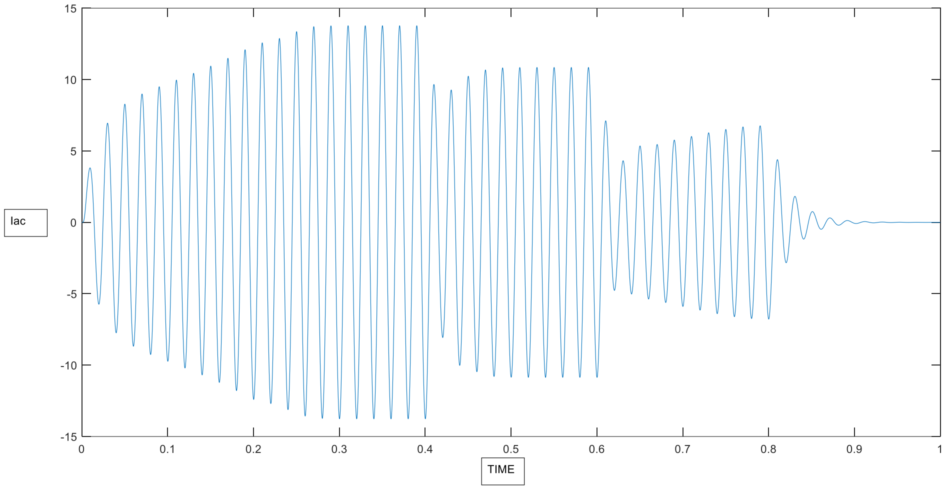


Figure (III.23): Current simulation results for influence of radiance and temperature constant (T = 25°c).

The graph shows fluctuations in the output current over time. These changes likely correspond to changes in irradiance levels. In general, higher irradiance levels will result in a higher output current from the PV module.

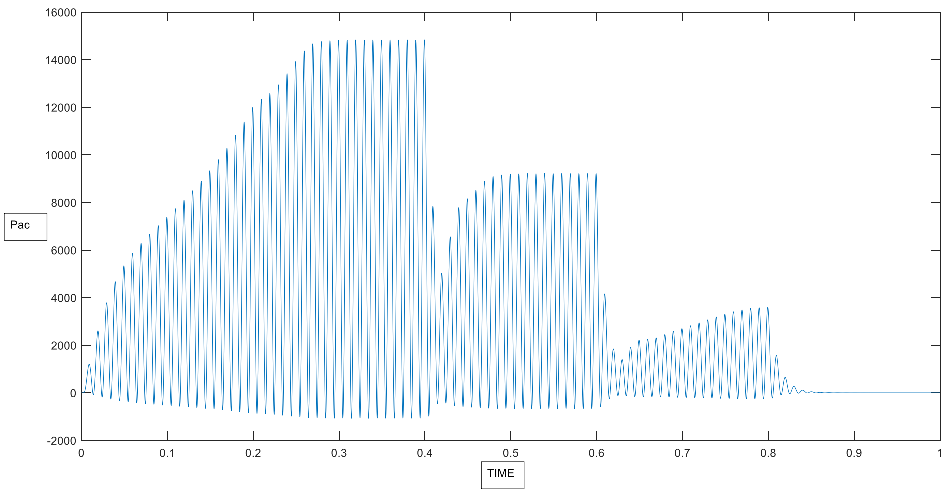


Figure (III.24): Power simulation results for influence of radiance and temperature constant (T = 25°c).

The graph shows a positive correlation between time and power, which means that the output power of the PV module increases with time. This is likely because the radiance increases as the day progresses.

b. Influence of Temperature :

By varying the Temperature (T) between(75°c at time 0 to 0.2 sec, 50°c at time 0.2 to 0.4 sec, 25°c at time 0.4 to 0.6 sec, 0°c at time 0.6 to 0.8 sec) the characteristic had given by the figure(III.25).

