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Impact of guide wall geometry on the performance of solar chimney power plants- an experimental study

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CONTENTS TABLE

CHAPTER I : SOLAR ENERGY

CHAPTER II : THE SOLAR CHIMNEY POWER PLANTS

CHAPTER III : CONCEPTION AND METHOD OF MEASUREMENT

CHAPTER IV : RESULTS AND DISSCUSION

شكر وعرفان

الحمد لله الذي وهبنا التوفيق والسداد ومنحنا الثبات واعاننا على اتمام هذا العمل بعد ان سافرنا لنضع النقاط على الحروف ونكشف ما وراء ستار العلم والمعرفة فها هي ثمار علمنا قد أينعت وحان قطافها.

كلمة شكر لابد لنا ونحن نخطو خطواتنا الأخيرة في الحياة الجامعية من وقفة نعود إلى أعوام قضيناها في رحاب الجامعة مع أساتذتنا الكرام الذين قدموا لنا الكثير باذلين بذلك جهودا كبيرة في بناء جيل واع مثقف.

نتوجه بجزيل الشكر والامتنان الى الأستاذ المشرف الدكتور قوجيل محمد بلال واستاذنا الفاضل الدكتور مقراني عمر بن خطاب الذي لم يبخل علينا بتوجيهاته ونصائحه القيمة التي كانت عونا كبيرا لنا في اتمامنا هذه المذكرة.

ولا يفوتنا ان نشكر اللجنة المناقشة على قبولهم مناقشة عملنا.

كما نود ان نشكر الدكتور ستو بالخير على مساندتنا وامدادنا بمعلوماته القيمة.

إهداء

وصلت مسيرتي الدراسية إلى نهايتها وها أنا أرفع القبعة احتراما لطيلة السنوات التي مضت. شكر وتقدير لكل من ساندني في رحلتي هذه.

اهدي تخرجي هذا أولا إلى من أحمل اسمه بكل افتخار وأرجو من الله أن يمد عمره ليرى ثمارا قد حان قطافها بعد طول انتظار "والدي الغالي". وإلى من كان دعائها سر نجاحي أغلى الحبايب "والدتي الغالية "وإلى من لهم الفضل الكبير في تشجيعي وتحفيزي إلى من بهم أكبر و عليهم أعتمد "إخوتي وأخواتي "وإلى من تحلو بالإخاء وتميزوا بالوفاء وإلى من برفقتهم في دروب الحياة سرت "أصدقائي".

كما أتوجه بكل الشكر والعرفان لرفيقتي في هذا العمل وطيلة مسيرتي الجامعية.

داعية المولى عز وجل أن يطيل في أعماركم.

عفان صبرينة.

Dedication

This work is dedicated to my dear parents, I appreciate your effort in bringing me up to be a better person and one day I'll be successful, people will inquire as to which college I attended. It doesn't matter, because my parents are the ones who created me who I am today, I'll say.

To my brothers Djamel and Abdou you're the best brothers anyone could ask for, Thank you, for everything, I'll never forget my little girl Safaa the family's jewel.

To Ahlem thank you for being my soulmate, the other half of me.

To my family and friends thank you all just for being there for me.

To my partner Sabrina

you're a wonderful person to work with, and I appreciate all of the time and effort you put into doing a fantastic job.

Cheyma bici.

FIGURES LIST

TABLES LIST

ABREVIATIONS LIST

h_C	Coefficient of heat exchange by convection [W/m²·K].
T	The temperature [°C].
T_{amb}	Ambient temperature [°C].
ΔT	Temperature difference between the collector center and the ambient temperature [℃].
$\dot{m}$	The mass flow rate of hot air passing through the solar chimney [kg/s].
v_C	The air velocity at the outlet of the collector [m/s].
$\acute{Q}$	Heat flux [W].
A_C	The solar chimney section [m²].
A_{Col}	The collector surface [m²].
C_P	Specific heat of air [J/kg.K].
G	Solar irradiation [W/m²].
$\tau\alpha$	Effective efficiency of absorbance and transmittance of the solar collector.
p_{Coll}	The air density at the collector outlet [kg/m^3].
P_{tot}	The power [W].
ΔP_{tot}	The pressure difference [W].
H_{Ch}	The height of the chimney [m].
g	Gravity Acceleration g = 9.81 m/s².
η_C	The collector efficiency [%].
η_{tur}	The turbine efficiency [%].
η_{Ch}	The chimney efficiency [%].

GENERAL INTRODUCTION

General Introduction:

The growth in energy demand induced by the increase in population and its growing needs for the coming years, the limitation of hydrocarbon resources and the dangers related to their exploitation such as water pollution by shale gas, risk that can be affected by accidents at nuclear power plants and their waste constitute all serious worries for the international community. Moreover, global warming has become a major concern for the international community especially since the adoption of the first international conference on the environment; which was held in Stockholm in 1972 under the slogan “One Earth” which is necessary to support; otherwise it will endanger the future of humanity. Therefore, it is extremely urgent to find a reliable alternative and better adapted to the problems related to respect for the environment and the constraints posed by conventional energy resources such as hydrocarbons and nuclear [1]. The use of fossil fuels is set to face multiple challenges: reduction of fossil fuels reserves, global warming and other environmental concerns and continuing fuel price rise. For these reasons, the existing sources of conventional energy may not be adequate to meet the ever-increasing energy demands. Consequently, sincere and untiring efforts shall have to be made by the scientists and engineers in exploring the possibilities of harnessing energy from several non-conventional energy sources (solar, biomass, tidal, hydrogen, wind and geothermal energy) which they are seen as possible solution to the growing energy challenges. According to energy experts, unconventional energy sources can be used for electric power generation that receives a great attention [2].

Where there has been a recent escalation of talk about energy security and renewable energy as a continuous alternative energy that covers the deficit experienced by traditional energy, even if it has not been canceled as an alternative energy stemming from the permanent, continuous and renewable resources of nature such as solar energy .It is noticeable on this source that is more concentrated in some countries of the south, foremost of which is Algeria, and specifically the Algerian Sahara. In our study, we will use the relative energy by the solar chimney.

The conversion of solar energy to electrical form comes in different forms: photovoltaic, solar chimney...Etc. Among of disadvantages is the collector takes up a lot of space.

GENERAL INTRODUCTION

The Algerian south presents an important solar deposit, which leads us to give our contribution in the installation of a solar chimney in our region. Among the parameters affecting the efficiency of the solar chimney are the dimensions, namely: the height of the chimney, the diameter of the collector, the diameter of the chimney height and the collector roof height.

The study of the effect of these parameters on the electrical production of solar chimney will be already an interest in improving the design of this equipment for more efficient production of energy.

Our memoir will be presented as follows:

The first chapter, which came under the title of "Solar Energy", in which the sun and solar energy were defined. We also mentioned the forms of this energy, then we talked about the areas of its uses.

The second chapter is entitled"The Solar Chimney Power Plants" in which we talked about the concept of the solar chimney, its principle of operation, and its components, mathematical and physical relations that control it. As we mentioned its most important models and people who worked in the field of chimney .Finally, we discussed the advantages and disadvantages of the solar chimney.

The third chapter was under the title "Conception and Method of Measurement". In this chapter, we defined the study area and the pieces used in this experiment. We also introduced some of the devices used in the measurement.

The fourth chapter came under the title of "Results and Discussion", in which the results of this experiment were discussed, which is represented in graphs of most of the phenomena we have studied. We also reached some conclusions regarding the impact of the air guide on the performance of the solar chimney and the final form of its design.

We end this work with a conclusion in which we present the results obtained during this experiment.

CHAPTER I : SOLAR ENERGY

I.1 Introduction:

Today renewable energies are the most important energy resources and the most appropriate alternative to fossil energies. Among these resources, we can cite solar energy.

Solar energy is the most dominant of all renewable energies. It gives the user the possibility of meeting part of his needs without intermediaries. In effect, the most widespread solar technologies are mainly observed in the field of real estate: passive solar thermal, active solar thermal, photovoltaic solar and natural lighting.

I.2 The sun:

The Sun is a star, the only one in the solar system, and the closest to us. The closest after it is Proxima Centauri, located 4.2 light years from the Sun. it is of gaseous constitution, of spherical shape of 14×10^5 km in diameter, its mass is of the order of 2×10^{20}kg. It consists mainly of 80% hydrogen, 19% helium and the remaining 1% is a mixture of more than 100 elements.

It is located at a distance from the earth equal to about 150 million km. Its total luminosity, i.e. the power it emits in the form of electromagnetic waves; 30% of this power is reflected back to space, 47% is absorbed and 23% is used as an energy source for the evaporation-precipitation cycle of the atmosphere .[3, 4].

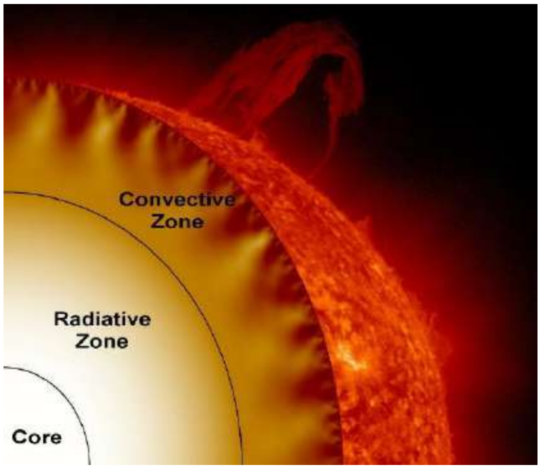


Figure I-1 The Solar Interior.

The radiative zone: It extends from 0.2 to 0.7 solar radius approximately. Its temperature is much lower than that of the core, but its density remains very high. This zone plays an important role in the transfer and filtering of energy from the core to the surface of the Sun.

The convection zone: It extends from 0.7 solar radius to 400 km from the surface of the Sun approximately. It allows energy exchanges between the radiative zone and the photosphere. Due to its low density, the exchanges in this zone take place by convection: the hot gases rise to the surface, cool, then come back down, warm up and rise again [5].

I.3 Solar energy:

Solar energy is the energy released by the sun in the form of radiation, direct or diffuse on earth. Because of the various executions, it can be transformed into another form of energy useful for human activity. By extension, the expression "solar energy" is often used to refer to electricity or thermal energy obtained from solar radiation.

Figure I-2 Solar energy.

I.4 Types of solar energy:

I.4.1 Thermal Solar Energy:

Solar thermal energy refers to energy harvested from sunlight by glazed solar thermal collectors to provide heating. There are two types of solar thermal energy:

a. Low-temperature solar thermal energy:

The sun's rays, trapped by glazed thermal collectors, transmit their energy to metal absorbers - which heat a network of copper pipes through which a heat transfer fluid circulates. This exchanger in turn heats the water stored in a cumulus. The temperature is between 0°C and 400°C.

A solar water heater produces domestic hot water or generally diffused heating by a "direct solar floor".

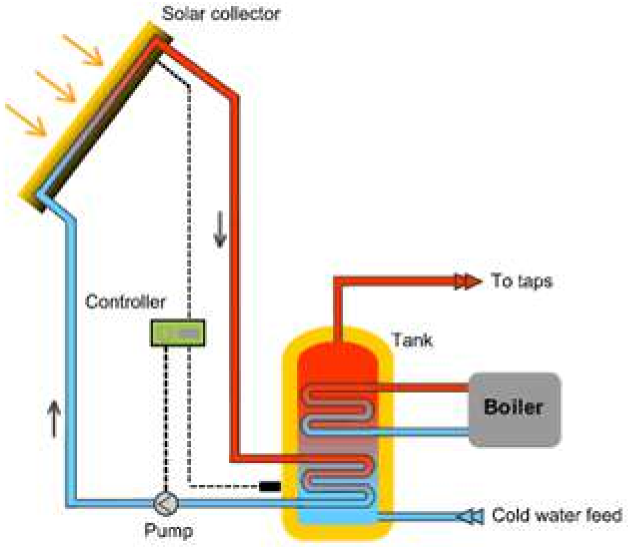


Figure I-3 Low-temperature solar thermal energy.

b. High temperature solar thermal energy:

The concentration of solar radiation on a collection surface makes it possible to obtain very high temperatures generally between 400°C and 1,000°C.

The solar heat produces steam, which feeds a turbine, which itself feeds a generator, which produces electricity; it is helio-thermodynamics that three distinct technologies are used in concentrated solar power plants:

- First technology: parabolic concentrators, the sun's rays converge on a single point, the focal point of a parabola.

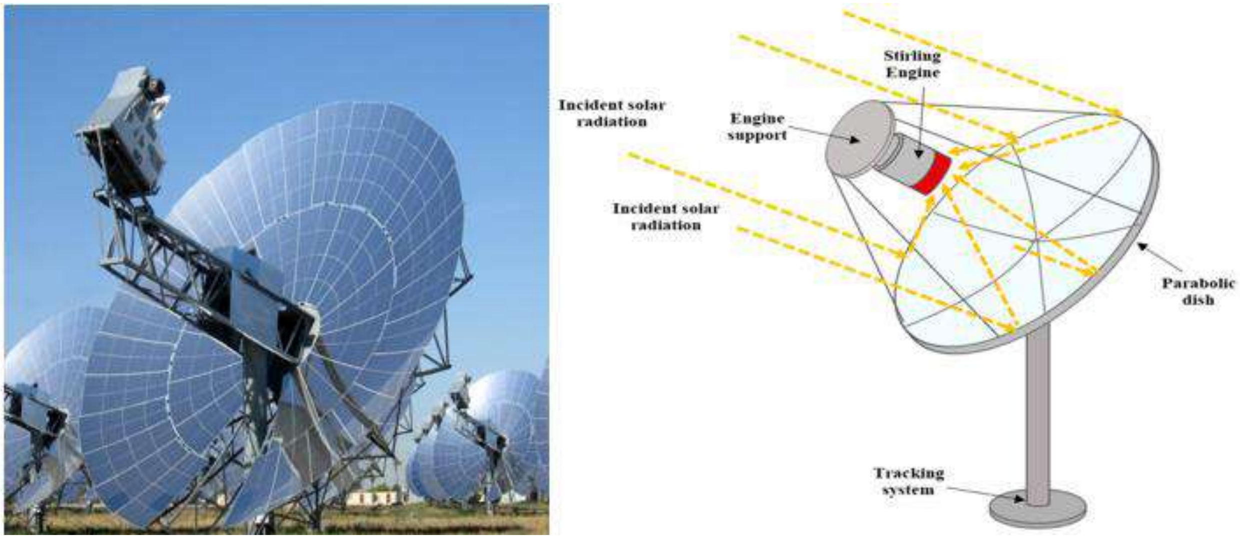


Figure I-4: Parabolic thermodynamic plant.

Second technology: tower power plants, hundreds or even thousands of mirrors (heliostats) follow the path of the sun and concentrate its radiation on a central receiver placed at the top of a tower.

