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Absolute safety of the irrigation pivots in El-Oued region - Algeria

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Dedication

We dedicate this work to the best teachers in our lives. To the persons who have been teaching us a lesson. Only one lesson! However, it is so important that everybody learn it in order to survive. The lesson which has been taking them so many years teaching it to us, and taking us all days of our lives learning it. It is the lesson of life.

To the truest love of our lives, to our parents.

Acknowledgment

First of all, praise is to Allah for giving us the spirit and courage to overcome all the obstacles and difficulties we encountered until we reached this point so far in our lives.

There are a number of people we would like to thank for helping us achieving this work.

The greatest debt is owed to our supervisor ***Mr. Abderrahmane KHECHEKHOUCHE****, who gave a real meaning to our work, guidance, support and encouragement throughout this research. We would like to thank him once more for his extreme patience while supervising this dissertation.*

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abbreviation	Terms	Unit
Isc	short-circuit current due to illumination E	[A]
Voc	open circuit voltage	[V]
Ip	solar cell current	[A]
Vp	solar cell voltage	[V]
Si	silicium	
R	Yield	[%]
∝	angle of inclination	[°]
PV	photovoltaic	
UV	Ultra-violet	
IR	Infra-rouge	
VL	Visible light	

General Introduction

General introduction

Algeria with its geographical location, occupies a privileged position in the exploitation of solar energy with a duration of sunshine which varies from 2650 hours / year in the north to 3500 hours/year in the south, one of the most brought up to the world. It receives the maximum energy during the summer solstice (June 21 or 22) and the minimum during the winter solstice (December 21 or 22) [1].

The goal of our work is to solve the problem of the electrification of the irrigation pivot and which each year causes several lives for farmers and their livestock.
A proposal has been made; it is the use of photovoltaic solar panels on the pivot. This method eliminates all the causes of electrification and also saves the use of more than 100 meters of wiring. The problem that arises is the orientation of these panels towards the solar rays because the pivot turns and the panels will not be facing the solar rays. our work will experimentally solve this problem to convince that our method is very functional.

The work that we present in this dissertation comprises four chapters.

- In the first chapter, we expose a general overview on energy and renewable energy, especially on photovoltaic solar cells.
- The second chapter includes two parts, in the first part, we expose the causes of the electrification of the irrigation pivots and their consequences on agriculture and the farmer of the region of El Oued, in the second part, we let us recall the characterization of photovoltaic panels (PV) and the principle of short-circuit.
- In the third chapter. We present the construction steps of a prototype irritation pivot completely secure by a photovoltaic (PV) system.
- In the fourth chapter. We present the main results obtained through real experiments.
- Finally, we end with a general conclusion that brings together all the main results of this work and perspectives.

Chapter I
Bibliography

I.1. Introduction

The limitation of the quantity of these reserves, the successive oil crisis and the increase in energy demand in all countries of the world have led industrialized countries to seek and develop new sources of supply. The nuclear industry was already launched, but its choice on a large scale can have serious consequences, especially for the environment, because of pollution and also nuclear accidents. The researchers have developed another form of energy called "renewable energy". These renewable energies all have the immense advantage of being of natural origin, inexhaustible and non-polluting since they do not emit greenhouse gases, CO2. Among these renewable energies, we can cite the production of electricity of solar origin by the photovoltaic effect (solar cells or solar cells). The conversion of light to electricity (photovoltaic conversion) occurs in semiconductor materials. Photovoltaics can play an important role in the transition to a sustainable energy supply system for the 21st century and is likely to cover a significant part of the electricity needs of several countries.

I.2. Solar energies

Renewable energies are inexhaustible energies. They come from natural elements: the sun, the wind, waterfalls, tides, the heat of the Earth, the growth of plants… Renewable energies are called “flow” energies as opposed to “stock energies”, Themselves made up of limited deposits of fossil fuels (oil, coal, gas, uranium). Unlike fossil fuels, the use of renewable energies generates little or no waste and polluting emissions. These are the energies of the future. But they are still underexploited compared to their potential since these renewable energies cover only 20% of the world electricity consumption.

I.2.1. The solar photovoltaic

Photovoltaics consists of transforming the energy produced by the sun into electricity. For this, solar panels or photovoltaic panels will capture this energy and will reinject it into electric current in your house. The power that you will produce in this way will be the kilowatt-peak unit of production. Many scientific studies are focused on the photovoltaic field [2, 3].

I.2.2. The solar photothermic

Solar thermal energy is a form of solar energy. It designates the use of thermal energy from solar radiation in order to heat a fluid (liquid or gas). The energy received by the fluid can then be used directly (domestic hot water, heating, etc.) or indirectly (production of water vapor to drive alternators and thus obtain electrical energy, production of cold, etc.).

Solar thermal energy comes from the heat transmitted by the Sun by radiation and should not be confused with other forms of solar energy and in particular photovoltaic solar energy which uses the photoelectric effect to transform the photons emitted by the sun into electricity. Photo thermic is also a very interesting field and many laboratories are interested in this field [4, 5].

I.3. Important definitions

I.3.1. Solar radiation

Radiation is the transfer of energy by electromagnetic waves. Radiation occurs directly from the source to the exterior in all directions. These waves do not need a material medium to propagate, they can travel through interplanetary space and reach Earth from the Sun. Each city has its own solar radiation, which is why researchers want to know the radiation from their regions [6]. The wavelength and frequency of electromagnetic waves are important in determining their energy, visibility and penetrating power. All electromagnetic waves travel in a vacuum at a speed of 299.792 km / s.

I.3.2. The photoelectric effects

The photoelectric effect is the emission of electrons by a material, generally metallic when it is exposed to light or electromagnetic radiation of sufficiently high frequency, which depends on the material.

In the photoelectric effect, a metal plate is illuminated and it emits electrons. Electrons are only emitted if the frequency of light is high enough (the limit frequency depends on the material), while their number, which determines the intensity of the current, is proportional to the intensity of the light source.

I.3.3. A semiconductor material

A semiconductor is a non-crystalline body that is non-conductive in its pure state, but capable of conducting electricity following a specific treatment, doping. This semi-conduction is obtained by introducing impurities, by n (for negative) or p (for positive) doping: this increases the conductivity of the semiconductors. Semiconductor technology is being developed in several research laboratories around the world [7].

This treatment is used in the case of silicon which is the basis of the photovoltaic cells which constitute the solar panels. The electrical conductivity of a semiconductor is intermediate between that of metals (good conductors) and that of insulators.

I.3.4. Photovoltaic solar panel

A solar panel is a system made up of a panel that captures the sun's rays to transform them into a heat source or an electrical source, intended to heat or supply energy to buildings.

I.3.5. Influence of illumination

Irradiance or irradiance is a radiometric term that quantifies the power of electromagnetic radiation striking per unit area perpendicular to its direction. It is the surface density of the energy flow arriving at the point considered on the surface.

In the International System of Units, it is expressed in watts per square meter (W/ m^2 or Wm^{-2}). The associated sending unit is the existence. The hemispherical distribution of the irradiance received on a surface element is the radiance. The photometric equivalent of irradiance is illuminance. The irradiance only considers the energy arriving on the surface element, as opposed to the energy emitted by this element, which is the exitance.

I.3.6. Photovoltaic modules

A photovoltaic solar module is a direct current electric generator made up of a set of photovoltaic cells electrically connected to each other, which serves as a basic module for photovoltaic installations and in particular solar power plants.

photovoltaic.

I.4. The photovoltaic cell

The photovoltaic cell is an electronic material, often composed of semiconductors, which produces continuous electric current when exposed to light. Electronic component which makes it possible to produce electricity from the radiation of light, relying on the photovoltaic effect.

I.4.1. Crystal cells

Upon cooling, the molten silicon solidifies forming a single large crystal. The crystal is then cut into thin slices which will give the cells. These cells are usually a uniform blue.

It has the advantage of a good efficiency, from 16 to 24% (in 2015) (~ 150 Wp / m^2), and a high number of manufacturers. However, it has a high cost, a lower efficiency under low illumination or diffuse illumination, and decreases in efficiency when the temperature increases.

I.4.2. Polycrystalline cells

Polycrystalline silicon cells are blue in colour with patterns on the crystals. They are formed from cooled silicon but which, instead of forming a single block, turns into a multitude of crystals. With this technology, the yield is excellent and the cost lower. In the process of making polysilicon, silicon slowly solidifies in a rectangular mold. Subsequently, a rectangular solid is obtained with many crystals called polycrystalline cells. These cells are smaller than the single crystal performance. But currently, they have a strong presence because they have a lower economic cost single crystal. When the molten silicon cools, it is observed the formation of crystals of different sizes and shapes.

Modules using polysilicon cells generally have an efficiency of between 12 and 14%. About 8m^2 of cells are needed to obtain 1kWp. These cells are simpler to manufacture and less expensive than monocrystalline silicon cells [8].

Polycrystalline cells can be recognized by the irregular shapes of the crystals that are clearly visible to the naked eye.