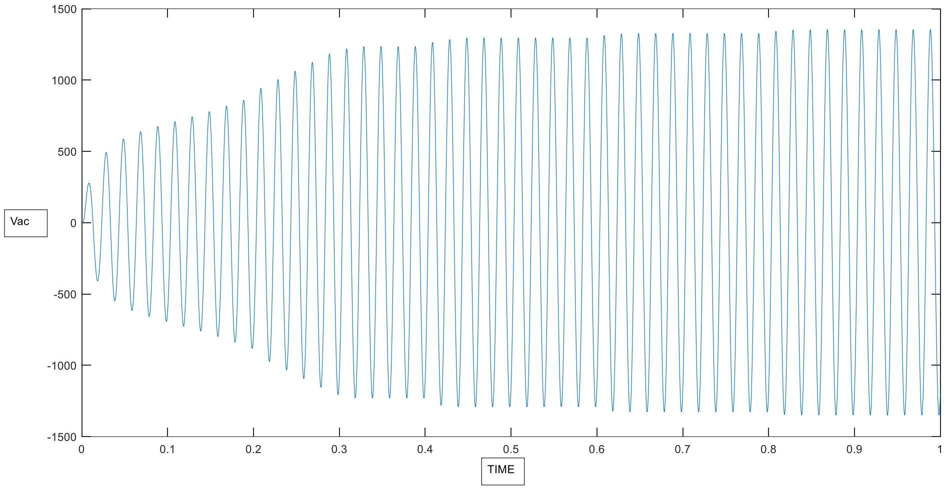


Figure (III.25): Voltage simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The effect of temperature on the output voltage of the PV module. The voltage appears to decrease as the temperature increases. This is because solar cells are made of semiconductors, and the conductivity of semiconductors increases with temperature. As a result, the voltage output of the solar cell decreases.

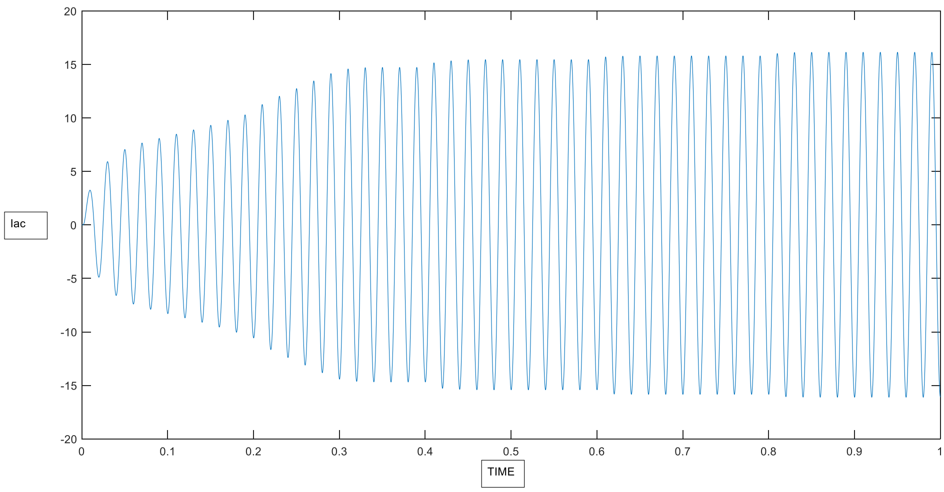
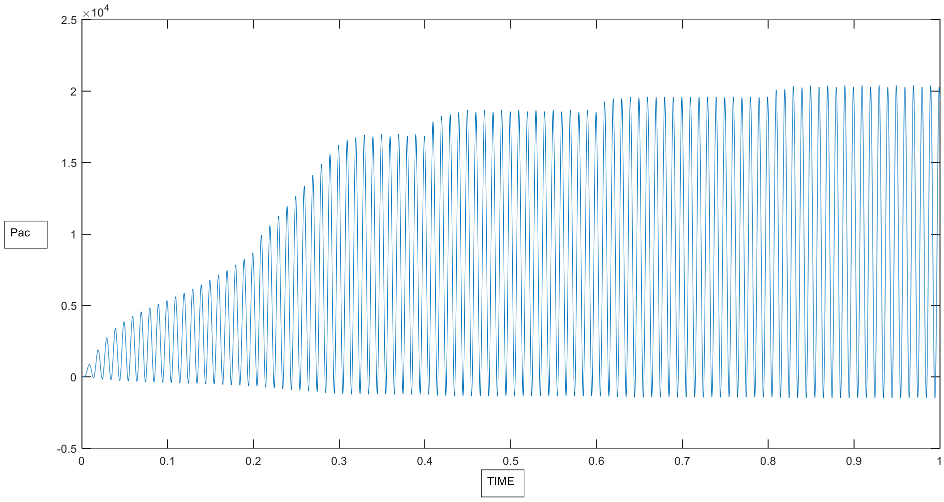


Figure (III.26): Current simulation results for influence of temperature and radiance constant

(G = 1000w/m²).



We know that temperature can affect the efficiency of PV modules. As the temperature of a PV module increases, its output current typically decreases. This is because higher temperatures can cause the internal resistance of the PV module to increase, which reduces the amount of current that can flow.

Figure (III.27): Power simulation results for influence of temperature and radiance constant

(G = 1000w/m²).