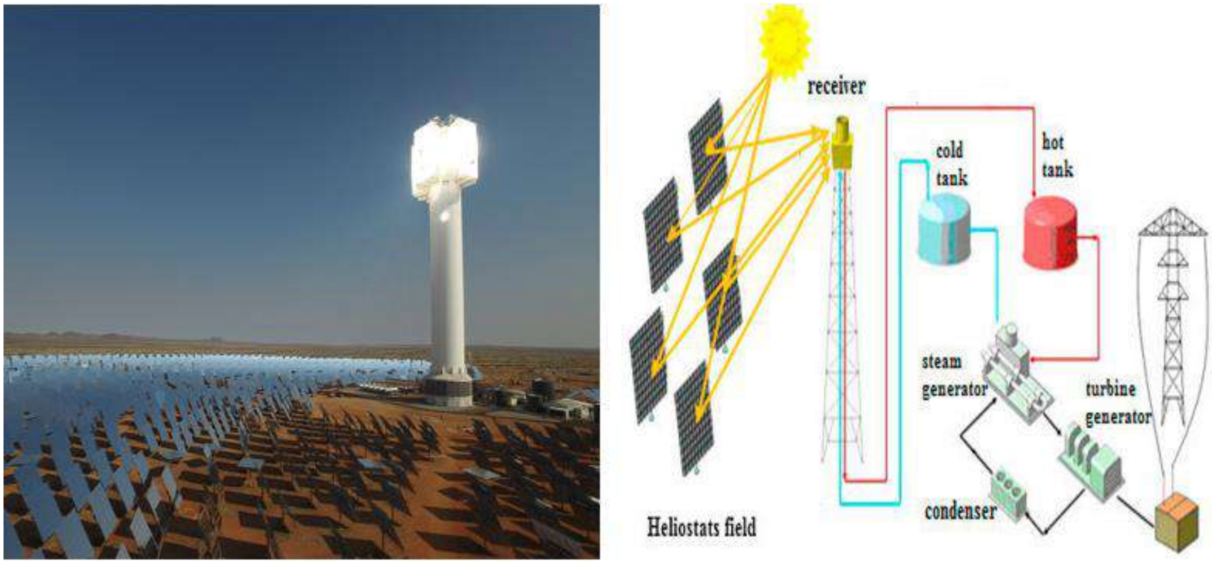


Figure I-5: Tower thermodynamic plant.

Third technology: cylindrical-parabolic collectors concentrate the sun's rays towards a heat pipe located at the focus of the solar collector.

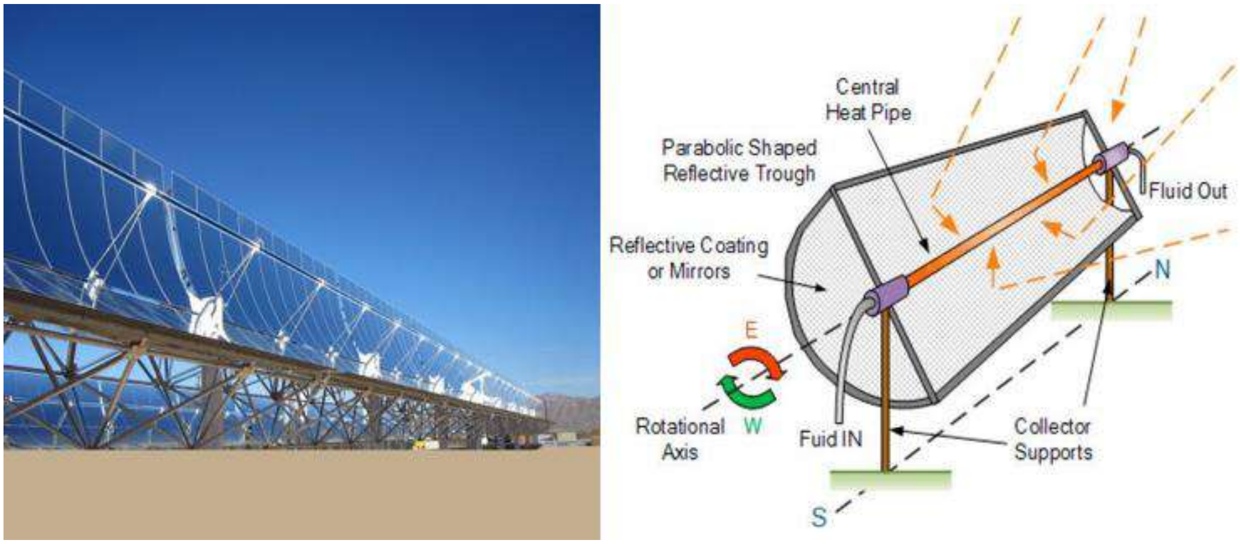


Figure I-6: Cylindrical-parabolic thermodynamic plant.

I.4.2 Photovoltaic Solar Energy:

Photovoltaic solar energy is the direct transformation of solar radiation into electricity in a solar cell. The photovoltaic effect discovered in 1839 by Antoine Becquerel is generally produced in very thin discs of monocrystalline silicon whose superimposed zones are doped with boron and phosphorus atoms; a voltage of 0.6 V appears between these areas. The incident photons collide with the atoms of the cell and cause a movement of the charges (electrons) between the two zones. The intensity of the direct current supplied is 0.03 A/cm² of cell [6].

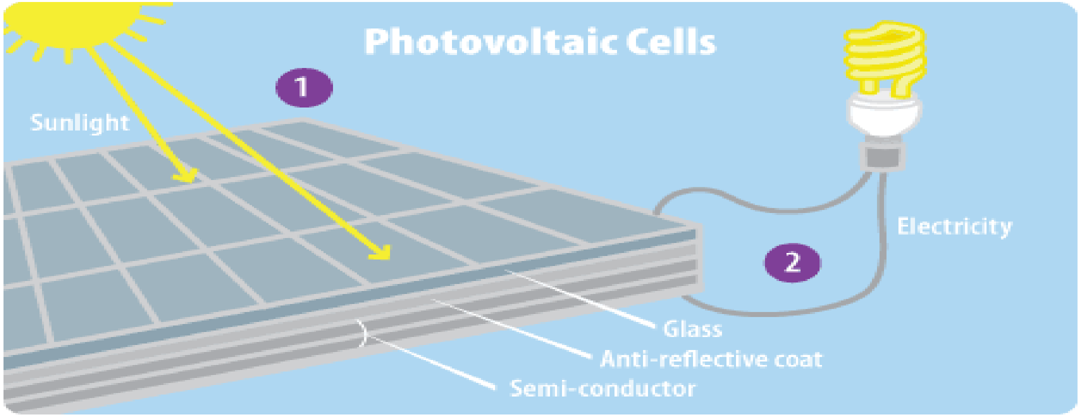


Figure I-7: Electricity production diagram by photovoltaic cell.

I.5 Potentials of solar energies in Algeria:

Given its geographical location, Algeria has one of the highest solar deposits in the world. The duration of sunshine on almost all of the national territory exceeds 2000 hours annually and can reach 3900 hours (high plateaus and Sahara).

The energy received annually on a horizontal surface of 1m² is nearly 1700 kWh/m² in the north and exceeds 2680 kWh/m² in the Great South, as shown in (TableI-1) and (FigureI-8) [7].

Table I-1: Solar potential in Algeria.

Regions	coastal region	Highlands	Sahara
Area (%)	4	10	86
Average duration sunshine (hours/year)	2650	3000	3500
Average energy received (kWh/m²/year)	1700	1900	2650

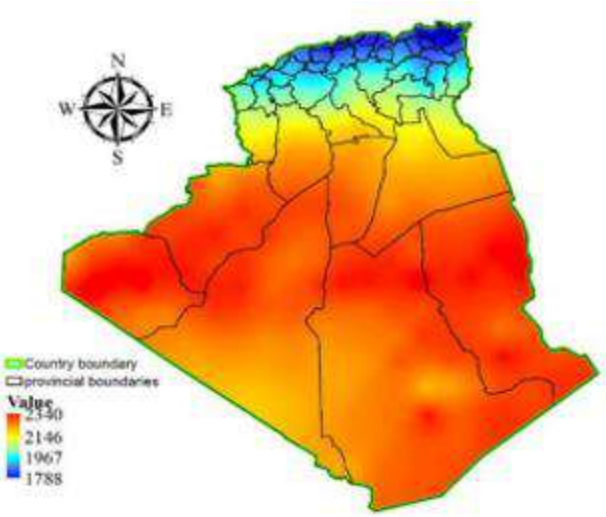


Figure I-8: Variation of solar radiation in Algeria.[8].

I.6 Conclusion:

Solar energy is one of the resources that is freely and abundantly available and a huge amount of energy can be harnessed.

It has many applications from solar thermal energy to solar electricity. Among new applications of solar thermal energy a Solar Chimney Power Plants (SCPP).

CHAPTER II : THE SOLAR CHIMNEY POWER PLANTS

II.1 Introduction:

Despite the significant existence of solar energy in hot regions, the wind is very weak. Therefore, the exploitation of wind energy in these regions is impossible. Unlike these regions, the wind in the other regions is always available, but it remains unstable, which affects its exploitation. Modern studies have shown the possibility of generating air movement in the form of artificial wind from solar energy; this airflow is used to drive one of the wind turbines. A device called the solar chimney does this association of two types of exploitation of solar energy. The solar chimney is a generator of electrical power from solar energy; it consists of three main components: 1) the solar collector, 2) the chimney or the tower, and (3) the wind turbine. These three essentials have been familiar from time immemorial.

All the main organs (collector, turbine and chimney) of the solar chimney are in continuous improvement, through studies on their performance, which will always ensure the improvement of electrical efficiency.

A solar chimney (radial solar heating system) is a renewable energy power plant constructed in such a way that air from a greenhouse heated by the sun is channeled through a chimney, in order to drive turbines to produce energy electricity.

II.2 History:

Many researchers around the world have introduced various projects of solar tower. Around 1500, Leonardo Da Vinci made sketches of a solar tower called a smoke jack (Figure II-1**a)**. [9] The idea of using a solar chimney to produce electricity was first proposed in 1903 by the Spanish engineer Isodoro Cabanyes). The German science writer Hans Gunther [10] , elaborated upon another earlier description in 1931. He proposed a design in the 25 August 1903 issue of ―La Energia Eléctrical‖, entitled ―Projecto de motor solar‖ (FigureII-1 b). In this bizarre contraption, a collector resembling a large skirt heats air, and carries it upwards towards a pentagonal fan inside a rectangular brick structure vaguely resembling a fireplace (without a fire). The heated air makes the fan spin and generate electricity, before it escapes up a 63.87 m tall chimney, cools, and joins the atmosphere [11].

In 1926, Prof Engineer Bernard Dubos proposed to the French Academy of Sciences the construction of a Solar Aero-Electric Power Plant in North Africa with its solar chimney on the slope of the high height mountain after observing several sand whirls in the southern Sahara [12].

The author claims that an ascending air speed of 50 m/s can be reached in the chimney, whose enormous amount of energy can be extracted by wind turbines.

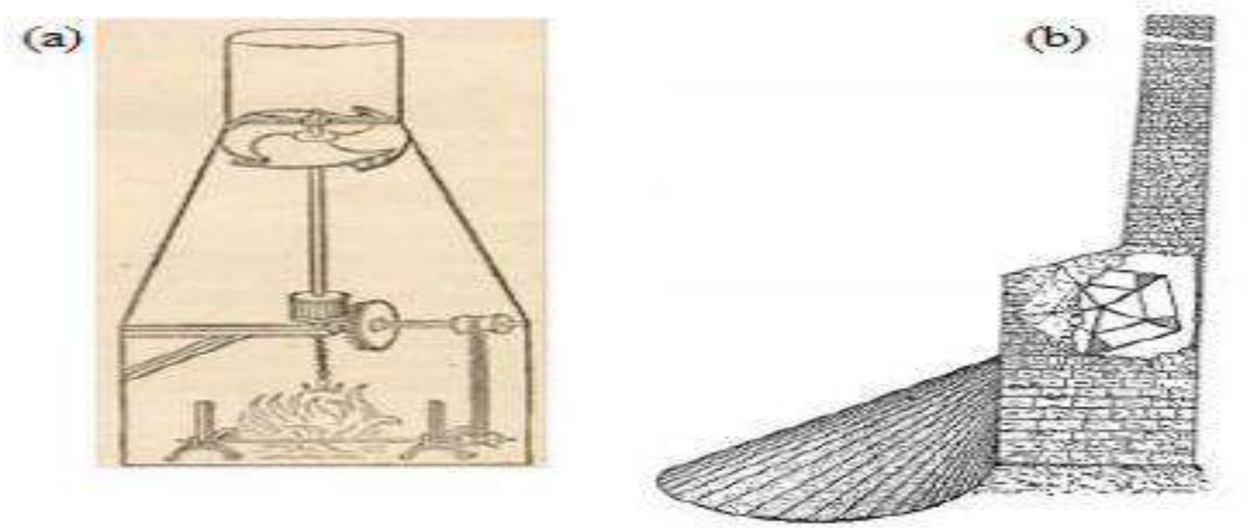


Figure II-1. (a) The spit of Leonardo da Vinci (1452-1519) (Library of Entertainment and Knowledge 1919). (b) Solar engine project proposed by Isodoro Cabanyes.

The academy recommended the Dubos's idea be followed up, especially in North Africa, which has no fuel and needs power. In fact, Dubos had the North African Atlas Mountains in mind when he developed his plans[13].In 1956; he filed his first patent in Algeria. It was artificially generate ancestry atmospheric vortex in a sort of round-shaped Laval nozzle and recover some energy through turbines. Nazare received a French patent for his invention in 1964 (Figure II-2)[12].

Figure II-2 the solar tower of the professor NAZARE.

In 1975, the American Robert Lucier filed a patent request based upon a more complete design. This patent was granted in 1981[12]. Starting in 1982, a team led by the German civil engineer Jörg Schlaich took the initiative and constructed a prototype in

Manzanares Spain, with a 200 m high and a maximum power output of 50 kW [14]. In 2002, Time Magazine identified this project as one of the best inventions of the year. The operating principle is considered revolutionary but is based on very common knowledge: Warm air rises [10].

II.3 Principle and diagram of operation:

The principle of a solar chimney power point, like the one we are studying, is very simple. Indeed, a large hollow tower, which is none other than a chimney, is placed in the center of a gigantic greenhouse called the collector. The air rushes under this greenhouse and is heated by the rays of the sun. The operation of this fireplace is based on a simple principle: hot air being lighter than cold air, it rises. It is therefore directed upwards by convection and the displacement of the air allows turbines, located at the base of the chimney, to produce electricity. In addition, non-return valves, located at the openings of the greenhouse at ground level, allow the admission of air at this level while preventing it from exiting to any place other than the chimney[15].

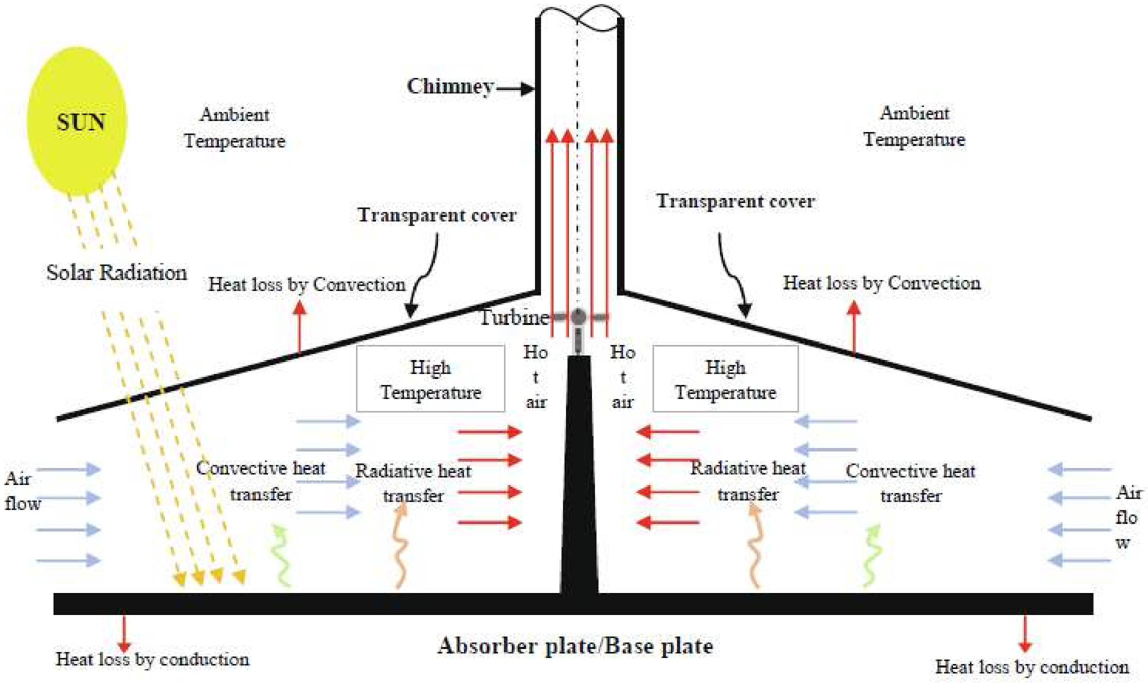


Figure II-3: Schematic diagram of SCPP.