The photovoltaic cells resulting from this technology are then not uniform and are dark blue in colour. In production, this kind of product is much more profitable. The panels also have a good lifespan of up to 30 years. In addition, these solar panels have good irradiation flexibility which gives a correct performance, even in cloudy weather. In terms of efficiency and effectiveness, they represent a good ecological alternative for the good of the planet.

I.4.3. Monocrystalline cells

Monocrystalline silicon cells offer the best efficiency among commercially available solar panels: between 13 to 15%.

It will therefore take fewer cells to achieve the desired power, but as monocrystalline silicon is also the most expensive, its only advantage is ultimately to use a reduced surface area: it takes around 7m² to obtain 1 kilowatt-peak (kWp).

I.4.4. Amorphous silicon cells

The amorphous silicon cell consists of a silicon having a disordered atomic structure, that is to say non-crystallized. This material absorbs much more light than crystalline silicon. It is part of the "thin film" technology which consists of depositing under vacuum on a substrate (glass, metal, plastic, ...) a thin uniform layer composed of one, and more often of several materials reduced to powder. Cells are dark gray in colour.

I.4.5. Perovskite cell

In 2012, the Swiss chemist Michael Grätzel had the idea of integrating perovskites in an original way in a type of photovoltaic cells that he invented twenty years earlier, and in which titanium dioxide very advantageously replaces - in in terms of cost and ease of manufacture - silicon usually used. Indeed, the silicon of photovoltaic cells must be purified by a very expensive process. The efficiency of these cells remained two times lower than that of silicon cells. The work of the teams of M. Grätzel in Lausanne and Henry Snaith in Oxford triggered a series of studies which demonstrate that the yield of Grätzel cells is considerably improved by this use of perovskites, up to efficiencies greater than 20 p. But these new solar cells have a major flaw: they degrade quickly and irreversibly under sunlight. Research is continuing in many laboratories to overcome this obstacle and obtain a stable material, for example by encapsulating cells. Long-term improvement of their characteristics requires a better understanding of the physical mechanisms underlying the particular behavior of electrons in the materials considered [9, 10].

I.5. Tilt angles

The angle of inclination for a sensing surface is the angle that this surface makes with the horizontal plane. The sun's rays are perpendicular to the horizontal at an angle. This angle varies from region to region. The angle of inclination also varies according to the seasons, so each season at its own angle but in general we take the average value.

In the region of El Oeud, the angle is of the order of 33 degrees. The variation of this angle has an influence on the efficiency, which has been proven by a group of local researchers [11].

I.6. Conclusion

A general introduction has been presented on energies and renewable energies in this chapter and some basic concepts were presented on solar energy and especially on photovoltaic. The photovoltaic is the subject of our study and we are going to use photovoltaic panels to solve a very dangerous local problem.

Chapter II
Electric shock in irrigation pivot

II.1. Introduction

In this chapter we will explode the mortal danger which affects family members of farmers in the region of El Oued south-eastern Algeria. This cause unfortunately is the irrigation swivel itself, the main tool of the farm. Dozens the farmer and their children and their cattle die from electroshock. In this section we will show the main causes of this electroshock and try to propose a solution via solar energy.

II.2. Geographical coordinates

The valley of El Oued as shown in Figure II.1 is located in the southeast of Algeria with an area of 54573 Km^2 and more than 700000 inhabitants. The geographical coordinates in decimals are 33.3683° of latitude and 6.8674° of longitude with an average altitude of 60 m.

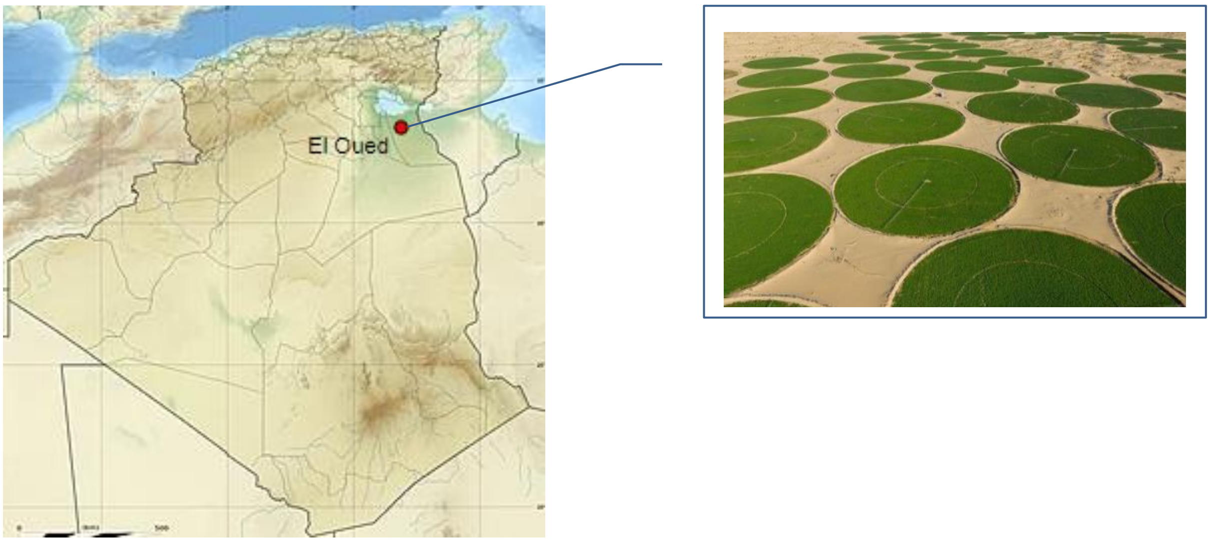


Figure II. 1. Region of El Oued

II.3. Irrigation system electrocution

An electrocution is a fatal electrisation by ventricular fibrillation, which continues with interruption of the current, or cardiopulmonary arrest. An electrification corresponds to the passage of an electric current when 2 points of the body are subjected to a potential difference (by direct contact with an active part, or indirect with a mass accidentally energized when the circuit is closed, most often with neutral or earth).

II.3.1. Pivot irrigation

The centre pivot irrigation system is increasingly becoming popular among farmers around the world on account of the benefits the system can offer compared to other methods. Due to the low irrigation efficiencies and high-water losses of surface irrigation and rise of water management and operation costs, the general trend in most of the country is to adopt modern pressurized irrigation systems. Subsequently, large numbers of center pivot systems have been introduced. The efficiency of a center pivot is solely dependent upon the operating parameters and the hydraulic design of the system. Uniformity coefficient from center pivot irrigation should exceed 90%.

II.3.2. Electroshock of the irrigation pivot

Electric shock of the irrigation pivot, it is quite simply that the metal of the pivot is electrified. The more water there is all around and the land is still wet. So, it is an extremely dangerous environment for humans or for animals. Anyone who touches where the pivot approaches will be electrified, which in most cases results in their death.

Figure II. 2 Pivot irrigation - El Oued

II.3.3. Cause of electrification of irrigation pivots

Electricity is lethal if we add water, it becomes very lethal. Our object of study is electroshock of the pivot, that is to say electricity plus water. We are dealing with a very deadly problem. Before looking for solutions we must know the races. After an investigation, we came to the four main causes. Figure II.3 groups together the main causes of the electrification of irrigation pivots.

- Blade's problems: Often times, contact occurs between the blades, which leads to a short circuit
- Water jet
- Small animals contact piece of their parts with the electrical wires (Rodents, lizards, reptiles)
- Climatic factors (Dust sand rain sun)