The diagram show that the output power of a PV module decreases as the temperature increases. This is due to the temperature coefficient of power, which is a well-known phenomenon in solar energy.

III.Conclusion:

Simulation results show that the performance of a PV panel strongly influenced by climatic conditions, particularly solar radiance and temperature. When the sunlight increases, the intensity of the current increases, which allows the module to produce greater electrical power, and the characteristic P = f (V) comprises maximum power point tracking (MPPT). The simulation results show that the control MPPT ensures the continuation of maximum power point tracking during the variation of the meteorological conditions (radiance, temperature) and the load.

General conclusion

The presented work relates to a study on the solar energy supply of laboratory n°. 9, where we discussed the definition of photovoltaic energy and the construction of photovoltaic cells and their impact, as well as the principle of photovoltaic energy and its advantages and disadvantages. We then combined the total capacity of the electrical equipment used in laboratory n°. 9 with a snapshot of each. In the third chapter, we calculated the number of solar panels required to feed the system and then studied the modeling and simulation of the electrical operation of a photovoltaic (PV) system adapted by numerical control (MPPT control) to ensure the maximum power continuity provided by the photovoltaic generator.

We have studied a DC/DC-type boost converter that provides a DC voltage. This converter has the advantage of being a voltage booster, which allows this system to adapt to weather changes and extract the maximum power available. The model of the MPPT is based on a DC/DC converter and a maximum power point search algorithm. Thus, it is based on the different algorithms for tracking maximum power points based on counter reaction (current power voltage), perturbation algorithm, and increase algorithm observation. The choice of the lift converter (boost) after the mathematical analysis of the different configurations of the DC-DC converters has made it easier for us to develop a model for searching for the MPPT in Simulink.

The P&O (perturber and observer) method has been chosen to implement an algorithm for tracking the operating point at maximum power of the panel PV (MPPT). Based on the simulation results obtained, it can be said that:

- The performance of the generator deteriorates as the temperature increases, the intensity of radiance decreases, and the load changes. The performance of the PV generator is evaluated under the standard conditions (CST): radiance of G=1000 W/m^2 and T = 25 °C.

- The converter gives a tension in optimum conditions at its upper exit to that given by the generative PV.
- These results show that the use of the control MPPT makes it possible to considerably improve the efficiency of photovoltaic installations.

References

[1] B. ABDELFETTAH, A. AMJED,« Etude technicoéconomique d’une installation photovoltaïque pour application dans la région de Ouargla » Mémoire de Master ;Univ. KASDI MERBAH OUARGLA, 2019/2020

[2] D. YASSER, D. SEDDIK, « ÉTUDE D’UN SYSTEME DE POMPAGE PHOTOVOLTAIQUE » ,

Mémoire de Master .Univ Mohamed Boudiaf –Msila 2021/2022

[3] K. RIAD ,« Détection et isolation de défauts combinant des méthodes à base de données appliquées aux systèmes électro-énergétiques » , Mémoire de Master ;UNIV FERHAT ABBES - SETIF 2015

[4] Planete-Energies ; La cellule photovoltaïque : comment ça marche ,« www.planete-energies.com» , 23.05.2024

[5] K.Taki Eddine,«Modélisation et commande d’un système photovoltaïque connecté au réseau électrique » Mémoire de Master, UNIV MOHAMED BOUDIAF - M’SILA ; 2016

[6] T.Nihed , K. Iskandar ,«ENERGIE SOLAIRE PHOTOVOLTAIQUE ET SYSTEME PHOTOVOLTAIQUE AUTONOME» Mémoire de Master, Université Badji Mokhtar –Annaba 2020/2021

[7] M.Djarallah,«Contribution à l'étude des systèmes photovoltaïques résidentiels couplés au réseau électrique », Thèse de Doctorat, Université de Batna 2008

[8] M . Mohamed ,S. Mohamed,«Contrôleurs de charge solaires » Mémoire de Master, UNIV M’HAMED BOUGARA-BOUMERDES ;2019/2020

[9] K.BEDDA , R.BAKKA ,« Conception d’une centrale photovoltaïque pour alimenter un site connecté au réseau électrique» Mémoire de Master, UNIVERSITE KASDI MERBAH OUARGLA 12/06/2021

[10] R.Lamine, T. Younes,«Commande d’un systèm photovoltaïque Connecté au Réseau Electrique» Mémoire de Master, Univ Abderrahmane MIRA- BEJAIA ; 2017/2018

[11] R.Lamine, T. Younes,«Commande d’un systèm photovoltaïque Connecté au Réseau Electrique» Mémoire de Master ,Univ Abderrahmane MIRA- BEJAIA ; 2017/2018