II.4 Main elements of the solar chimney:

II.4.1 The collector:

One of the major components of the SCPP plays the role of a heat exchanger within the system, in that the collector converts solar radiation into thermal energy utilizing the greenhouse effect. The thermal energy of a heat absorber first warms the air and then the thermal energy of this heated air is converted to kinetic energy. A transparent roof, column structure and support matrix are all of the primary parts of the collector, and the principal mechanism occurs when irradiance through the transparent canopy hits the absorber section. The transparent canopy, which is often plastic or glass, is then not able to pass any infrared radiation emitted from the absorber back to the atmosphere, but instead, the absorber heats air which the overall process then exploits[16].

The energy equation is given by:

$$\mathbf{\acute{Q} = \dot{m}\, C_p\, \Delta T = (\tau\alpha)\, A_{Coll}\, G - h_{\,C}\Delta T\, A_{Coll} \; = \; \eta_{Coll}\, A_{Coll}\, G} \qquad \text{II-1)}$$

h_C : Coefficient of heat exchange by convection [W/m²·K].

$\dot{m}$: The mass flow rate of hot air passing through the solar chimney, it is given by:

$$\mathbf{\dot{m} = \; p_{Coll}\, A_C\, v} \qquad \text{II-2)}$$

The air velocity at the outlet of the collector is expressed by:

- A_{Coll} : The collector surface [m²].

$$\mathbf{v = \frac{(\tau\alpha)\, A_{Coll}\; G \; - \; h_C\, \Delta T\, A_{Coll}}{p_{Coll}\, A_C\, C_p\, \Delta T}} \qquad \text{II-3)}$$

The collector efficiency is given below:

$$\eta_C = \frac{\mathbf{\dot{Q}}}{\mathbf{A_{Coll}\, G}} \qquad \text{II-4)}$$

- C_P : Specific heat of air [J/kg.K].
- A_C : The solar chimney section [m²].
- A_{Coll} : The collector surface [m²].
- G : Solar irradiation [W/m²].
- h_C : Coefficient of exchange by convection of the solar collector [W/m².K].
- $\tau\alpha$: Effective efficiency of absorbance and transmittance of the solar collector;
- p_{Coll} : The air density at the collector outlet [kg/m^3].
- ΔT : Temperature difference between the center temperature of the collector and ambient temperature [℃].

We can estimate the value of ΔT by the following relation:

$$\boldsymbol{\Delta T = T_{coll} - T_{amb}} \qquad \text{II-5)}$$

II.4.2 Chimney:

The part of the system that conducts heated air from the collector part to the atmosphere has been called a chimney, updraft tower or solar tower. In respective of the term, it is a giant tube that is sited at the center of the collector, acting as the thermal engine for the plant. Despite the long tube, it has been claimed that the chimney has a low friction loss because of its suitable surface-to-volume ratios and is so likened to a hydropower station pressure tube or penstock [16].

According to J. Schlaich, the chimney efficiency is expressed as follows:

$$\boldsymbol{\eta_{Ch} = \frac{P_{tot}}{\dot{Q}} = \frac{gH_{Ch}}{C_p T_{amb}}} \qquad \text{II-6)}$$

- H_{Ch} : is the height of the chimney.
- P_{tot} : is the power contained in the flow, which can be written as follows:

$$\boldsymbol{P_{tot} = \eta_{Ch}\, Q = \frac{\dot{g}\, H_{Ch}}{T_{amb}}\, P_C\, A_C\, \nu_C\, \Delta T} \qquad \text{II-7)}$$

The pressure difference, which is produced between the chimney base and the ambient, is calculated by:

$$\Delta \mathbf{P}_{\mathbf{tot}} = \mathbf{p}_{\mathbf{Coll}}\, \mathbf{g}\, \mathbf{H}_{\mathbf{Ch}} \frac{\Delta \mathbf{T}}{\mathbf{T}_{\mathbf{amb}}} \qquad \text{II-8)}$$

II.4.3 Turbines:

Turbines are often placed at the base of the tower. The use of turbines serves to convert the kinetic energy of the air flowing inside the chimney into an energy rotating mechanics. Use of the mechanical output of the turbines in the form of energy rotation can be derived from the airflow in the chimney. The turbines in a solar chimney do not work with stepped speed as in converters conventional wind energy systems, but rather, pressure-staged as in a turbo generator, or as a hydroelectric plant, where the static pressure is converted by an integrated turbine into useful rotational energy.

Power output in a SCPP can be calculated through the following equation:

$$\boldsymbol{P_{tot} = \dot{m}\, g\, H_{ch} \frac{\Delta T}{T_{amb}}} \qquad \text{II-9)}$$

Turbine pressure drop (ΔP_t) is associated with the air velocity at the turbine inlet through

A linear regression as given below:

$$\Delta \mathbf{P}_{\mathbf{t}} = \mathbf{18,87}\boldsymbol{V} - \mathbf{57,59} \qquad \text{II-10)}$$

The turbines efficiency is expressed as follows:

$$\eta_{\boldsymbol{tur}} = \frac{\boldsymbol{P_{tot}}}{\boldsymbol{\Delta P_t}} \qquad \text{II-11)}$$

g : Gravity Acceleration g = 9.81 m/s².

- The turbines efficiency is given as a constant $\eta_{\boldsymbol{tur}} = \mathbf{0.8}$

II.5 Advantages and disadvantages of solar chimney:

II.5.1 Advantages: [17]

- ✓ The collector can use all solar radiation, direct and diffuse.
- ✓ Due to the heat storage system, the solar chimney will operate 24 h on pure solar energy.
- ✓ The solar chimneys are particularly reliable and not exposed to break down, in comparison with other solar production installations.
- ✓ Considering the robustness of its structure, the solar chimney does not need much maintenance and functions naturally. It does not require non-renewable fuels for operation and does not produce any emissions.
- ✓ Solar chimneys do not need cooling water. This is a main advantage in the many sunny countries, which already have major problems with drinking water.
- ✓ The building materials required for solar chimneys, mainly concrete and glass, are available everywhere in sufficient quantity.
- ✓ It has a long lifespan (at least 80 to 100 years). The technology of a solar chimney power station will not easily become obsolete.

II.5.2 Disadvantages: [17]

- The initial investment is higher
- The production is not constant during the day or the year.
- No similar scale structure has been built before.
- The construction of the chimney requires huge quantities of materials. These quantities can cause logistical problems pertaining to the availability and transport of materials.
- The collector occupies a huge area.
- Negative visual impact (some see it as a degradation of the landscape).

II.6 Solar Chimney Plant Projects:

II.6.1 Manzanares prototype:

A project which was the result of a collaboration between the Spanish State and the German researchers Schlaich Bergermann and Partner in 1982 (Figure II-4) [18].

Figure II-4: Manzanares prototype in Spain.

The plant operated until 1989. The technical and dimensional parameters of this prototype are given in the following table (Table II-1***)***.

Table II-1 Technical data of the Manzanares prototype.

chimney height	***194.6 m***
chimney diameter	***10.16 m***
Plastic collector surface	***40 000 m²***
Glass collector surface	***6 000 m²***
Temperature difference in collector ΔT	***20 °c***
number of turbines	***4***
Power produced	***50 KW***

II.6.2 Australian project (Buronga):

The Buronga tower is located in Australia, 630km southwest of Sydney, in an arid and desert area located on the border of the states of New South Wales and Victoria. In 2001, the Australian government voted to build a 200 MW power station at Buronga. This project is the most ambitious today, it was proposed that the chimney be 1000 m high with 120 m in diameter and a collector of 7000 m in diameter [19, 11].

The main dimensions and technical data of the prototype are given in Table:

Table II-2 Characteristics of the Buronga power plant.

chimney height	**1000m**
chimney diameter	**120 m**
Collector diameter	**7000 m**
Heated air temperature	**70 °c**
Electric power	**200 MW**
Electricity production price	**12.3344 DA/kWh**
Investment price	**308.36 DA/W**

II.6.3 Chinese project:

A 200 kW facility in Jinshawan, China began in May 2009 and aimed to build a facility covering 277 hectares and producing 27.5 MW by 2013. The greenhouse was operated in such a way as to reduce sandstorms [20,21].

Another development in China is the proposal to build a 1000m high solar chimney for power generation and tourism development in Shanghai.

II.6.4 Spanish project:

A solar power plant project is expected to be installed in Ciudad Real, Spain, titled Ciudad Real which would be 750 m high, covering an area of 350 hectares with a planned power of 40 MW [19].

The technical and dimensional parameters of this prototype are given in the following table:

Table II-3 Characteristics of the Spanish project.

Chimney height	**750 m**
Collector diameter	**3000 m**
Air velocity inside the chimney	**12 m/s**
Nominal electric power	**40 MW**
Project cost	**37,066,022,400,00 DA**

II.6.5 Namibian Project:

The Namibian government approved in 2008 a construction proposal a 400 MW solar chimney called Green Tower. The tower is expected to be 1500 m in height and 280 m in diameter, and the base will be a 37 km2 greenhouse that can be exploited and cultivate[19, 22].

The technical and dimensional parameters of this prototype are given in the table:

Table II-4 Characteristics of the Namibian Project.

chimney height	**1500 m**
chimney diameter	**280 m**
Nominal electric power	**400 MW**
Project cost	**146 170 000 000 DA**

II.6.6 Arizona Project:

A plant is planned in the Arizona desert in 2001, where a production of 200 MW has been targeted. Which could generate 4000 times more power than the one built in Manzanares in Spain. The construction work was given to an Australian firm working under the advice of the German Schlaich Bergermann.

The technical and dimensional parameters of this prototype are given in the table following:

Table II-5 Characteristics of the Arizona power plant.

chimney height	**1000 m**
chimney diameter	**130 m**
Heated air temperature	**60 – 70 ℃**
Nominal electric power	**200 MW**
Collector area	**35 Km²**

II.7 Progress of experimental studies and research:

The design of the solar chimney has been in the hands of the Spanish Isidoro Cabanyes for more than 100 years. In 1903, where it was initially proposed a design of a chimney solar power plant. Then in 1926, the French **Bernard Dubos** proposed the construction of an aero-electric solar power plant in North Africa with its solar chimney on the slope of a large mountain. In 1931, the German researcher, **Hanns Gunther** developed a technology that simply used the greenhouse and chimney effect to drive a turbine that generated solar energy. Several decades later, Professor **Jorg Schlaich** put the same idea again in 1974 so that the world's first prototype chimney solar power plant was built in Manzanares in 1982 [23]. The construction of this prototype was the starting point for researchers from many countries to build different sizes and types of solar thermal energy generation systems.

- In 1983, **Kristt** built, in West Hartford, Connecticut, USA, a device 6 m high equipped with a collector 10 m in diameter with a production of 10 W[24].
- In 1997, **Pasurmarthi Sheriff and Florida** (see Figure II-5) established a system. They present the construction and testing of a small scale chimney. The testing focused on the heat transfer performance of the collector and methods to try and improve this [25]. The diameter of 9.15 m is equal to the tower height is equal to 7.92 and its diameter gradually decreases from 2.44 m to 0.61 m base to the summit [19]. A pilot experimental solar chimney power setup composed of 5 m radius air collector and a chimney 8 m in height has been built in HUST

FigureII-5 Solar Chimney Prototype for Basurmarthy Sharif, Florida.

- The pilot solar chimney power setup was designed and built in December 2002, Wuhan, China by **Xinping Zhou and others**. In order to investigate the temperature field as well as to examine the effect of time of day on the temperature field (Figure II-6) [26]. The collector roof and the SC were made of glass 4.8 mm in thickness and PVC, respectively [27].

Figure II-6 Solar chimney prototype for Xinping Zhou and there.

- A solar chimney was also built on the campus of Suleyman Demirel University-RACRER (Research and Application Center for Renewable Energy Resources), in Isparta, Turkey, which had 15 m high, 1.2 m in diameter and a glass covered collector 16 m in diameter (Figure II-7).
  After the experimental studies, the system is modeled theoretically with depending on the design. Then, this model constituted the basis for developed computer program and performance parameters of the system are obtained [28].

Figure II-7 Prototype Solar chimney (Üçgül, 2005).

- In 2007, **Ketlogetswe and others**. in Botswana (Figure II-8) built a 22 m high reinforced glass chimney to measure temperature and velocity fields as well as solar radiation [29].

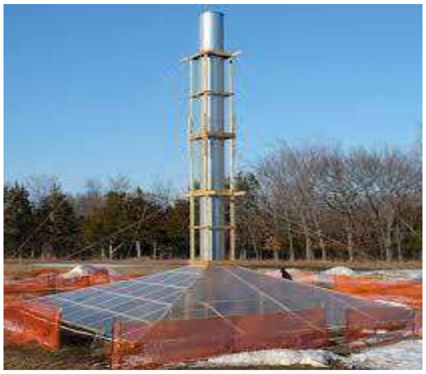


Figure II-8 Prototype solar chimney (Ketlogetswe and there, 2007).

- A practical prototype model of the solar chimney power plant was designed and constructed to investigate the influence of basement kinds on chimney‘s air temperatures, in the region of Baghdad city-Iraq. The prototype is composed of a circular transparent roof (6 meters diameter) opened at the periphery (2 cm high from ground). In the middle of the roof, there was a vertical tower (4 meters tall and 20cm diameter) with large air inlets at its base (10 cm high from the ground). The study was conducted in Baghdad from August to November 2010 (Figure II-9)[30].

Figure II-9 Prototype solar chimney in Baghdad, 2010.

- In order to evaluate the solar chimney model, a prototype is constructed in AlAin, United Arab Emirates (UAE) as shown in (Figure II-10). which consists of a 10m x10m collector and an 8.25 m tall chimney [31]. The solar chimney data are collected over the period of three days on December 2011.The purpose of this work is to evaluate experimentally the performance of solar chimney and compare it with the mathematical thermal model prediction. The study report the effect of internal collector dynamic temperature, the amount of solar energy trapped within the collector, and expected wind draft inside the chimney.

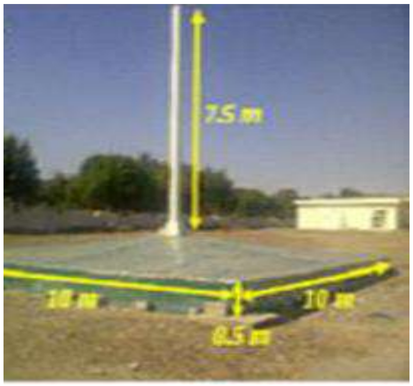


Figure II-10 Pprototype solar chimney in ALAin (UAE).

- A practical experience of making a small and less expensive prototype plant, which can be built on rooftops of residential buildings. In Bangladiche, 2014 by Md. Takmil Sakir (Figure II-11). The plant covering approximately 16.4 sq. meter area has a polythene cover as the collector instead of glass for reducing the cost. The base is tar covered concrete. The tower is made of PVC and approximately 3.05 meters high. Data were taken within November and December 2013. Experimental results show that the average power output varies from 3 to

Figure II-11 the prototype plant (Md. Takmil Sakir, 2014).