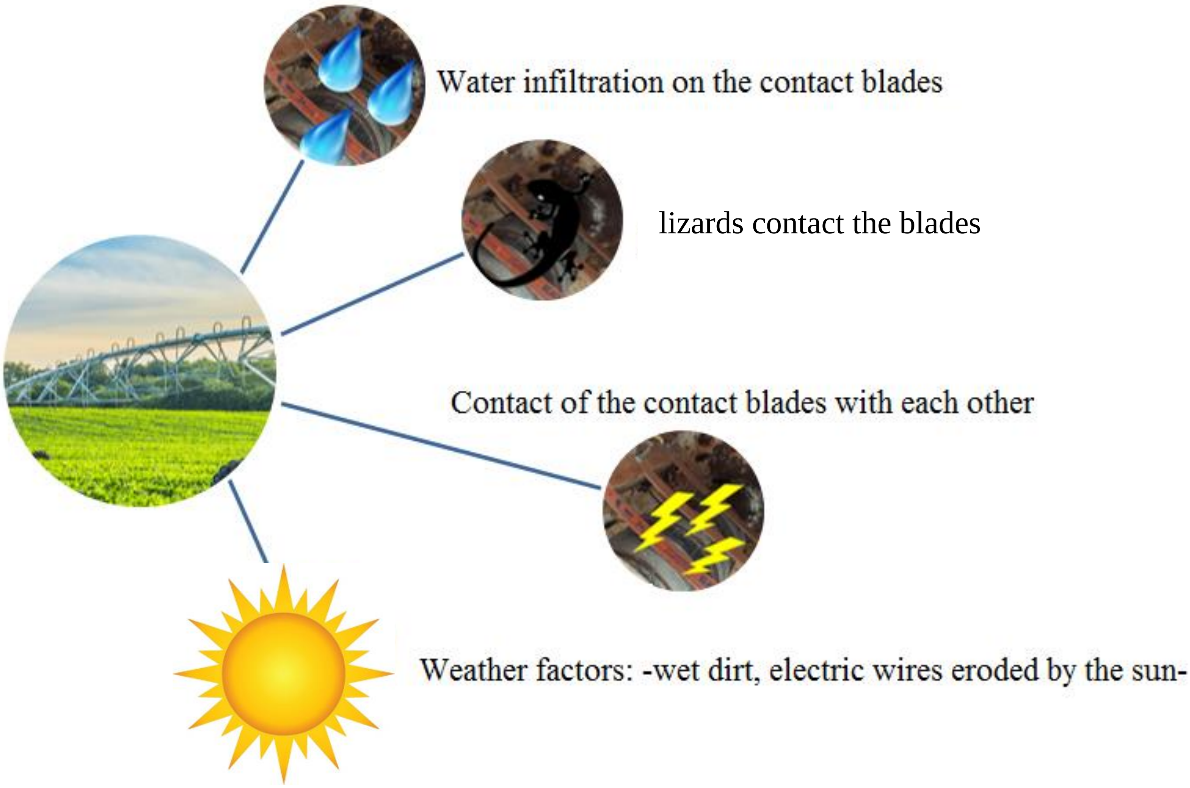


Figure II. 3. Cause of electrification of irrigation pivots

II.3.4. The consequences

Many irrigators have received minor tingles while working around electrical irrigation machinery. Under pressure to keep the system running, they tend to ignore warning signs until serious injury occurs

- Death and serious injuries
- The work is disrupted
- The fires
- Damage to equipment
- Repair losses

II.3.5. Proposed solution

Based on a survey, photovoltaic panels are offered as a perfect solution to our problem. Photovoltaic panels are just mounted on the pivot train motor as shown in Figure II.4, this way we eliminate contact tears which are the main cause of the electrification of the pivots. But the problem which arises, will the horizontal position of the PV panels give a constant output during the whole path of the pivot? to answer this question you need to know the characteristics of the photovoltaic panel

Figure II. 4. Horizontal position of the PV

II.4. The characteristic parameters of a photovoltaic solar panel

The main effect of temperature on solar cells results from the variation of three main parameters, which are usually used to characterize the performance of the solar cell, these are: the short-circuit current (Isc), the voltage of open circuit (Voc) that is in principle characterized by the saturation current (Is) and the factor of ideality (n) of the diode, and the form factor (FF); which is a function of (Voc). As showing in the Figure II.5.

Figure II. 5. Solar panel

II.4.1. The short-circuit current (Isc)

In the case of a real photovoltaic cell, other parameters taking into account resistive effects and leakage to the edges; that they must be taken into account and the equation of the characteristic II-1 then becomes:

$$I = I_{ph} - I_s\left\{exp\left\{\frac{V+RI_S}{nV_{th}}\right\} - 1\right\} - \frac{V+IR_S}{R_{sh}} \quad \text{(II.1)}$$

Some authors use shunt conductance ($G_{sh} = \frac{1}{R_{sh}}$) to write the equation (II.1)

in the form: $$I = I_{ph} - I_s\left\{exp\left\{\frac{V+RI_S}{nV_{th}}\right\} - 1\right\} - G_{sh}(V + IR_s) \quad \text{(II.2)}$$

According to the equation (II.2) we find *Isc*; taking (*V=0*)

$$I_{sc} = \frac{I_{ph} - I_S\left[\exp\left(\frac{qR_SI_{SC}}{nKT}\right) - 1\right]}{1 + G_{sh}R_S} \quad \text{(II.3)}$$

The solution of this equation is not possible analytically, nevertheless from a practical point of view we accept a linear dependence of the short-circuit current (Isc) as a function of the temperature.

For the majority of solar cells, the following approximation is acceptable [12]

$$R_{sh} = \frac{1}{G_{sh}} \gg R_s \rightarrow \frac{R_s}{R_{sh}} \ll 1 \rightarrow 1 + \frac{R_s}{R_{sh}} \approx 1$$

As a result, the short circuit current of the cell becomes:

$$I_{sc} = I_{ph} - I_s \left[exp\left(\frac{qR_sI_{sc}}{nKT}\right) - 1\right] \quad \text{(II.4)}$$

In most cases it is possible to apply the following famous approximation

$$I_{ph} \gg I_s \leftrightarrow I_{sc} \approx I_{ph} \quad \text{(II.5)}$$

Based on a scientific study, I_{ph} depends on the available solar irradiance (G), the temperature of the cell (T) and the temperature coefficient of the short-circuit current (μIsc) [13].
The current photo $I_{ph}$for all operating conditions is linked to the current photo at reference conditions by:

$$I_{ph}(T) = \frac{G}{G_{ref}}\left[I_{ph,ref} + \mu_{I_{cc}}(T - T_{ref})\right] \quad \text{(II.6)}$$

With
μ_{Isc} : is the temperature coefficient of the short-circuit current [*A/K*].
G et *T* : are the operating conditions (irradiance and temperature respectively).
G_{ref} et T_{ref} : are the reference conditions (irradiance and temperature respectively); they are given digitally [14]: $G_{ref} = 1000 W/m^2$ and $T_{ref} = 25°C = 298.15\ K$.

II.4.2. Open circuit voltage (Voc)

It is obtained from the equation (II.2) we take (I=0) where:

$$V_{co} = \frac{nkT}{q} log\left(1 + \frac{I_{ph}}{I_s} - \frac{G_{sh}V_{co}}{I_s}\right) \quad \text{(II.7)}$$

if ($I_{ph} >> G_{sh}Voc$) et ($I_{ph} >> I_s$) the voltage *Voc* becomes

$$V_{co} = \frac{nkT}{q} log\left(\frac{I_{ph}}{I_s}\right) \quad \text{(II.8)}$$

I_s is a function of the properties of the material and it is also temperature sensitive.

The useful equations are given by [15].

$$I_s(T) = I_{s0} exp\left\{-\frac{E_A}{nkT}\right\} \quad \text{(II.9)}$$

Where I_{s0} is a constant, E_A is the activation energy for the saturation current (the saturation current due to minority carriers is thermally activated, where E_A is the activation energy of these minority carriers, *n* is the ideality factor and *kT* is thermal energy [16, 17].

By replacing Is by its expression (II.9) in the expression of *Voc*, we obtain the dependence of *Voc* as a function of the temperature

$$V_{co}(T) = \frac{E_A}{q} - \frac{nkT}{q} ln\left(\frac{I_{s0}}{I_{ph}}\right) \quad \text{(II.10)}$$

II.4.3. The form factor (FF)

The FF form factor depends on a set of cell parameters including current and voltage at maximum operating point, ideality factor, and parasitic series and shunt resistances. Hence, it is difficult to find a formula to describe the sensitivity of this parameter to temperature.

The FF usually shows an inverse dependence on temperature.

We have seen that *Isc* and *Voc* usually show the almost linear ehaviour as a function of temperature. For R_s and R_{sh} we will discuss their ehaviour as a function of temperature below:

There are only three types of thermal dependence of electrical resistors [18] :

conductive type, negative temperature coefficient type and positive temperature coefficient type. We will discuss below the three types of thermal sensitivities for electric resistors:

Conductor type

$$R(T) = R_0(1 + \alpha T) \quad \text{(II.11)}$$

Where α is the temperature coefficient of the conductor ($\alpha > 0$) and R_0 is the resistance of

reference. We obtain

$$\frac{dR}{dT}\alpha R_0 > 0 \quad \text{(II.12)}$$

Negative temperature coefficient type

$$R(T) = R_0 exp\left\{\frac{B}{T}\right\} \quad \text{(II.13)}$$

Where *B* is a coefficient specific to the material of the semiconductor *B* >0) and R_0 is a referential resistance. We obtain

$$\frac{dR}{dT} = -\frac{BR}{T^2} < 0 \quad \text{(II.14)}$$

Positive temperature coefficient type

$$R(T) = R_0 exp\{BT\} \quad \text{(II.15)}$$

Where *B* is a coefficient specific to the material of the semiconductor (*B* >0) and R_0 is a referential resistance. We obtain

$$\frac{dR}{dT} = BT > 0 \quad \text{(II.16)}$$

II.4.4. The power

The electric power absorbed by a purely resistive load is proportional to the voltage U across the resistor and to the current I flowing through it. Which can be summed up by the formula:

$$P = U.I \quad \text{(II.17)}$$

With:

P in watts, **U** in volts and **I** in ampere.

II.4.5. Efficiency

The maximum power of the PV module changes with climatic conditions, and there is only one value for the current (Impp) and the voltage (Vmpp), which defines the maximum power point (MPP), as shown in Figure II.6 and Figure II.7 [19].