[12] R.Lamine, T. Younes,«Commande d’un systèm photovoltaïque Connecté au Réseau Electrique» Mémoire de Master, Univ Abderrahmane MIRA- BEJAIA ; 2017/2018

[13] S. Abdelmonaim, Z. Nour Elhouda,«Etude sur l'Utilisation de l’Energie Photovoltaïque dans un Système de Pompage» Mémoire de Master, Univ Echahid Hamma Lakhdar - El-Oued;2022/2023

[14] S. Abdelmonaim, Z. Nour Elhouda, «Etude sur l'Utilisation de l’Energie Photovoltaïque dans un Système de Pompage» Mémoire de Master, Univ Echahid Hamma Lakhdar - El-Oued;2022/2023

[15] Dr. BELAID LALOUNI Sofia , «Cours Energie Solaire Photovoltaïque» Mémoire de Master ,Université A.MIRA de BEJAIA , 2014/2015

[16] Davide Poli and Massimo Ciraolo, «Fundamentals of Electrical Power Engineering: From Electromagnetics to Power Systems» Mémoire de Master , Diyala University

[17] Orientalmotor; AC Motor Fundamentals; Oriental Motor U.S.A. CORP

[18] Saurabh kumar singh , «fr.scribd.com jun2022» ,

[19]Matheus Lima , «fr.scribd.com jun2017» ,

[20] Mansouri Khalida , Belaid Lynda , «Dimensionnement d'un Moteur Asynchrone Triphasé à Cage d'Ecureuil d'une Puissance 5,5 kW en Utilisant Le Logiciel Speed Pc-imd » Mémoire de Master, Université de Mouloud Mammeri de Tizi Ouzou : 2011/2012

[21] ZELACI Saida , MANANE Hamida , «Etude des caractéristiques du moteur à courant continu (à excitation séparée et shunt) » Mémoire de Master, UNIV D'EL-OUED 2008-2009

[22] ABDELLAOUI Mohamed/ TAIBI Ahmed Abdellah , «Simulation d'un transformateur monophasé en régime transitoire par le logiciel COMSOL-Multiphysics» Mémoire de Master , UnivMohamed Khider de Biskra lundi 20 juin 2022

[23] L.AMEUR, «ETUDE ET MODELISATION DE LA MACHINE SYNCHRONE » Mémoire de Master , Univ Badji Mokhtar – ANNABA;2020/2021.

[24] motac.Fr/blog/2018/07/17-les differents-types-de-moteur-electriques-asynchrones

[25] pompe-moteur.Fr/blog/moteur-asynchrone-triphase-valeur-sur-n16

[26] J. F.Reynaud, « Recherches d'optimums d'énergies pour charge/décharge d'une batterie à technologie avancée dédiée à des applications photovoltaïques » , Thèse de Doctorat de l'Université de Toulouse, 2011.

[27] S.Bensmail, «Contribution à La Modélisation Et à l'Optimisation Des Systèmes Photovoltaïques» , Mémoire de Magister de l'Université de Béjaia, Algérie, 2012.

[28] F. Benyarou , « Conception assistée par ordinateur des systèmes photovoltaïques» Mémoire de Master.
modélisation, dimensionnement et simulation », Thèse de Doctorat d'état. Université de Tlemcen Juillet 2004.

[29] M.N.Mchalikh , CH.Hmada ; «Modélisation et simulation d'un système photovoltaïque en fonctionnement autonome et connecté au réseau ; Mémoire de Master Université Kasdi Merbah–Ouargla 2013.

[30]K.Sobaihi ; «étude et réalisation d'un hacheur de Tracking du point de puissance Maximale (MPPT) a contre réaction ; Mémoire de Magister Ecole Nationale polytechnique 10, Avenue Hassen Badi El –Harrach Alger.

[31] F. Slama ; «Modélisation d'un système multi générateurs photovoltaïques interconnectés au réseau électriqu» , Mémoire de Magister UNIVERSITE FERHAT ABBAS SETIF-01/04/2011.

[32] L. Amira «Contribution à la gestion d'énergie dans un système hybride à énergies renouvelables» , thèse doctorat Univ 8 Mai 1945 Guelma 2022

[33] M.Mohamed ,S.Mohamed bourhane «Contrôleurs de charge solaires» Mémoire de Master , UNIV M'HAMED BOUGARA-BOUMERDES 2010.

[34] H.fatiha ;R.aicha «Modélisation et simulation d'un système photovoltaïque» ;Mémoire de Master,Université Kasdi Merbah–Ouargla 2013