20 watts and the efficiency was maximum 0.11% [32].

- In 2016, Christos D. Papageorgiou, in Greece. They present ESCP technology a tested in a small experimental power plant in Greece (FigureII-12) could be a major player in renewable technology market after its successful testing with relatively low cost demonstration plants. The ESCP technology can combine low levelized cost of electricity with smooth 24 hours/day operation for 365 days/year [33].

Figure II-12 The ESCP experimental plant.

- An Experimental study and numerical analysis of the collector roof height effecton the solar chimney performance in tunisia,2018 by Ahmed Ayadi and others .The aim of this work is to study and optimize the characteristics of a solar chimney power plant (SCPP) using numerical and experimental way. The numerical simulation is performed using the commercial computational fluid dynamics (CFD) code “Ansys Fluent 17.0”. An experimental setup of a SCPP is developed in the national school of engineers of Sfax, University of Sfax, Tunisia in the North Africa (Figure II-13). [34].

. **Figure II-13** the SCPP prototype.

- In 2020, **Bagher Mokhtari Shahdost and others,** in Tehran, Iran. They present Modeling of power plant chimney gas power generation based on buoyancy using a mixture of power plant heated output with ambient air and examining different discharge rates and temperatures of power plant heated output on an empirical scale.

Figure II-14 Different views of the system built on a pilot scale.

An empirical model is generated, on the same scale as the modeling (Figure *II-14*), and used to validate the modeling results. The obtained results showed that a result of the buoyancy phenomenon, the merging of power plant exhaust gases with ambient air results in a larger volume of liquid with good velocity inside the chimney compared to power plant exhaust gases only[35].

II.8 Conclusion:

The use of chimney solar power plants (SCPPs) to manufacture clean and environmentally friendly energy has attracted a lot of attention in recent years and has become (over the past decades) one of the most promising solutions in the solar energy field. The low efficiency, construction difficulties, and other required improvements encouraged researchers, to work on this system, and many researchers, have put their efforts into proposing an improved configuration of the main components. While others have proposed innovative ideas and alternative techniques to improve the efficiency of solar chimney power plants, among which is the vertical placement of the guide blades from Absorber plate base, to the top of the manifold cover.

CHAPTER III : CONCEPTION AND METHOD OF MEASUREMENT

III.1 Introduction:

The increase in the production efficiency of the solar chimney is the subject of several studies, among the parameters affecting the efficiency of the solar chimney are the dimensions, namely: the height and diameter of the chimney and the roof height of collector the surface thereof. In order to study the influence of air guide geometry on the production efficiency of the solar chimney. A solar chimney is manufactured designed and built in the University of KASDI MERBAH OUARGLA. We measured and evaluated temperatures and air velocity with and without a guide.

III.2 Ouargla region:

III.2.1 Presentation of the site:

Ouargla is one of the important wilayas of southern Algeria, covering an area of 361,980 km². The region is located at an altitude of 141 meters, a latitude of 31.92°' North and longitude with 5.4°' East. Ouargla is geographically limited to the north by the wilayas of Djelfa and the Oued, to the south by Tamanrasset, and Illizi. To the west by Ghardaia.to the east by the Republic of Tunisia.

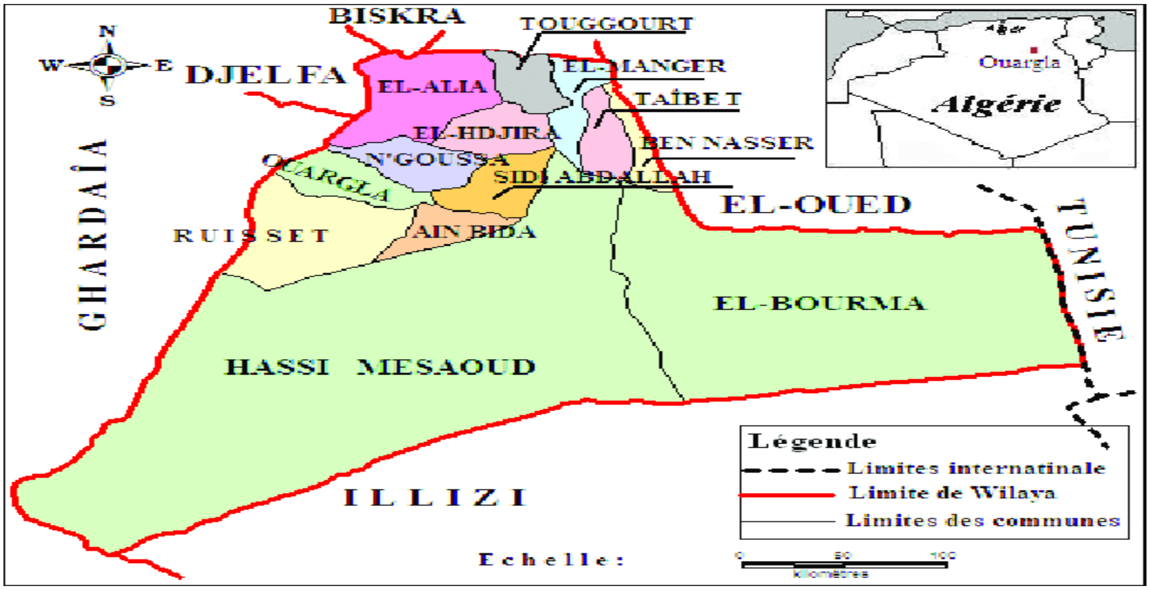


Figure III-1: Location of Ouargla.

III.2.2 Climatic data of Ouargla:

The climate of Ouargla is of the Saharan type, weak winter temperatures and very high summer temperatures varying between 35 and 44°C, low atmospheric humidity, characterize it. The month of December records the maximum of humidity while the month of July the minimum; humidity in the Ouargla region is limited between 24-62% in the year. The rainfall is low, it varies from 20 to 60 mm. the wind blows from the North-East and South, the most frequent winds in winter are the winds of the West, while in spring it is the North-East and West winds that dominate, in summer they blow from the northeast and southwest. The average annual speed Vmoy = 3.70 m/s.

The solar radiation is considerable in Ouargla, because the atmosphere presents a clear sky during the whole year with 138 days on average of the year when the sky is completely clear, this factor is considered advantageous and economical.

The average solar insolation is estimated at 2900 kWh/m² annually, the city of Ouargla changes from 2,280 kWh/m² in December to 7,620 kWh/m² in July, on a surface horizontal. Diffuse radiation is evaluated at 1,324 kWh/m² in January and 1,984 kWh/m² in July.

III.3 Ouargla solar chimney prototype:

The objective of this prototype (FigureIII-2**)** is to study the effect of the guide on the performance of the solar chimney by measuring the parameters (ambient temperature, wind speed, solar radiation, speed of the flow inside the chimney...etc.).

Figure III-2: prototype of solar chimney power plants in Ouargla.

III.4 Structure and component:

III.4.1 The chimney:

The chimney consists of a standard PVC pipe 0.2 m in diameter, 6.2 mm thick and 8 m high. This pipe is covered with a glass wool blanket (thickness 0.025 m and thermal conductivity (λ = 0.7 W/ (m·K)) which is used as thermal insulation to reduce heat loss from the chimney wall. The heat insulation is covered with thick aluminum foil to prevent it from external influences, in particular moisture. The PVC conduit is mounted on a solid iron support, which is fixed to the ground (Figures III -3, III -4.). To hold the chimney vertically.

Figure III-3: A picture of the chimney.

Figure III-4: Metal structure of the chimney.

III.4.2 The Collector:

The solar collector has a circular shape with an inclination of 8 degrees and 12 m in diameter. The roof of the solar collector was raised by a steel frame from a height of 0.2 m at the outer radius to 0.8 m at the center of the solar collector directly below the chimney entrance. In order to allow air to flow through the system, the opening height at the periphery of the collector was chosen as 0.02 meter and was constructed to be easily adjustable at different heights (0.05-0.2 m) to provide an air inlet.

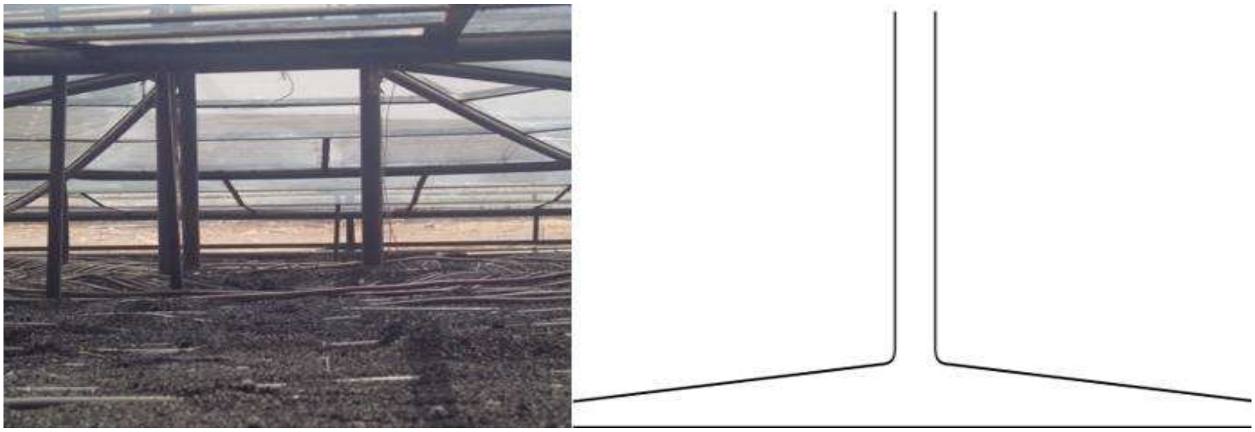


Figure III-5 prototype of collector

In addition, the need to direct the flow to facilitate the upward movement of air at the chimney inlet was revealed; Air guide has been added aiming to reduce the loss caused by the change of flow direction. This situation is illustrated in (figure III -6)**.**

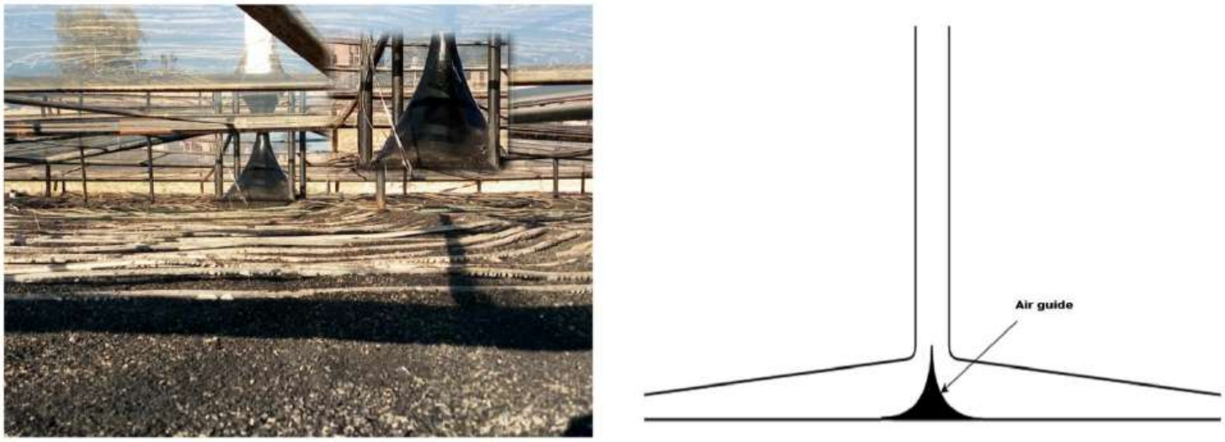


Figure III-6 Chimney regulation system flow rate (Air guide).

III.5 Conception of air guide:

Guide wall are placed vertically from the absorber plate base to the collector cover top. It is used to generate the nozzle effect near the chimney base and to direct the air towards the chimney base.

The purpose of this guide is to direct the flow in upward direction towards the turbine. It produces turbulence effect, hence the airflow velocity increases further, and hence, there is increase in kinetic energy. It is also used to hold various sensing instruments such as velocity sensors in fixed position by clamping to it.

In this experimental study, we have tried two types of air guide (Guide 1 see figure III-7),(Guide 2 see figure III-8) to get the optimal results and we have made changes in the length of the perfect guide.

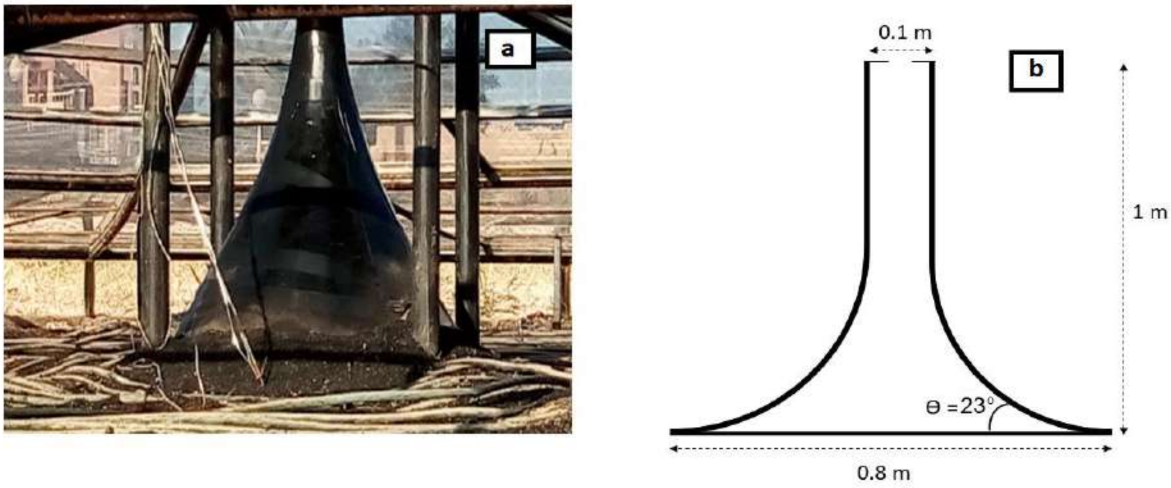


Figure III-7 Prototype of air guide 1 a) Real picture, b) Diagram.

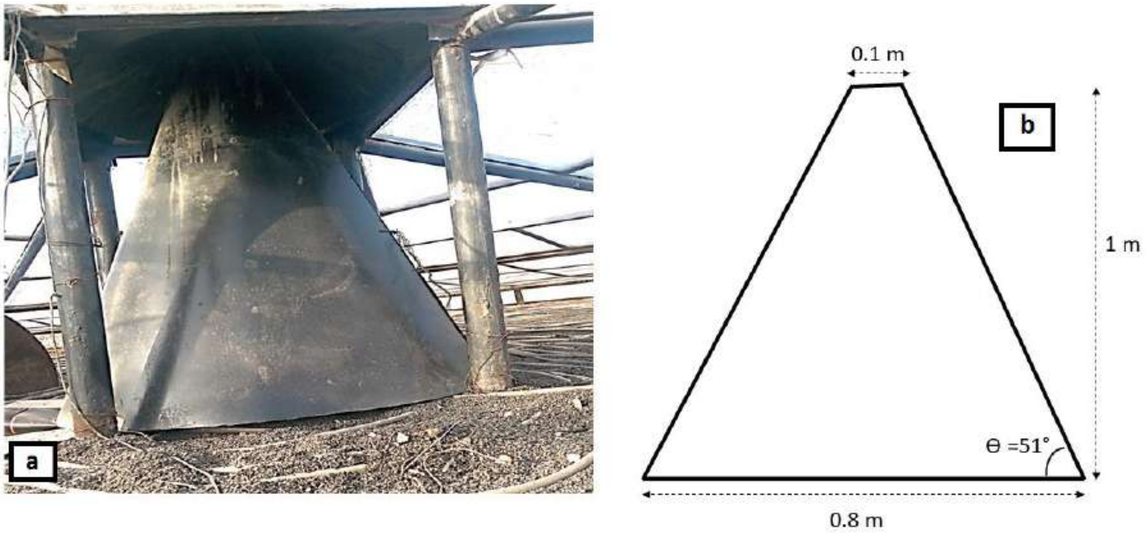


Figure III-8 Prototype of air guide 2 a) Real picture, b) Diagram.