The PV current changes with the solar irradiation level, whereas the PV output voltage changes with the temperature of the PV module. Therefore, an important challenge in a PV system is to ensure the maximum energy generation from the PV array with a dynamic variation of its output characteristic and with the connection of a variable load. A solution for this problem is the insertion of a power converter between the PV array and load, which could dynamically change the impedance of the circuit by using a control algorithm. Thus, MPP operation can be obtained under any operational condition.

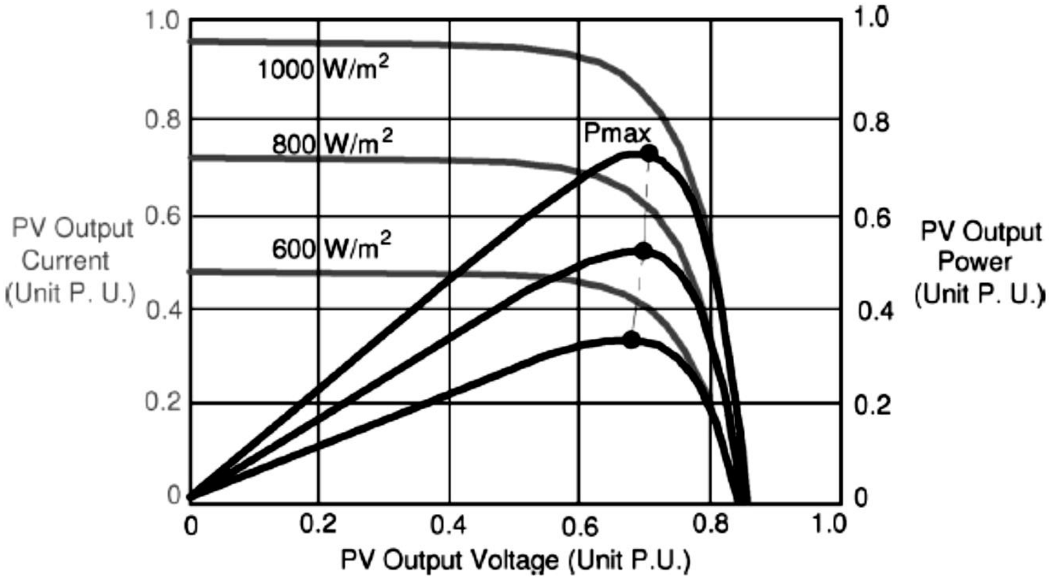


Figure II. 6. Output characteristic of a PV module.

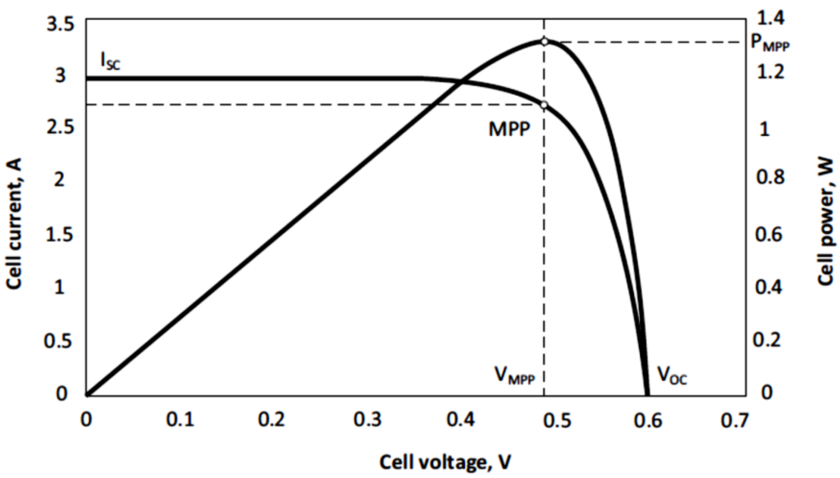


Figure II. 7. Solar panel Efficiency.

II.5. Conclusion

This chapter has exposed the main causes of electrification of an irrigation pivot. Its causes were the subject of several deaths of agriculture in the wilaya of El Oued without forgetting their family member and their cattle. The thermal electrification has been defined in this chapter and also solutions to this problem have been proposed.

Chapter III
Prototype building

III.1. Introduction

A solution with solar energy was proposed in the previous section. The main cause of electrification has been eliminated altogether more than and more than 100 m of electrical wiring has also been eliminated. This chapter will translate this new solution in the field. To bring it closer to reality, a prototype of an irrigation pivot be designed in the hydromechanics laboratory of the University of El Oued, with the aim of integrating this solution on a prototype. This chapter explains in detail all the tools and all the construction steps.

III.2. Used equipment

Table III.1 gathers all the elements necessary for the construction of the prototype. In this table are the details and the photo of each element without forgetting the current prices of the Algerian market.

Table III. 1. Used equipment

Copper tube: Standards: BS 2871-1 Table X (EN 1057 half hard) Colour: Copper Material: Copper Metric/Imperial: Metric Outside Diameter: 05 mm Pipe Length: 35 cm Standard: BS 2871-1 Type: Copper Tube Price: 500.00 DA	
Wheel + Tyre + Motor DC 3V-6V: A DC motors with gear, single axis, with DC 6V operating voltage and an RPM of 100R / minute. This gear box is ideal for robotic car or line-tracing robot. With plastic construction and coloured in bright yellow, the DC gear motor measures 18pprox.. 6.5cm long, 2.5cm wide and 1.8cm thick.	

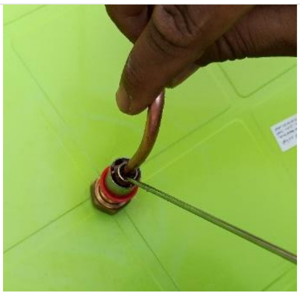
<u>Motor Detailed parameters:</u> speed (6V): 100RPM current (6V): 60mA Motor speed: 100 r/min Motor Size: 19 pprox.. 6.5 x 2.2 x 1.8cm Voltage: 6V Price: 750.00 DA **<u>Wheel:</u>** Diameter: 66mm Width: 28mm Colour: Yellow 1.9mm holes of 2mm axle can be seated Price: 200.00 DA	
Solar panel **<u>Parameters</u>** Module Type: MP- 002WP Peak Power: 2 W Maximum Power Current: 0.27A Maximum Power Voltage: 5V Short Circuit Current: 0.31A Open Circuit Voltage: 8.2v Maximum System Voltage: 1000 Wind Resistance:2400pa Price: 1000.00 DA All technical data at standard test condition, AM=1.5E=1000W/M2 Tc=25°C	
Windshield Washer Pump windscreen washer pump, which can resist -25 degrees to above 80 degrees. **<u>Features</u>** 1. Single Outlet / 2 Pin Connector. 2. Special sealing design, leak-proof. 3. Large displacement and high temperature resistance. 4. Ready to push fluid through the washer nozzle out. **<u>Specifications</u>** Material: ABS Colour: Black Displacement: Approx. 450ml / 10s Resistance to Low Temperature: -25 degrees Resistance to High Temperature: Above 80 degrees Price : 400.00 DA	

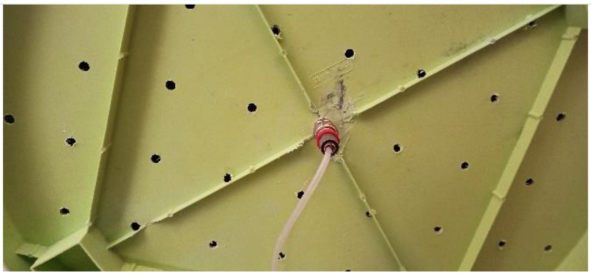
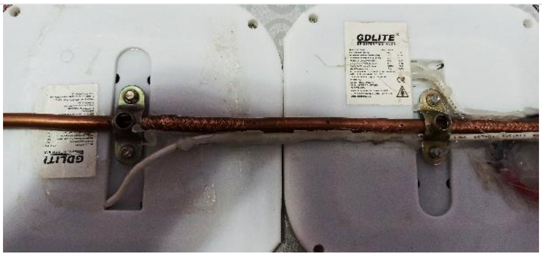
Red black Wires Material: Copper Length: 20 cm Diameter: 2X1.5 Price: 25.00/m DA	
Round plastic table Diameter: 75 cm Price: 950.00 DA	
sterile bubble tubing: Length: 50 cm Price: 25.00 DA	
Artificial grass: Price: 800.00/ m^2 DA	