III.6 Parameters studied:

Through this experimental study, which aims to find a possible high flow speed of the flow (air) at the entrance of the chimney, for the possibility of rotating a turbine, which can be added to our prototype in another complementary study. There are many parameters affected the operation of the solar chimney, mainly we quote:

- Tamb: Ambient temperature (°C).
- Tcoll: Temperature at the center of the collector (°C).
- R: Solar radiation (W/m²).
- V: Velocity of the flow inside the chimney (m/s).
- Wind speed (m/s).

III.7 Measuring instruments used in the experiment:

III.7.1 Measurement of global solar radiation:

- Measures the solar power and transmission up to 2000 W/m², 634BTU / (ft2xh)
- Selectable measurement units either W/m² or BTU / (ft2 x h)
- Max/min functions to identify locations with maximum or minimum power.
- Accuracy: ±10 W/m2 or ±5% (depending on sunlight)

Figure III-9 Amprobe SOLAR-100 Solar Power Meter.

III.7.2 Measurement of Air velocity:

- **Testo 416 vane anemometer:** Testo 416 is a compact anemometer with telescopic vane probe (max. length 890 mm, diameter 16 mm). The flow rate, which is calculated very precisely (0.6 → 40 m/s (0 → +60 °C)), is indicated directly on the display.

- Accuracy: ± (39.4 fpm + 1.5 % of mv) / ± (0.2 m/s + 1.5 % of mv)

Figure III-10 Testo 416 vane anemometer.

III.7.2.1 **UNI-T UT361 anemometer:** UNI-T's UT361 is an accurate anemometer. An anemometer is intended to measure wind speed and flow. The meter is equipped with an 8-bit microprocessor for data processing. The UT361 can display wind speeds in m/s, km/h, ft/min, mph and knots.

Accuracy: 2 - 10 m/s: ± (3%+0.5) and 10 - 30 m/s: ± (3%+0.8)

Figure III-11 UNI-T UT361 anemometer.

III.7.3 Temperature measurement:

The measurement of the temperatures is carried out using type K thermocouples were the temperatures at different places of the solar chimney. To obtain these data, we used several thermocouples; the sensors were positioned as follows:

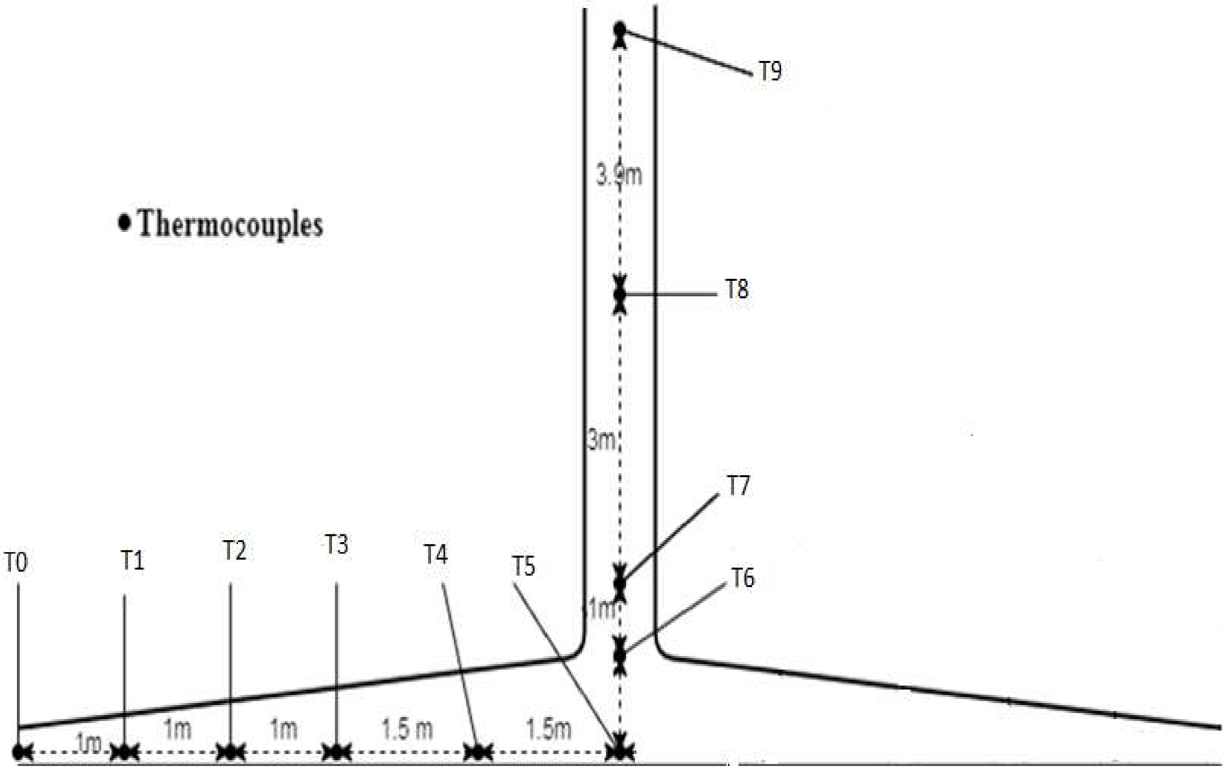


Figure III-12 Location of the nine thermocouples in the solar chimney.

CHAPTER IV : RESULTS AND DISSCUSION

IV.1 Introduction:

In this chapter, we are interested in the analysis of the experimental results obtained with regard to the influence of the guide on the production efficiency of the solar chimney. Through the contours and curves of different physical quantities, a discussion and interpretation will take place, in order to define the relationship between the use of guide and the production efficiency of the solar chimney.

IV.2 Results and Discussions:

- The period of these measurements lasted for two weeks, starting from February $\mathbf{15}^{th}$, 2022.

IV.2.1 Solar radiation intensity, ambient temperatures and wind speed:

The series of graphs groups together the variation of the climatic parameters as well as the effect of the air guide on the temperature of the center of the collector, on the difference in temperature between the ambient and the center of the collector and on the air velocity in the tour depending on the local time.

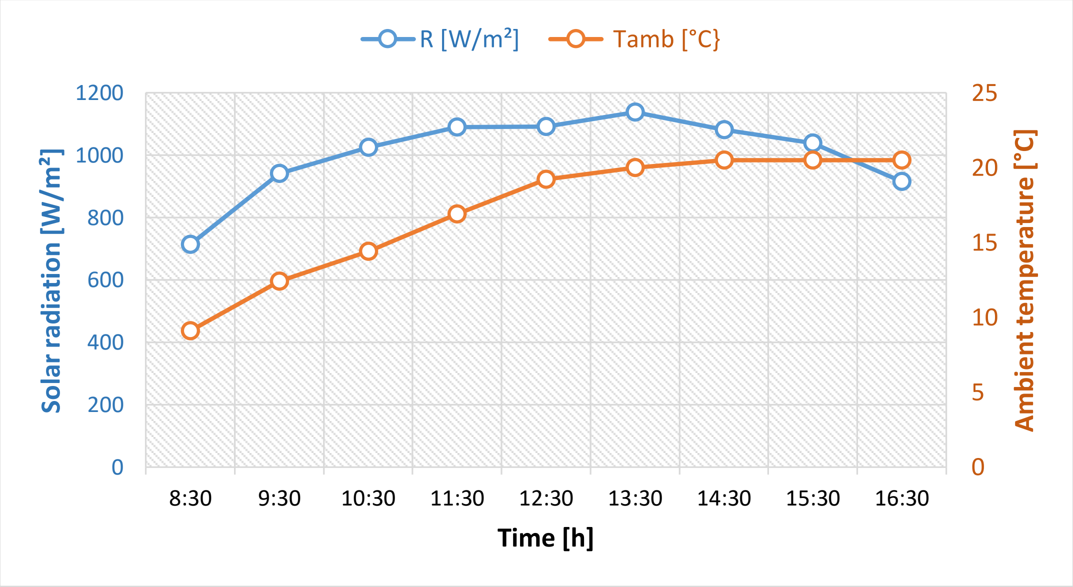


Figure IV-1: solar radiation and ambient temperature as a function of local time.

- Figure IV-1 present the variation of solar irradiation and ambient temperature as a function of local time. The intensity of solar radiation begins to increase in the morning from 714 W/m² at 08:30 a.m. the maximum solar radiation was obtained just before the noon and was 1138W/m² at 1:30 p.m. then it decreases again, down to 915 W/m² at 4:30 p.m. The ambient temperature begins to increase in the morning from 9.1°C at 08:30 a.m. The maximum value was 20.5 °C, is reached around 2:30 p.m. and we notice its stability until 4:30 p.m. at the same value.

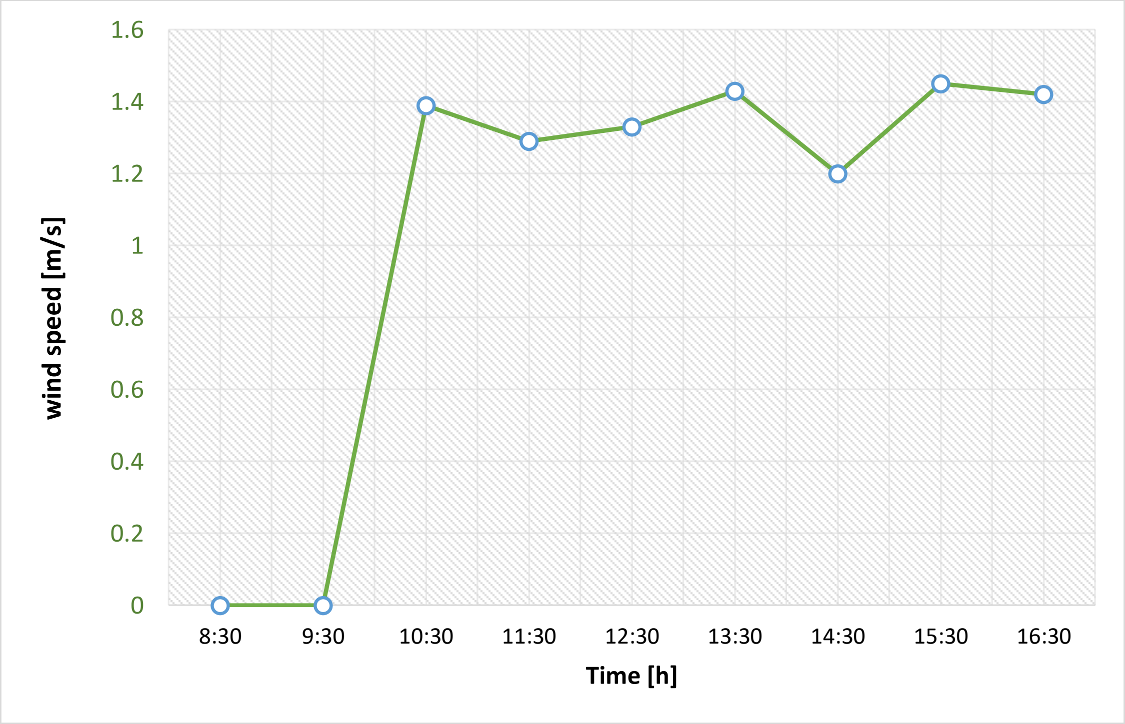


Figure IV-2: The wind speed as a function of local time.

- Wind speed generally were not uniform. It recorded for this day varied between 1.2 and 1.45 m/s; the average value obtained is 1.32 m/s.

IV.2.2 Solar chimney power plant case study:

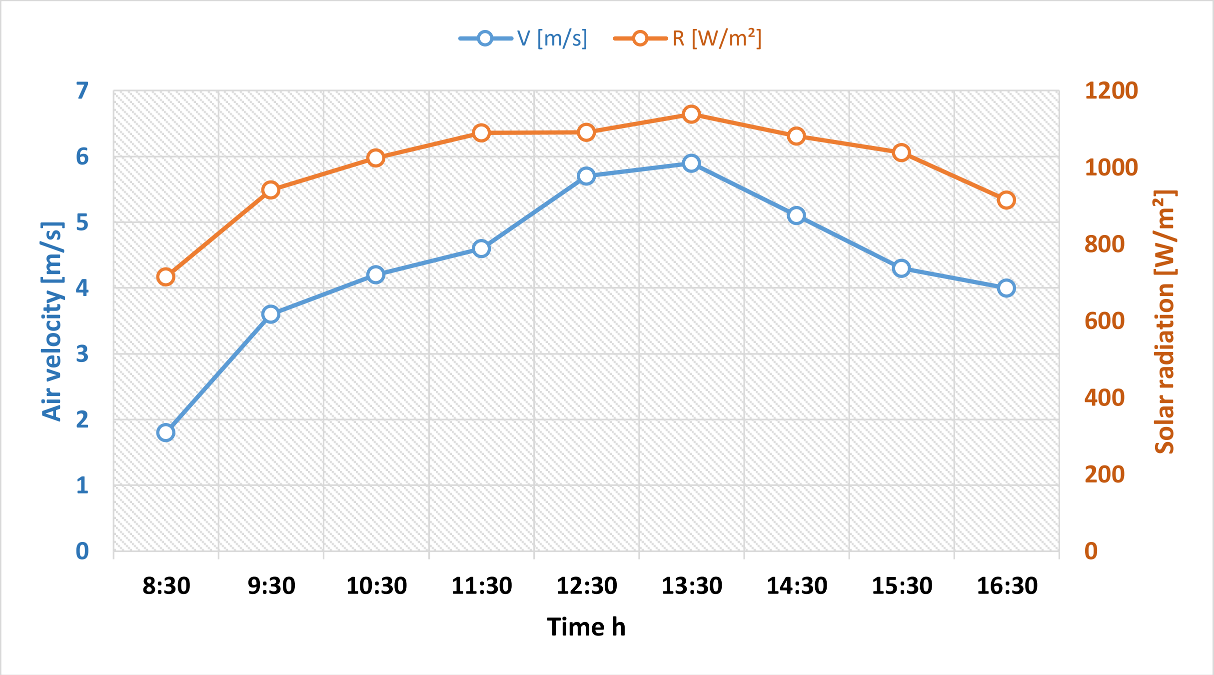


Figure IV-3: Air velocity at the chimney inlet with solar radiation as a function of time.

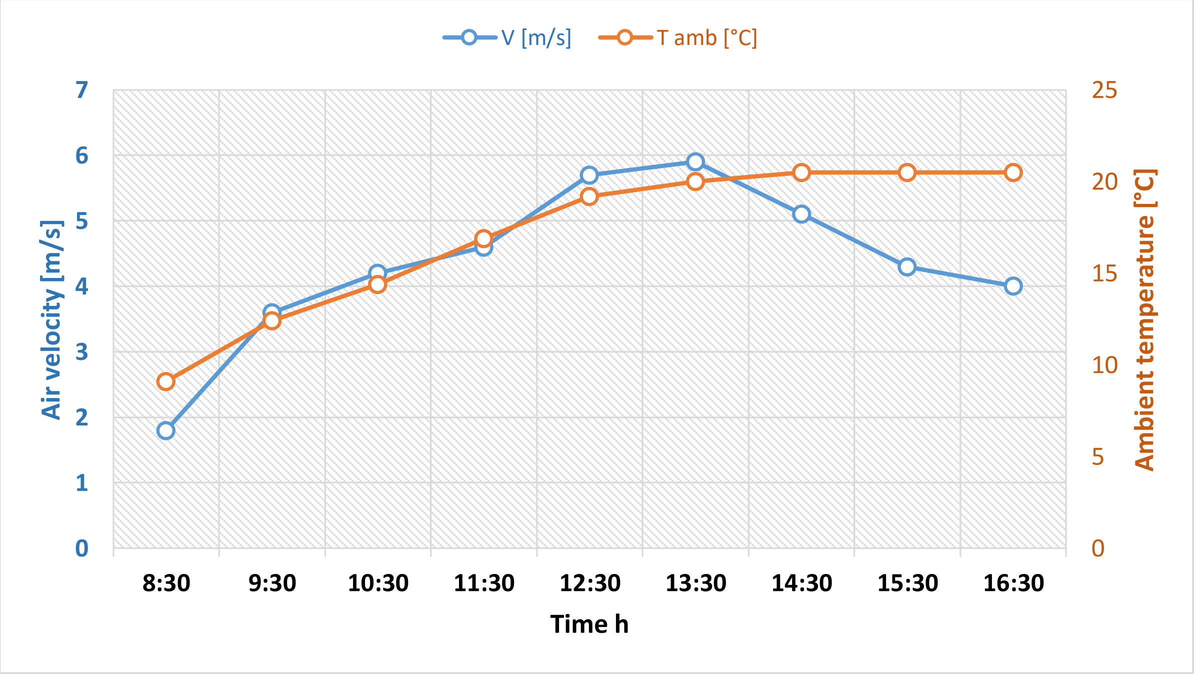


Figure IV-4: Variation of the air velocity in chimney with the ambient temperature as a function of time.

- Figures (IV-3, IV-4) present the variation of the air velocity inside the chimney and also the solar radiation and the ambient temperature as a function of time. It is clear that air velocity increases with increasing solar radiation and ambient temperature, but the effect of solar radiation is more important compared to temperature. It starts at 8:30 a.m. with (R=714W/m², Tamb=9.1°C, V=1.8m/s), the maximum value was at 1:30 p.m. (R=1138W/m², Tamb=20°C, V=5.9m/s), Then it decreases until (R=915W/m², Tamb=20.5°C, V=4m/s) at 4:30 p.m.

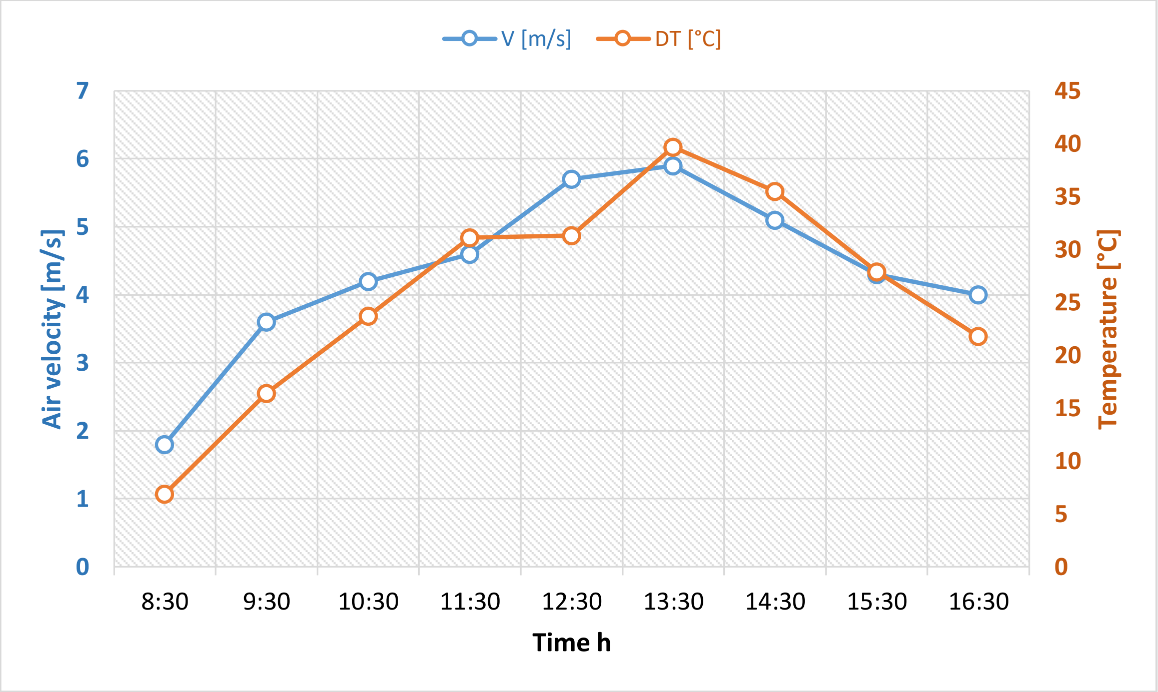


Figure IV-5: The difference between the center temperature of the collector and the ambient temperature with air velocity as a function of time.

- FigureIV-5 present the difference between the center temperature of the collector and the ambient temperature with air velocity as a function of time. Through the graph, we see that there is a direct correlation between them. The air velocity increases with increasing of DT.

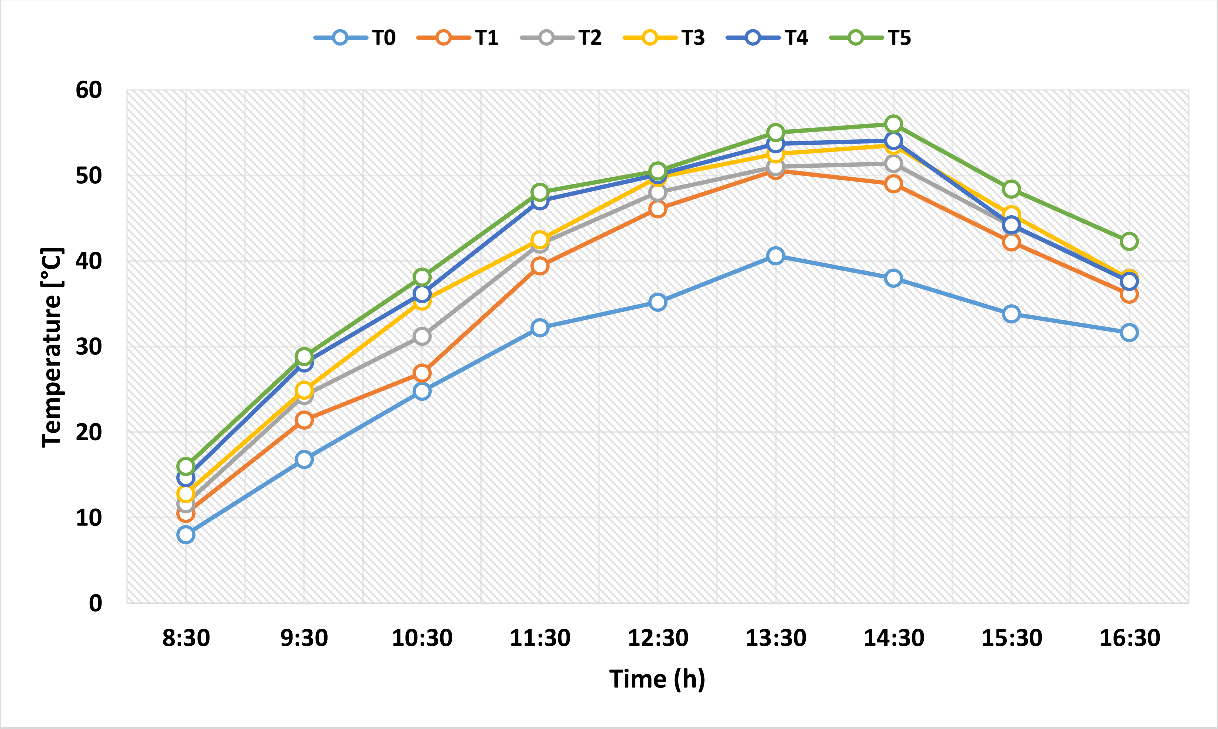


Figure IV-6 : Temperatures at different positions in the collector as a function of time.

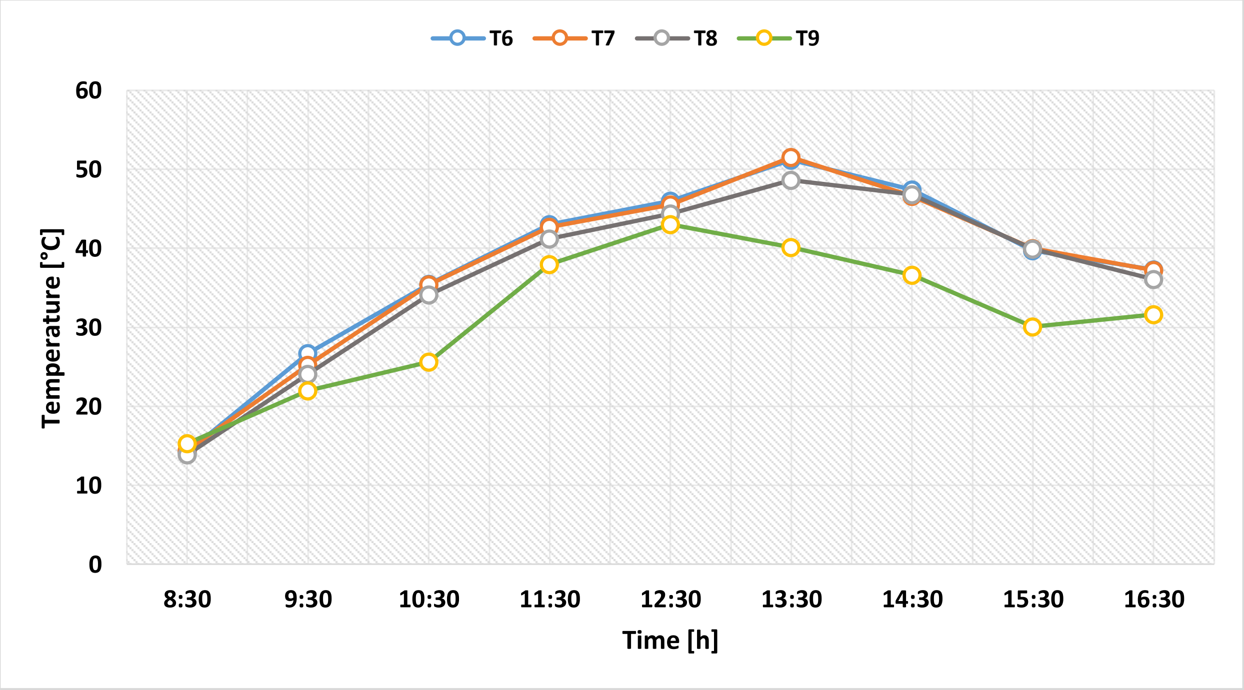


Figure IV-7 : Temperatures at different positions in the chimney as a function of time.

- Figures (IV-6, IV-7) show the air temperature graphs at different locations in the collector and the chimney as a function of time. The temperature rises in the collector from the inlet to the center, this is explained by the fact that the air in it heats up near the ground and the density of hot air is less than that of cold air. Thus, the hot air is drawn towards the center. Then it rises to the roof to cool, it gradually decreases in the other part of the chimney towards the exit.

IV.2.3 The effect of air guide:

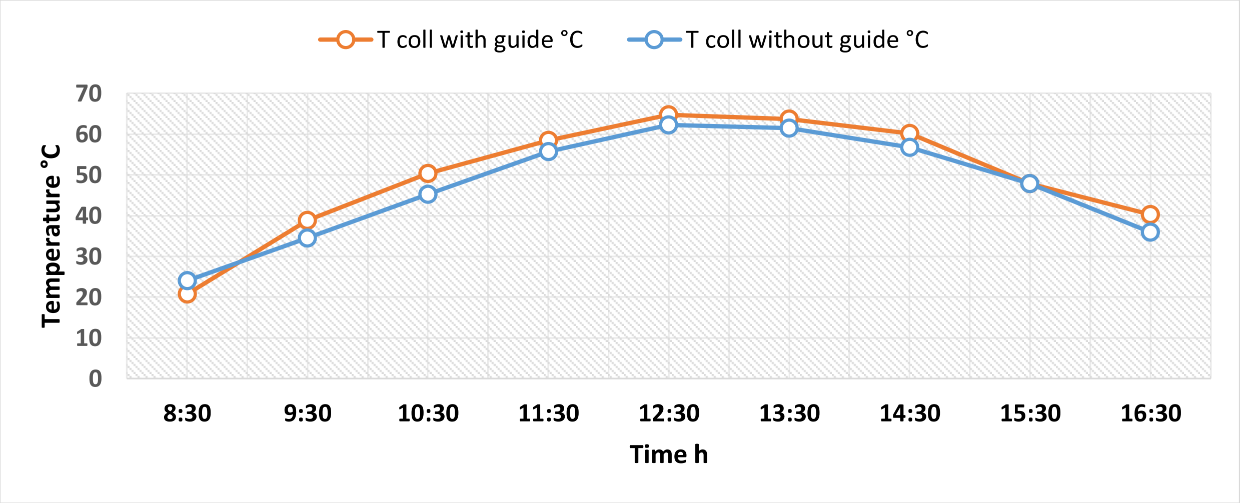


Figure IV-8: Variation of the center temperature of the collector with and without guide as a function of time.

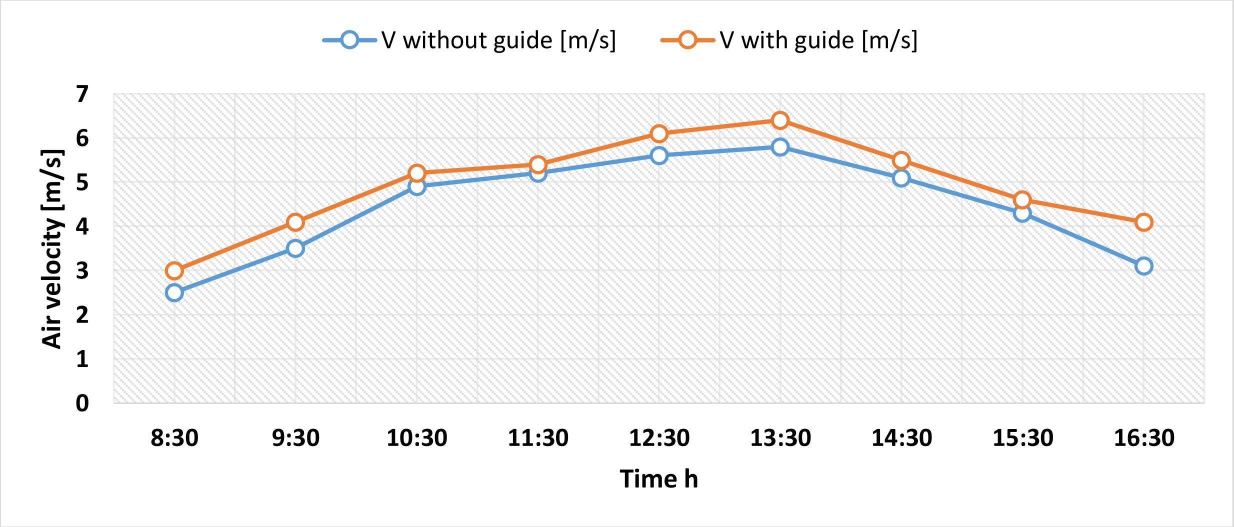


Figure IV-9 Variation of the air velocity with and without guide as a function of time.