III.3. Building the prototype

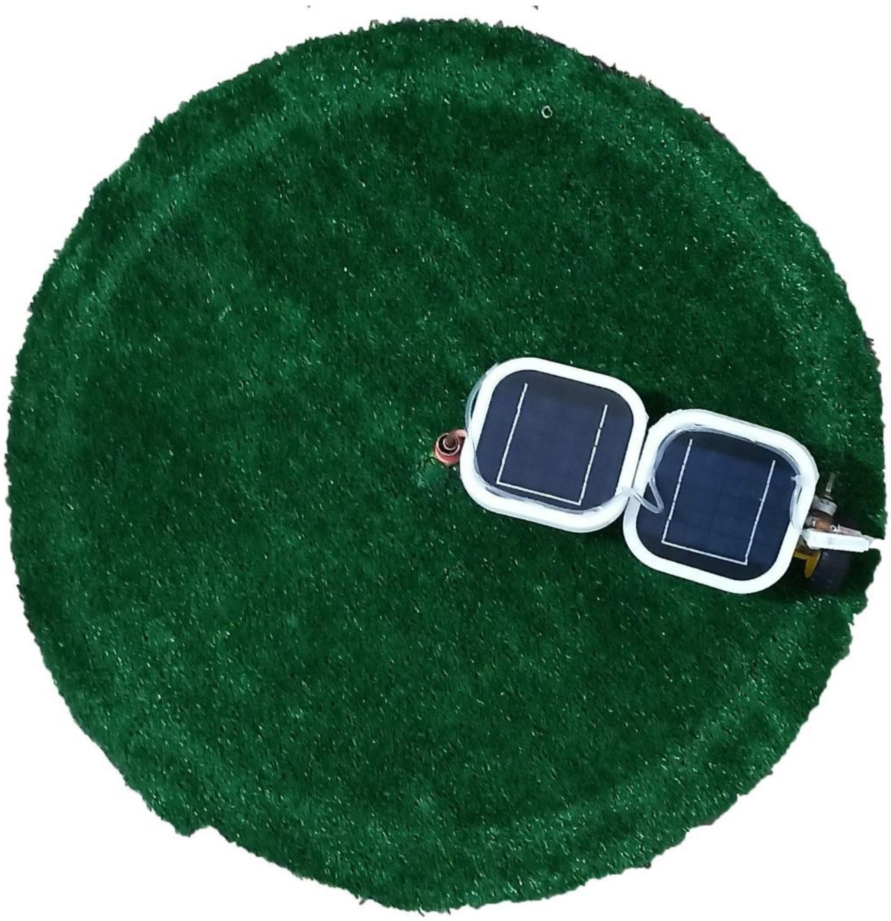
Table III.2 shows with detail and with colour photos all the stages of construction of the mini prototype of a mini delegation pivot. at the end of the table are clear photos of the final prototype.

Table III. 2. Construction stages

We bring all the equipment that we need.	
We make holes in the copper tube.	
We make a hole in the center of the plastic table and install the brass nipple adapter.	 
We connect the tube in the center of the plastic table.	 

We make holes on the round table And we connect the sterile bubble tubing between the plastic table and the pump	
We installed a water pump	
After that, we installed the solar panels on the pivot	
Then we installed the wheel on the axis of rotation	
We cover the round plastic table with artificial grass	

The last step is to install the pivot	 



III.4. Conclusion

The prototype facilitates the understanding of the problems related to this system and it facilitates to understand the principle of operation itself. With the help of the prototype, we were able to solve several small problems in the laboratory without going to the farm. The prototype saved us time and helped us move forward quickly in our study. So, it is necessary to make a prototype for any experimental study, of course if there is a possibility.

Chapter IV
Results and discussion

IV.1. Introduction

In this chapter, experiments have been made to show the effectiveness of our solution. First of all, we made an experiment which shows the variation of the angle of the solar panels does not have much influence on the efficiency of the solar panels and this is an advantage for our solution. The experiments were carried out at the electrical engineering laboratory of the University of Oued at the beginning of June 2021.

IV.2. Experiment series

IV.2.1. Ambient temperature and Solar radiation

Figure IV.1 shows the solar radiation evolution (in W/m^2) during the day. The curve obtained has a normal form as it was found in literature and having its maximum radiation between 11:30h and 14:00h. The sky was clear during the course of the experiment. Solar radiation is one of the major factors in in the production of electricity by photovoltaic panels. The other curve shows the ambient temperature variation in °C over the time (in hour) starts to vary between 22°C at launch and reaches a maximum of about 34°C between 14:30h and 16:00h. In general, for a given solar radiation, when the temperature increases, the open-circuit voltage Voc, drops slightly, while the short-circuit current increases [19].

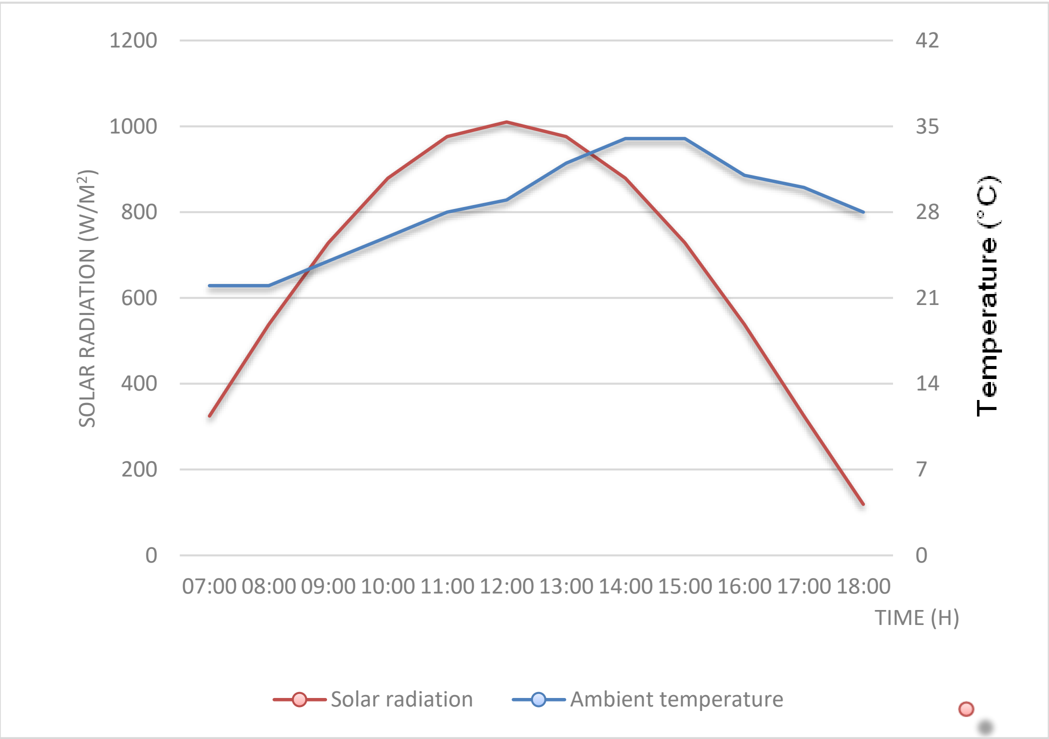
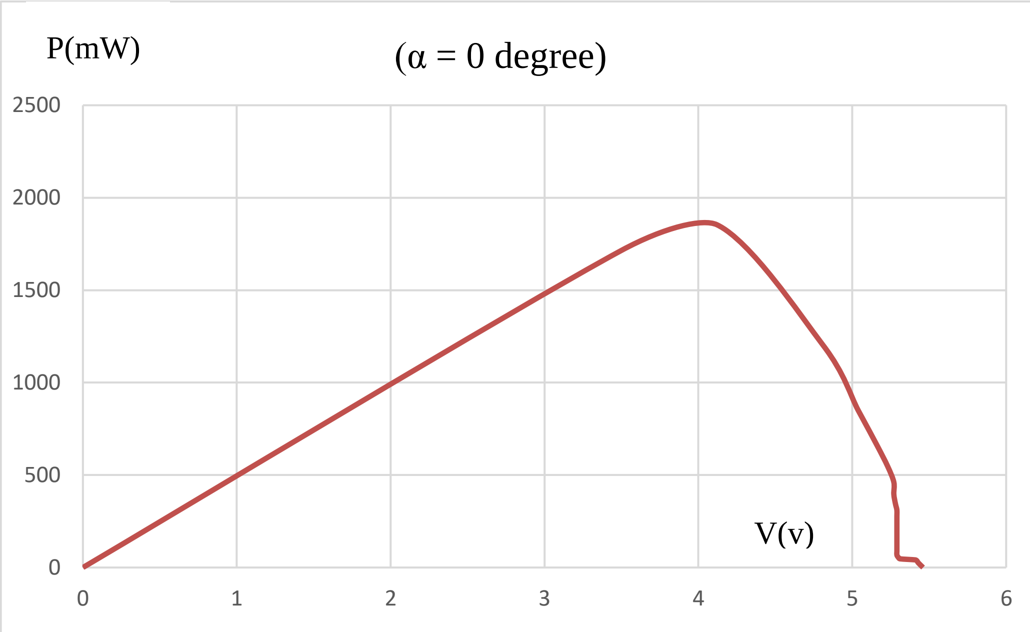


Figure IV. 1. Evolutions of the solar radiation and the ambient temperature.