- Figures (IV-8, IV-9) present the variation of the center temperature of the collector and the air velocity with and without guide as a function of time. As we can see, the temperature and the velocity increases with time. The temperature reach the maximum value at 12:30 p.m. with (Tmax with guide=64.7 °C, Tmax without guide=62.2 °C). The maximum value of air velocity was at 1:30 p.m. (Vmax with guide=6.4 m/s, Vmax without guide=5.8 m/s) We note that with guide, the maximum values are more than without it since the guide regulates the direction of hot air movement towards the center, and thus increases both temperature and air velocity.

IV.2.4 The effect of the guide length:

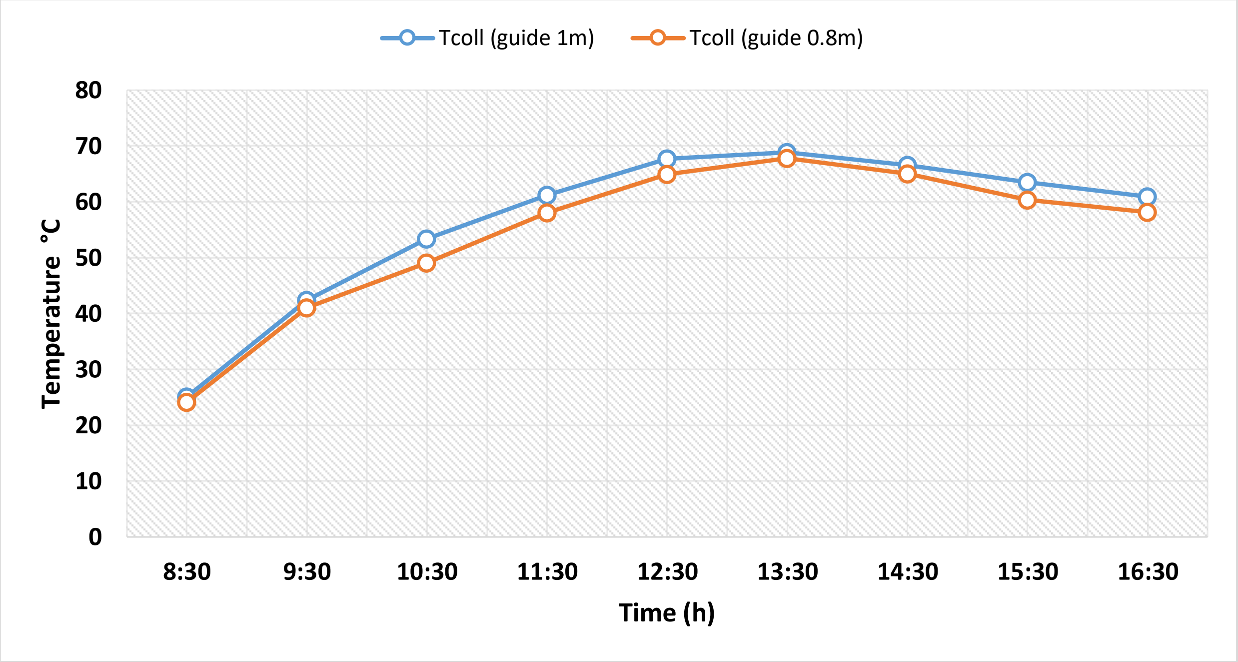


Figure IV-10: Variation of the center temperature of the collector with guides of 0.8m and 1m.

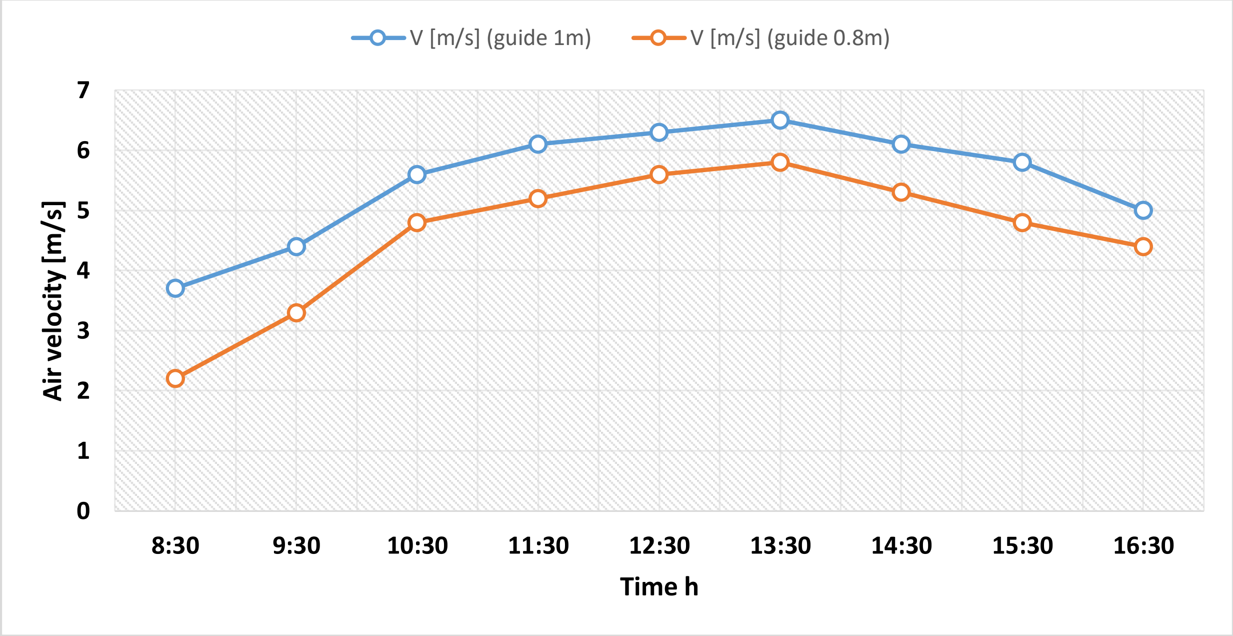


Figure IV-11: Variation of the air velocity with guides of 0.8 m and 1m.

- Figures (IV-10, IV-11) present the variation of the center temperature of the collector and the air velocity with guides of 1 and 0.8 m as a function of time. The optimal results was in this experience with 1m guide which was (Tmax=67.8 °C, Vmax=6.5 m/s).

IV.2.5 The effect of the guide angle:

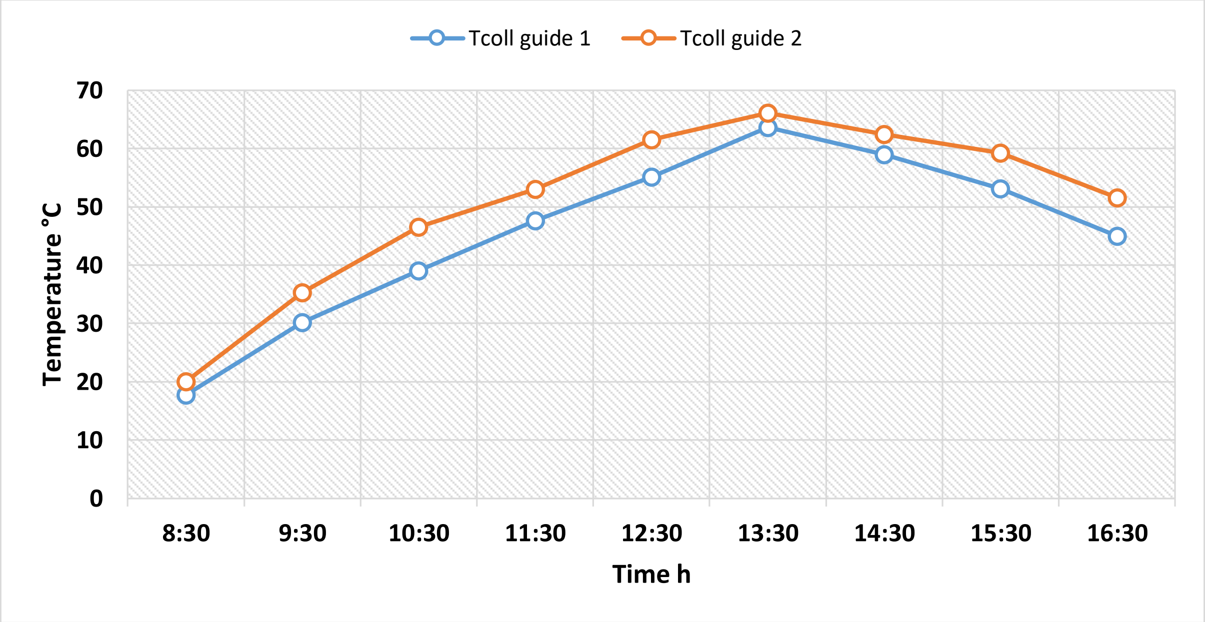


Figure IV-12: Variation of the center temperature of the collector with guide 1 and 2.

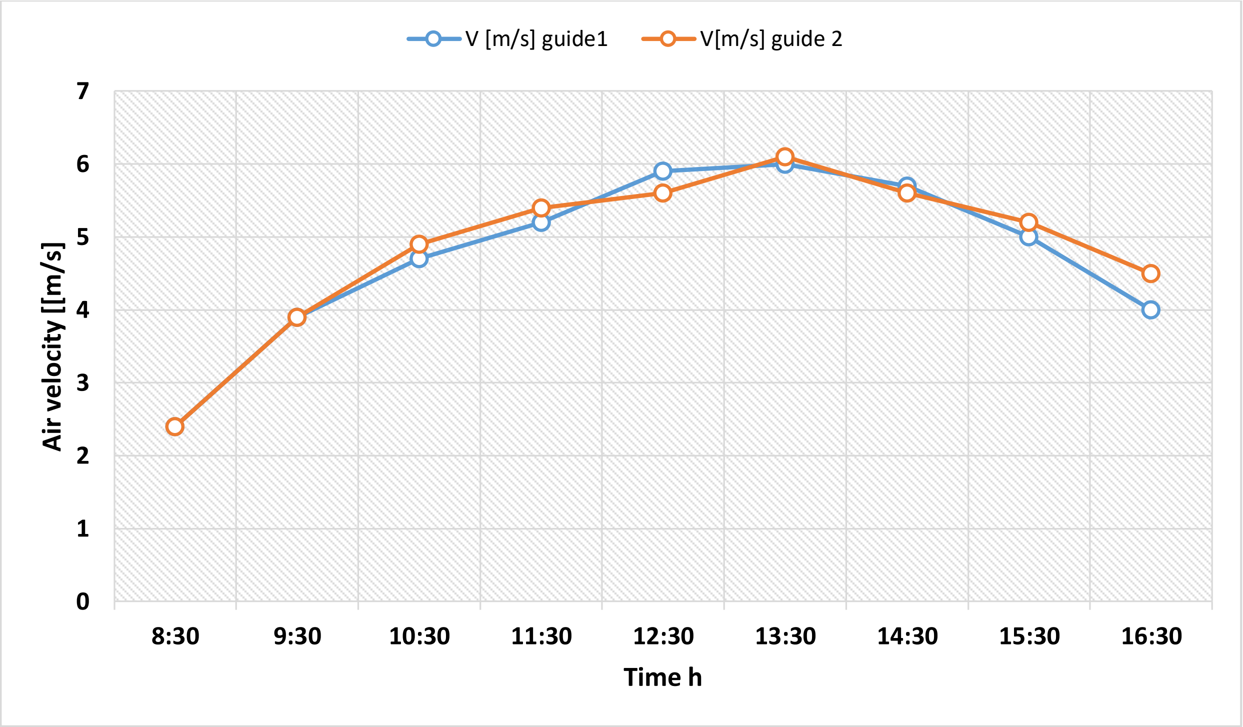


Figure IV-13: Variation of the air velocity with guide 1 and 2.

- Figures (IV-12, IV-13) present the variation of the center temperature of the collector and the air velocity with guide 1 and 2 as a function of time. Compared with the results of the first guide. The second guide gave better results, which are (Tmax=66.1 °C, Vmax= 6.1 m/s)

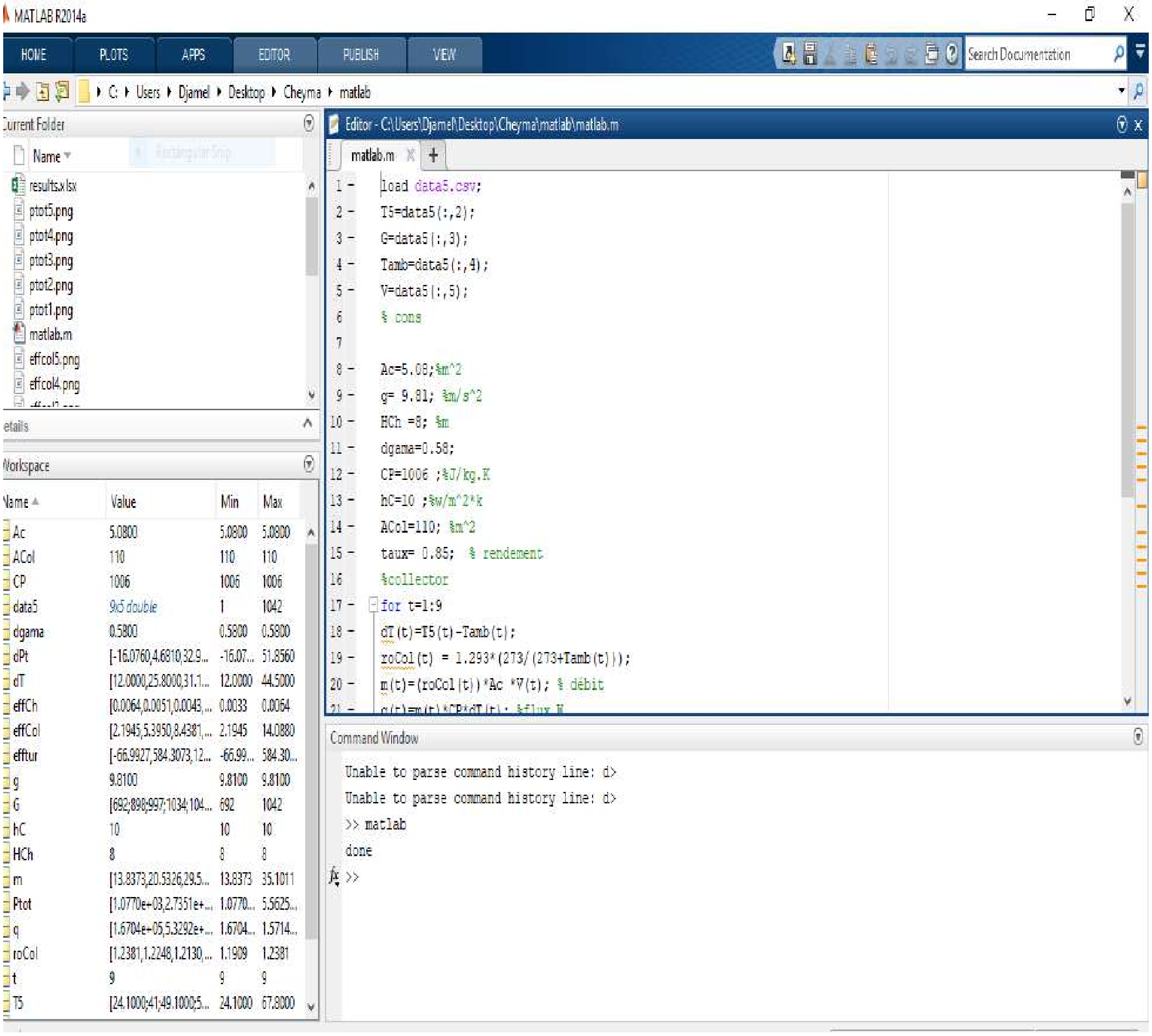
Based on the previous graphs, we concluded that the best performance of the solar chimney power plant is by using the guide that has a length of 1 m and an angle 51°.