IV.2.2. Evolution of current in terms of tension

Figure IV.2a represents the evolution of current in terms of tension when the panels are absolutely horizontal (α = 0 degree), where we see that the graph is fixed at 490 mA and decreases from 4 - 5.5 volts to 0. Figure IV.2b represents the change of current in terms of tension when the panels have a small angle with the horizontal (α = 10 degree), where we see that the graph is fixed at 372 mA and decreases from 4.2 - 5.5 volts to 0.



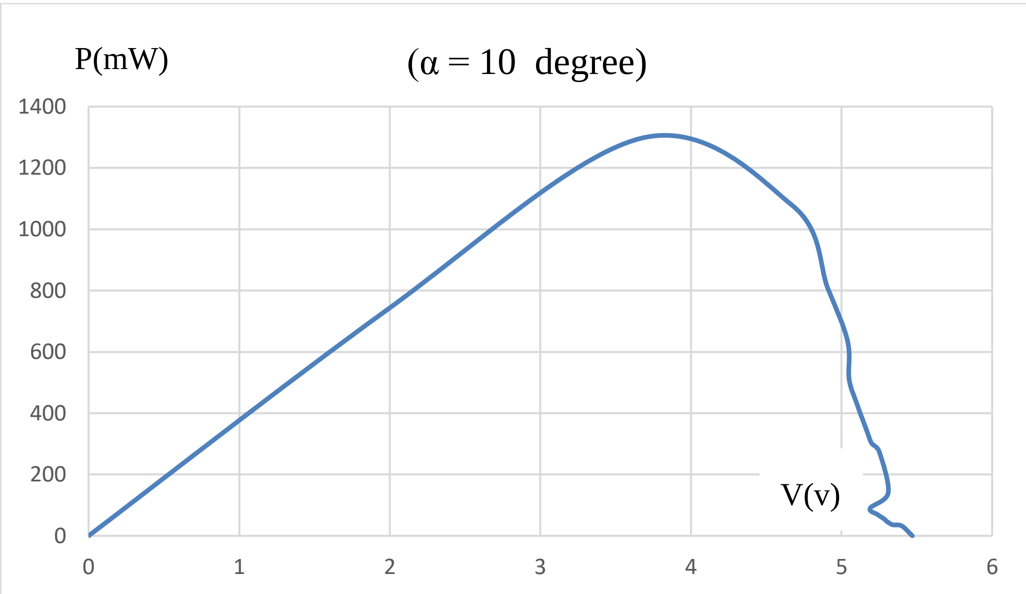


Figure IV. 2. Evolution of current in terms of tension.

IV.2.3. Evolution of power in terms of tension

Figure IV.3 represents the evolution of power in terms of tension when the panels are absolutely horizontal (α = 0 degree), where we see that the graph is rises from the point 0 to 1854 in the range of 0 – 4.12 and it decreases from 1854 in the range of 4.12 – 5.46. Figure IV.3b represents the change of power in terms of tension when the panels have a small angle with the horizontal (α = 10 degree), where we see that the graph is rises from the point 0 to 1295.64 in the range of 0 – 3.66 and it decreases from 1295.64 in the range of 3.66 – 5.47

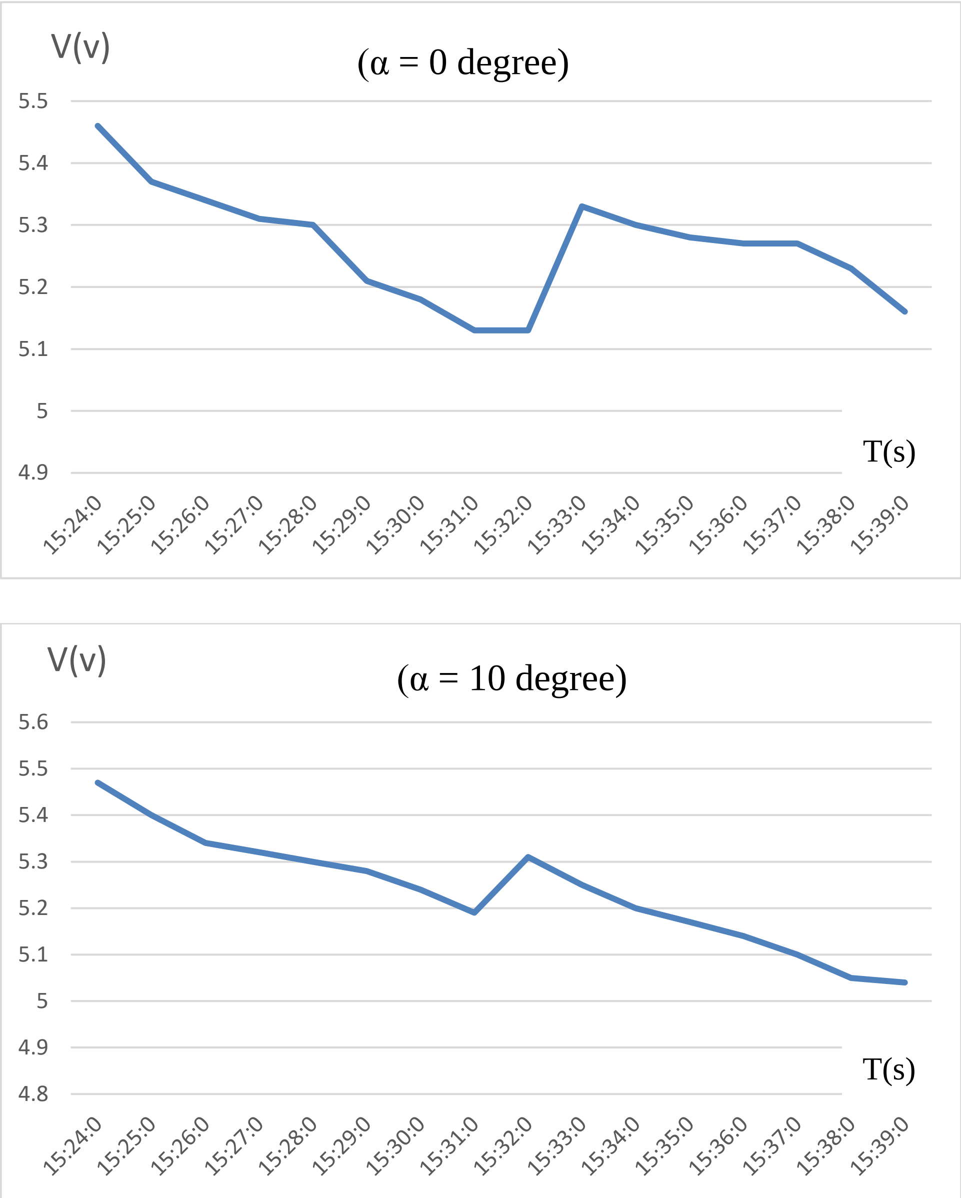
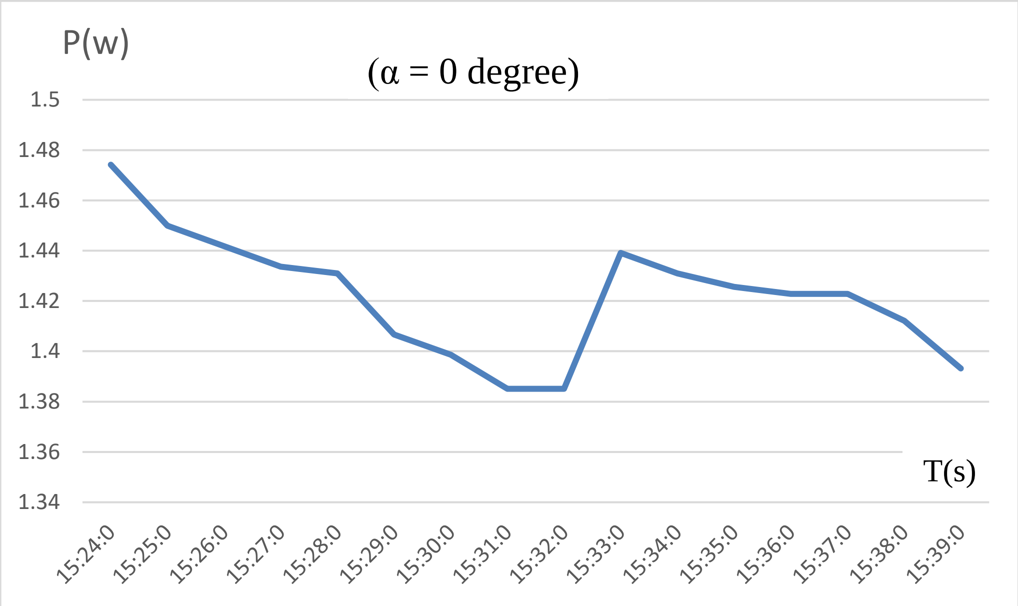


Figure IV. 3. Evolution of power in terms of tension

IV.2.4. Evolution of voltage in terms of time

Figure IV.4a represents the evolution of voltage in terms of time when the panels are absolutely horizontal (α = 0 degree), where we see a decrease in the current from 5.45 volts to 5.11 volts in the range between 15:24:0 and 15:27:0 and it is relatively stable at 5.6 volts in the range between 15:27:0 and 15:47:0. Figure IV.4b represents the change of voltage in terms of time when the panels have a small angle with the horizontal (α = 10 degree), where we see a decrease in the current from 6.1 volts to 5.4 volts in the range between 15:24:0 and 15:27:0 and it is relatively stable at 5.5 volts in the range between 15:27:0 and 15:47:0



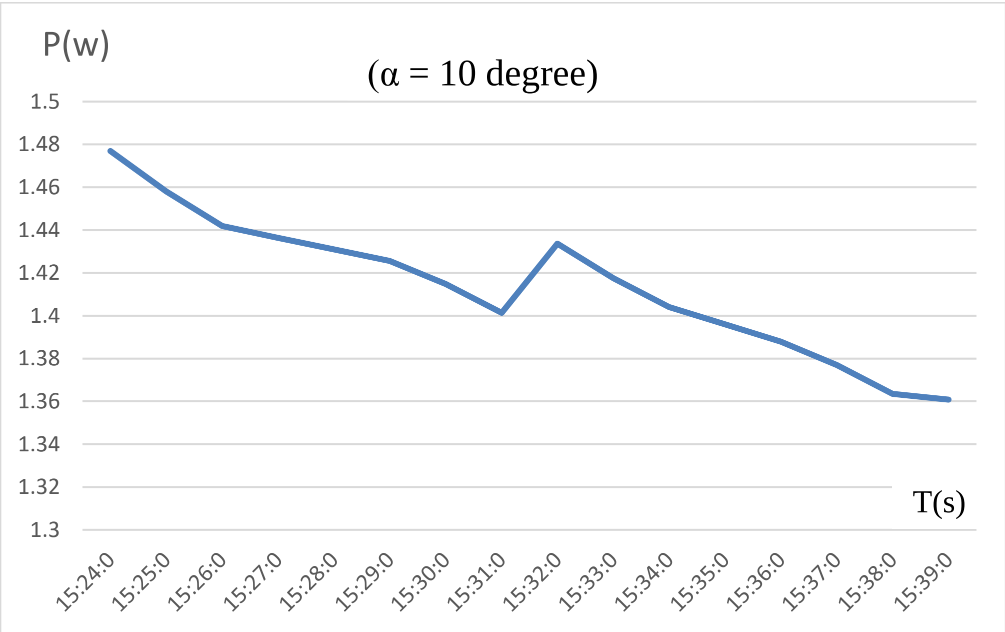
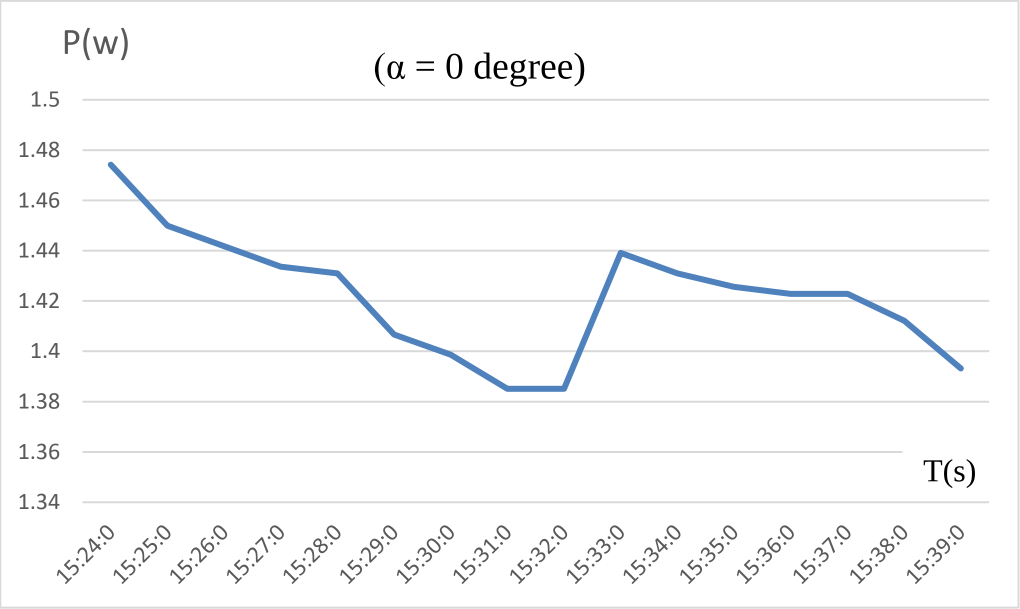


Figure IV. 4. Evolution of voltage in terms of time

IV.2.5. Evolution in power in terms of time

Figure IV.5a represents an evolution in power in terms of time when the panels are absolutely horizontal (α = 0 degree), where we see a decrease in power from 1.47 watts to 1.38 watts in the range between 15:30:0 and 15:32:0 and it is relatively stable at 1.40 watts in the range between 15:32:0 and 15:39:0. Figure IV.5b represents a change in power in terms of time when the panels have a small angle with the horizontal (α = 10 degree), where we see a decrease in power from 1.47 watts to 1.40 watts in the range between 15:30:0 and 15:32:0 and it is relatively stable at 1.38 watts in the range between 15:32:0 and 15:39:0.



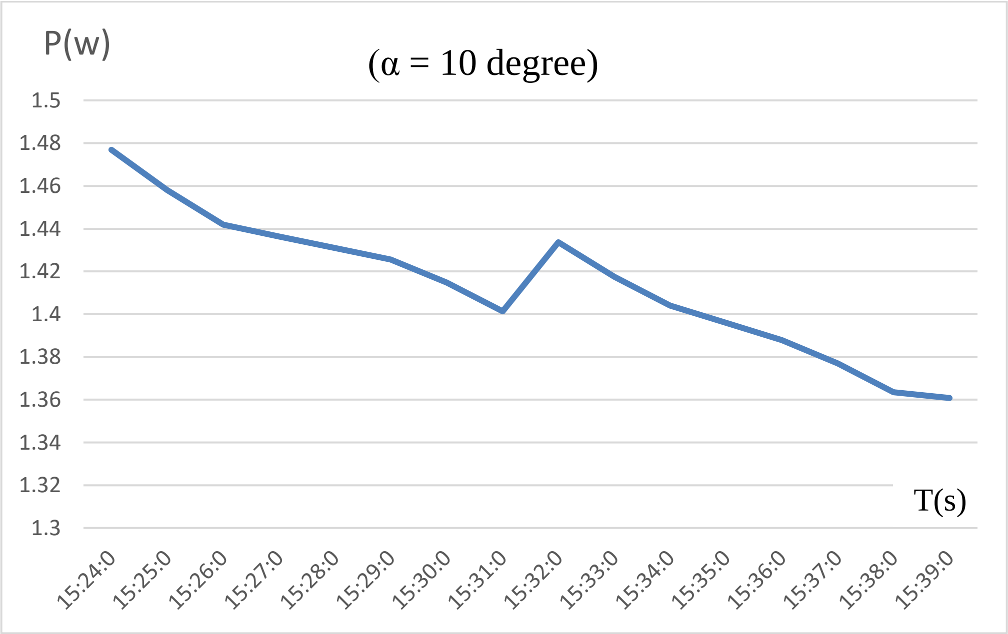


Figure IV. 5. Evolution in power in terms of time

IV.3. Discussion of results

The tilt angle is the angle formed by the plane of the solar module relative to the horizontal. We have shown in this study that if the photovoltaic solar panels are placed on an irrigation pivot in a horizontal fashion, then the electricity production of these panels can operate and rotate the pivot in an acceptable manner. We have slightly modified the angles of its panels so that the water injected by the pivot does not precipitate on the surface of the panel and over time, a layer of limestone will form and this will cause degradation of the performance.

We made an experimental study comparing the two productions. The results that the yields of photovoltaic panels are very close, so that is why we favour the use of a slight angle to avoid degradation of the yield of our panels.

Since our proposal is theoretically and experimentally functional then we can say that the solution of electrification of irrigation pivots be solved by solar energy. This method is very safe from the point of view of danger. It is also very acceptable from an economic point of view because this proposal saves more than 100 meters of wiring in the cost is very high.

IV.4. Conclusion

The positioning of the photovoltaic solar panels directly on the pivot saves more than 100 meters of wiring from an economic point of view. This method saves the lives of humans and animals a very valuable benefit. Since the water in the El Oued region is infected, we notice that there is formation of intensive layers of limestone on the pivot, which is why we preferred to install the panels at a slight angle to avoid precipitation. of this water on the panels and this to prevent the formation of limestone layers.

General conclusion

General conclusion

Protecting the environment has become a major concern in recent years. Many avenues of research have therefore been directed towards the use of renewable energies, including solar energy. Photovoltaic solar energy is renewable energy because it uses a naturally occurring source of energy which is the Sun. It is therefore a real efficient alternative to fossil fuels in several ways: it is inexhaustible, it can be produced locally and according to local needs.