In the last part of our work, we will calculate the efficiency of each of the chimney and the collector, as well as the total power in the presence of the chosen guide.

IV.3 Efficiency calculation:

IV.3.1 Matlab program :

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language and problem-solving environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages compared to conventional computer languages (C, FORTRAN) for solving technical problems.



```
load data5.csv;
T5=data5(:,2);
G=data5(:,3);
Tamb=data5(:,4);
V=data5(:,5);
% cons

Ac=5.08;%m^2
g= 9.81; %m/s^2
HCh =8; %m
dgama=0.58;
CP=1006 ;%J/kg.K
hC=10 ;%w/m^2*k
ACol=110; %m^2
taux= 0.85;  % rendement
%collector
for t=1:9
dT(t)=T5(t)-Tamb(t);
roCol(t) = 1.293*(273/(273+Tamb(t)));
m(t)=(roCol(t))*Ac *V(t); % débit
```

Name	Value	Min	Max
Ac	5.0800	5.0800	5.0800
ACol	110	110	110
CP	1006	1006	1006
data5	9x5 double	1	1042
dgama	0.5800	0.5800	0.5800
dPt	[-16.0760,4.6810,32.9...	-16.07...	51.8560
dT	[12.0000,25.8000,31.1...	12.0000	44.5000
effCh	[0.0064,0.0051,0.0043,...	0.0033	0.0064
effCol	[2.1945,5.3950,8.4381,...	2.1945	14.0880
efftur	[-66.9927,584.3073,12...	-66.99...	584.30...
g	9.8100	9.8100	9.8100
G	[692;898;997;1034;104...	692	1042
hC	10	10	10
HCh	8	8	8
m	[13.8373,20.5326,29.5...	13.8373	35.1011
Ptot	[1.0770e+03,2.7351e+...	1.0770...	5.5625...
q	[1.6704e+05,5.3292e+...	1.6704...	1.5714...
roCol	[1.2381,1.2248,1.2130,...	1.1909	1.2381
t	9	9	9
T5	[24.1000;41;49.1000;5...	24.1000	67.8000

```
Unable to parse command history line: d>
Unable to parse command history line: d>
>> matlab
done
>>
```

Figure IV-14: Page of Matlab program.

IV.3.2 Graphs:

a) Efficiency:

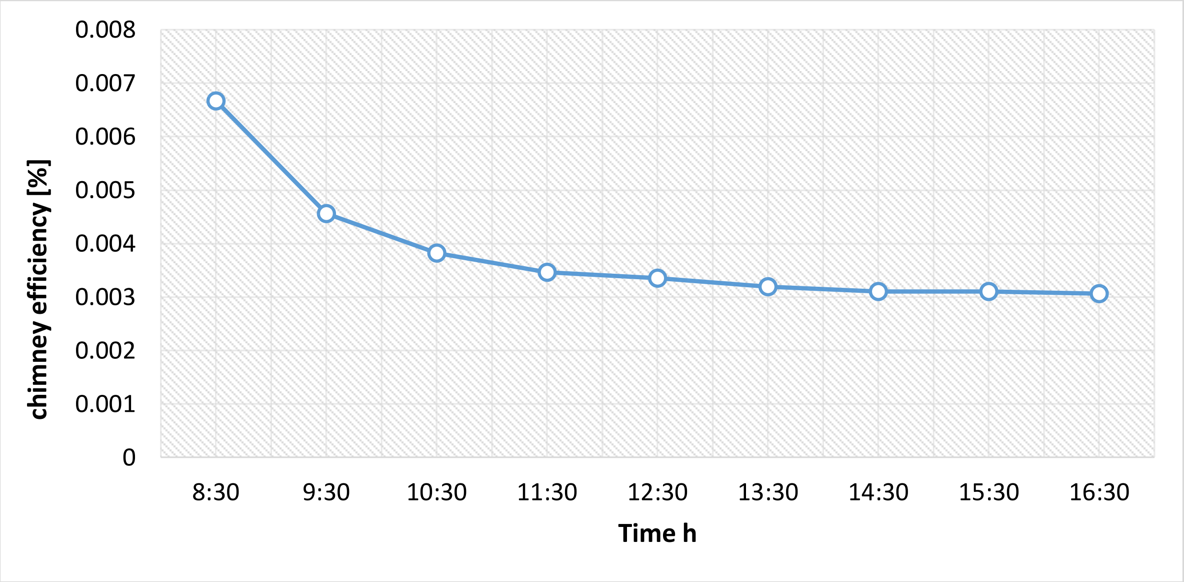


Figure IV-15: Variation of chimney efficiency as a function of time.

- FigureIV-15 present the variation of chimney efficiency as a function of time. We get the maximum value at 8:30 a.m. which was $\boldsymbol{\eta_{chimney}}$=0.0066. As the ambient temperature is lower, so the rapport of (DT/ Tamb) increases (see eq. IV-6). Then it decreases with increasing of ambient temperature.

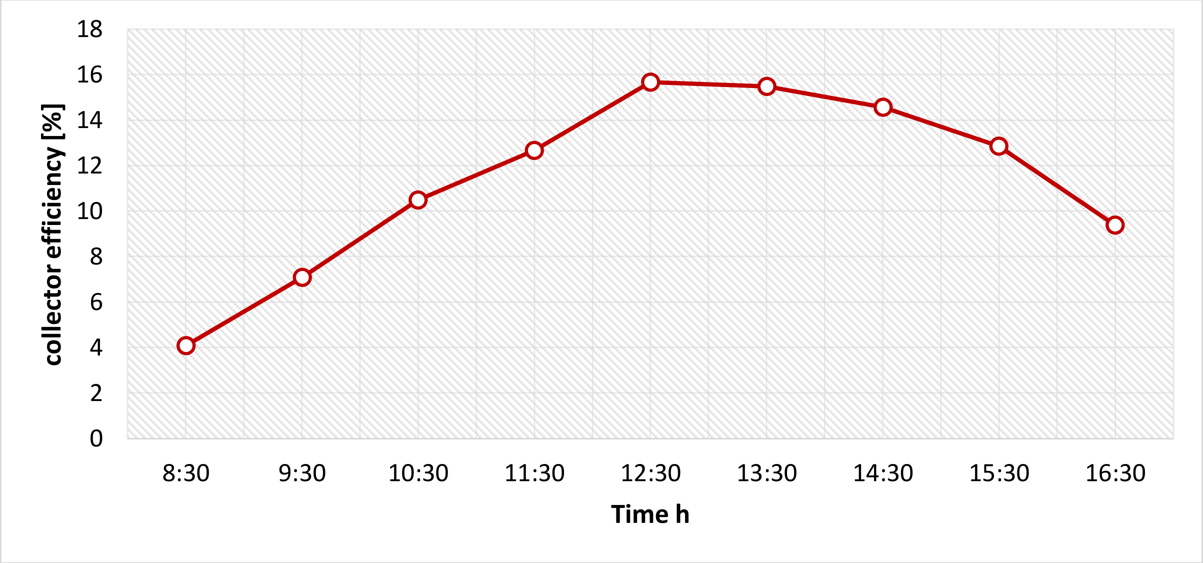


Figure IV-16: Variation of collector efficiency as a function of time.

- FigureIV-16 present the variation of collector efficiency as a function of time. Its value increases with time to reach the maximum value at 12:30p.m. Which was $\boldsymbol{\eta_{collector}}$=15.66. Because the solar radiation and the difference between the temperature of the collector center and the temperature ambient were at their maximum value.

b) Electric total power:

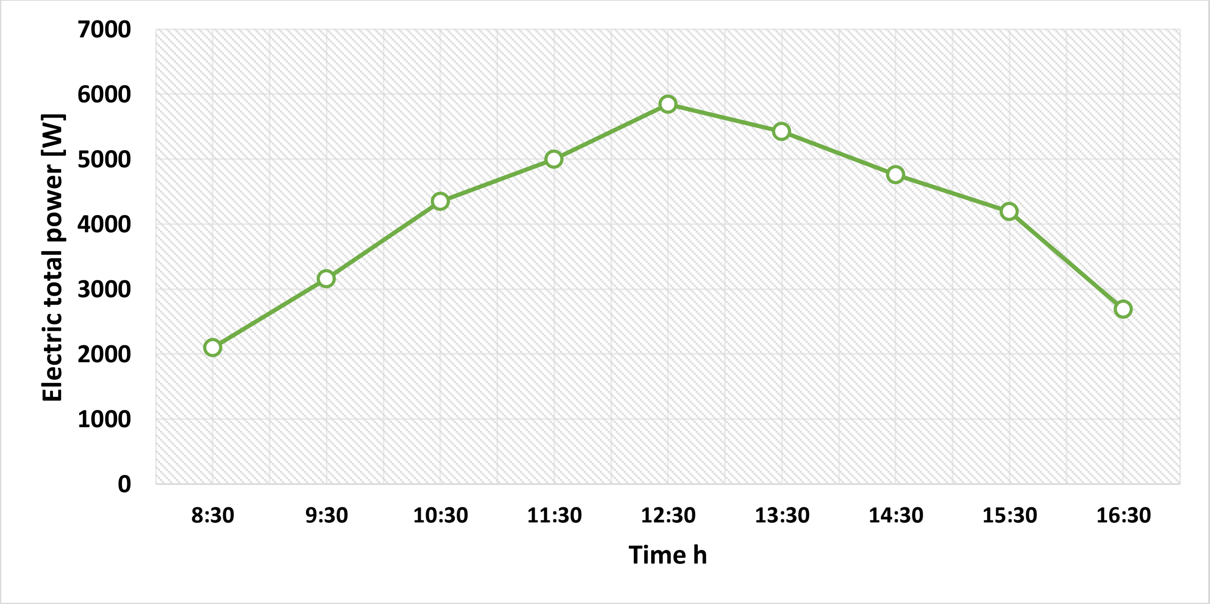


Figure IV-17: Variation of electric total power as a function of time.

- FigureIV-17 present the variation of electric total power as a function of time. The electric total power increase with time, its maximum value was at 12:30 $\boldsymbol{P_{tot}}$=5843.16 W. From (eq. IV-7) we conclude that: when the temperature difference increases, the total power value is higher.

GENERAL CONCLUSION

General Conclusion:

Algerian desert serves as a large reservoir for sustainable solar energy, but this important natural resource has been kept away from national interest for many years after the country's independence. As it seemed to those in charge of economic affairs that oil and conventional energy were able to meet the country's needs for many years, without the need for natural resources such as solar energy. The danger became clear after the collapse of oil prices in international markets, and traditional electricity generation operations became costly.

The solar chimney is a very simple system that does not require great technology for construction, all these constituent elements are very simple and do not cost very much. Solar chimneys are modern means of producing electrical energy without causing a polluting impact on the environment and without the process being linked to fossil or temporary energy. Several studies have been made to develop the operation of solar chimneys.

The main objective of our work at Ouargla University is to study the impact of guide on the performance of the solar chimney to achieve the highest efficiency and produce the highest velocity to rotate the turbines. We also talked about models designed for solar chimneys in Spain, China, Australia and Iran…etc.

The use of air guide is necessary for large velocity output. Therefore, an enhancement of guide shape when saving the scale leads to an increase in the global performance of the system. The aim of this work is to highlight the influence of the guide geometry on the local characteristics and the performance of the solar chimney power plant. Two configurations of air guide are analyzed. By comparing the different systems, findings show that the divergence shape of this latter is very influential on the performance of the SCPP system.

After many experiments we carried out after using the guide and changing its angle and length with recording the temperature and air velocity inside the collector, we reached the optimal design for the guide, which has dimensions as follows:

High diameter: 0.1 m.		Low diameter: 0.8 m.

Length: 1 m.		Angle: 51°.

GENERAL CONCLUSION

Through this study, the following was concluded:

- ✓ Many factors affect the temperature inside the solar chimney, including the change in the external temperature and solar radiation.
- ✓ The greater the difference between the air temperature inside the solar chimney and outside the solar chimney, the larger the air will be, and the inferred current produced will be greater for sure.
- ✓ The results obtained in this experiment tell us that the solar chimney as an investment project is a valid and successful project in our region, and we must be aware of this and move towards it.

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Abstract: A solar chimney power plant (SCPP) converts solar thermal energy into electricity by generating a buoyant flow in a chimney. To assist the airflow in shifting its direction from horizontal to vertical, a guide wall (GW) is usually set in the collector-to-chimney transition region. The primary objective of this study is to examine the impact of the GW geometry on the power output of a SCPP. In this work. The pilot was constructed based on locally available materials. Velocity, and temperature were measured at various locations inside the pilot, also the effect of the parameters (ambient temperature, wind speed, solar radiation …etc.).Performance parameters of SCPP plant were estimated. The experiments were carried out for days. The maximum air velocity was with guide 2 (1m, 51°) 6.5 m/s. and the maximum temperature in the collector center was 67.8 °C. Chimney and collector efficiencies were estimated and these were 0.0066 and 15.66, respectively. The maximum total power output was 5843.16 W.

Keywords: Solar chimney power plant, Thermal energy, Electricity, Guide wall, Power output.

الملخص: تقوم محطة توليد الطاقة من المدخنة الشمسية بتحويل الطاقة الحرارية الشمسية الى كهرباء عن طريق توليد تدفق طافي في المدخنة. لمساعدة تدفق الهواء في تغيير اتجاهه من الافقي الى العمودي، يتم عادة استعمال الدليل في منطقة الانتقال من المجمع الى المدخنة. الهدف الاساسي من هذه الدراسة هو فحص تأثير هندسة الدليل على الطاقة الناتجة من المدخنة الشمسية.

في هذا العمل تم انشاء هذا النموذج بناءا على المواد المتاحة محليا، تم قياس السرعة ودرجة الحرارة في مواقع مختلفة داخل النموذج كما تمت دراسة تأثير كل من الاشعاع الشمسي والحرارة المحيطة وسرعة الرياح...الخ. اجريت التجارب لعدة ايام، كانت سرعة الهواء القصوى مع الدليل الثاني الذي طوله (1 متر) وزاويته (51°) 6.5 متر/ثانية وكانت درجة الحرارة القصوى في مركز المجمع 67.8 درجة مئوية. تم تقدير كفاءة كل من المدخنة والمجمع 0.0066 و15.66 على التوالي، وكان الحد الاقصى للطاقة الناتجة هو 5843.16 واط.

الكلمات المفتاحية: المدخنة الشمسية، الطاقة الحرارية، كهرباء، دليل الهواء، الطاقة الناتجة.

Résumé: La cheminée solaire (SCPP) convertit l'énergie solaire thermique en électricité en générant un flux flottant dans une cheminée. Pour aider le flux d'air à changer de direction de l'horizontale à la verticale, le guide d’air(GW) est généralement installé dans la région de transition du collecteur à la cheminée. L'objectif principal de cette étude est d'examiner l'impact de la géométrie GW sur la puissance de sortie d'une SCPP. Dans ce travail. Le pilote a été construit à partir de matériaux disponibles localement. La vitesse et la température ont été mesurées à divers endroits à l'intérieur du pilote, ainsi que l'effet des paramètres (température ambiante, vitesse du vent, rayonnement solaire, etc.). Les paramètres de performance de la centrale SCPP ont été estimés. Les expériences ont été menées pendant des jours. La vitesse maximale de l'air était avec le guide 2 (1 m, 51°) de 6,5 m/s. et la température maximale au centre du collecteur était de 67,8 °C. Les efficacités de la cheminée et du collecteur ont été estimées et celles-ci étaient de 0,0066 et 15,66, respectivement. La puissance totale maximale de sortie était de 5843, 16 W.

Les mots-clés: La cheminée solaire, Énergie thermique, Électricité, Guide d’air, Puissance de sortie.