The region of El Oued southeast of Algeria is a very important agricultural area with a very important solar energy potential. Farmers in this region have a very dangerous problem with irrigation Pivots. The latter took several lives of agriculture by electrification.

The objective of our work is to offer a very secure and inexpensive solution that can save the life of agriculture and its livestock. Experiments have been done on a prototype of a pivot irrigation to confirm that our proposal is official and this has been proven.

To avoid that photovoltaic solar panels will not face the solar rays, we have proposed to install the panels horizontally on the pivot in such a way that the solar rays cover the entire surface of the panel. Then we made another experiment, urging the panels at a slight angle to avoid the precipitation of water on the surface of the panels and this to avoid the formation of a layer of limestone on the panels. By comparing the two experiments, we obtained that the yield of the two experiments are very close, which is why we favored using the second solution, that is to say the panels with a slight angle as a solution to our problem.

The respective part of our work is to make a real study on a real irrigation pivot in the region of El Oued south-eastern Algeria.

References

References

[1] Benbouza Naima, Etude du rayonnement solaire dans la région de Batna, Magister en Electrotechnique, Université de Batna, 2008.

[2] Ashutosh Barua, Arvind Kumar Jain, Pankaj Kumar Mishra, Divya Singh, Design of grid connected microgrid with solar photovoltaic module, Materials Today: Proceedings, 2021.

[3] Bhubaneswari Parida, S. Iniyan, Ranko Goic, A review of solar photovoltaic technologies, Renewable and Sustainable Energy Reviews, Volume 15, Issue 3, 2011, Pages 1625-1636.

[4] K. Ravi Kumar, N.V.V. Krishna Chaitanya, Natarajan Sendhil Kumar, Solar thermal energy technologies and its applications for process heating and power generation – A review, Journal of Cleaner Production, Volume 282, 2021.

[5] Burcu Koçak, Ana Ines Fernandez, Halime Paksoy, Review on sensible thermal energy storage for industrial solar applications and sustainability aspects, Solar Energy, Volume 209, 2020.

[6] Maryam MeshkinKiya, Riccardo Paolini, Uncertainty of solar radiation in urban canyons propagates to indoor thermo-visual comfort, Solar Energy, Volume 221, 2021.

[7] Muhammad Tahir, Sehar Tasleem, Beenish Tahir, Recent development in band engineering of binary semiconductor materials for solar driven photocatalytic hydrogen production, International Journal of Hydrogen Energy, Volume 45, Issue 32, 2020.

[8] Adama Ouédraogo, Bernard Zouma, Emmanuel Ouédraogo, Lamoussa Guissou, Dieudonné Joseph Bathiébo, Individual efficiencies of a polycrystalline silicon PV cell versus temperature, Results in Optics, Volume 4, 2021.

[9] Imad Kemerchou, A. Khechekhouche, A. Timoumi, Fatiha Rogti, Hima Abdelkader, A. Sadoun, A. Tliba, Aida Mohammed salah, Study of the chemical structure of CH3NH3PbI3 perovskite films deposited on different substrates, Journal of Materials Science: Materials in Electronics, (in press), 2021.

[10] Ridha Cherraye, Bachir Bouchekima, Djamel Bechki, Hamza Bouguettaia, Abderrahmane Khechekhouche, "The effect of tilt angle on solar still productivity at different seasons in arid conditions-south Algeria. International Journal of Ambient Energy, 2020.

[11] Imad Kemerchou, Fatiha Rogti, Benhaoua Boubaker, Nacereddine Lakhdar, Hima Abdelkader, Benhaoua Othman, Abderrahmane Khechekhouche. Processing Temperature Effect on Optical and Morphological Parameters of Organic Perovskite

CH3NH3PbI3 Prepared Using Spray Pyrolysis Method. Journal of Nano- and Electronic Physics, Volume 11, Issue 3, 2019, pages 03011-1 - 03011-4.

[12]Xin Hui, Yudong Zheng, Haijun Yan, Water distributions of low-pressure sprinklers as affected by the maize canopy under a centre pivot irrigation system, Agricultural Water Management, Volume 245, 2021.

[13] Chegaar, M., Azzouzi, G., & Mialhe, P. Simple parameter extraction method for illuminated solar cells. Solid-State Electronics, 2006, Volume 50, Issue (7-8), pages 1234–1237.

[14] Karatepe, E., Boztepe, M., & Colak, M. Neural network based solar cell model. Energy Conversion and Management, 2006, Volume 47, Issue (9-10), pages 1159–1178.

[15] De Soto, W., Klein, S. A., & Beckman, W. A. Improvement and validation of a model for photovoltaic array performance. Solar Energy, 2006, Volume 80, Issue 1, pages 78–88.

[16] Malm, U., Malmström, J., Platzer-Björkman, C., & Stolt, L. Determination of dominant recombination paths in Cu (In,Ga)Se2 thin-film solar cells with ALD–ZnO buffer layers. Thin Solid Films, 2005, Volume 480-481, pages 208–212.

[17]Samia Rachedi, Keireddine Ghaffour. Analyse des caractéristiques I-V des jonctions PN à base de SiC.MajecSTIC 2005 : Manifestation des Jeunes Chercheur francophones dans les domaines des STIC ,IRISA – IETR – LTSI, Rennes, 2005, pages122-126.

[18] Gules, R., De Pellegrin Pacheco, J., Hey, H. L., & Imhoff, J. (2008). A Maximum Power Point Tracking System With Parallel Connection for PV Stand-Alone Applications. IEEE Transactions on Industrial Electronics, Volume 55, Issue 7, pages 2674–2683.

[19]Abderrahmane Khechekhouche, Boubaker Benhaoua, Muthu Manokar, Ravishankar Sathyamurthy, Abd Elnaby Kabeel, Zied Driss. Sand dunes effect on the productivity of a single slope solar distiller. Heat and Mass Transfer Journal. Spinger Nature, 2020, Volume 56, Issue 4, pages 1117-1126.

Abstract

Abstract

The region of El Oued in the south-east of Algeria is a very important agricultural area. Farmers in this region have a very dangerous problem with the irrigation pivots. The latter took several lives of agriculture by electrification. The aim of our work is to offer a very safe and inexpensive solution that can save the life of agriculture and its breeding. We proposed to install the panels horizontally on the pivot so that the solar rays cover the entire surface of the panel. Then we did another experiment, pushing the panels at a slight angle to prevent water precipitation on the surface of the panels and to prevent the formation of a layer of limestone on the panels. By comparing the two experiments, we obtained that the yields of the two experiments are very similar, which is why we favored the use of panels with a slight angle as a solution to our problem.

Key words: irrigation pivot, solar energy, Farmers, solar panel, solar rays.

Résumé

La région d'El Oued au sud-est de l'Algérie est une zone d’agriculture très importante. Les agriculteurs de cette région ont un problème très dangereux avec les pivots d'irrigation. Ce dernier a pris plusieurs vies d'agriculture par électrification. L'objectif de notre travail est d'offrir une solution très sûre et peu coûteuse qui peut sauver la vie de l'agriculture et de son élevage. Nous avons proposé d'installer les panneaux horizontalement sur le pivot de manière à ce que les rayons solaires couvrent toute la surface du panneau. Puis nous avons fait une autre expérience, en poussant les panneaux à un léger angle pour éviter la précipitation d'eau à la surface des panneaux et pour éviter la formation d'une couche de calcaire sur les panneaux. En comparant les deux expériences, nous avons obtenu que les rendements des deux expériences sont très proches, c'est pourquoi nous avons privilégié l'utilisation des panneaux avec un léger angle comme solution à notre problème.

Mots clés : pivot d'irrigation, énergie solaire, Agriculteurs, panneau solaire, rayons solaires.

ملخص

تعتبر منطقة الواد جنوب شرق الجزائر منطقة زراعية مهمة للغاية. يعاني المزارعون في هذه المنطقة من مشكلة خطيرة للغاية مع محاور الري. هذا الأخير أودى بحياة العديد من المزارعين بالتكهرب. الهدف من عملنا هو تقديم حل آمن للغاية وغير مكلف يمكن أن ينقذ حياة المزارعين ومواشيهم. اقترحنا هو تثبيت الألواح الشمسية أفقيًا على المحور بحيث تغطي الأشعة الشمسية كامل سطح اللوحة. ثم قمنا بتجربة أخرى حيث وضعنا الألواح بزاوية صغيرة لمنع احتقان المياه على سطح الألواح ولمنع تكون طبقة من الحجر الجيري على الألواح. بمقارنة التجربتين، توصلنا إلى أن نتائج التجربتين متقاربة جدًا، ولهذا فضلنا استخدام الألواح بزاوية طفيفة كحل لمشكلتنا.

الكلمات المفتاحية: محور الري، الطاقة الشمسية، المزارعون، الألواح الشمسية، الأشعة الشمسية.