American Journal of Botany and Bioengineering
https://biojournals.us/index.php/AJBP
ISSN: 2997-9331

Effect of Annealing Temperature on the Film CIGS Solar College and the Preparation by Evaporation Precipitation Method Thermal

Ali Lafta Khalaf Yassin
Department of Physics, College of Science, University of Kufa

Ali Hashim Hadi Jweid
Department of Physics, College of Science, University of Karbala

Aseel Haitham Kahdam
Department of Physics, College of Science for Women, University of Baghdad

Noor Hadi Kareem
Department of Physics, College of Science, University of Baghdad

Ali Khaled Abdullah
Department of Physics, College of Science, University of Karbala

Received: 2024 19, Sep
Accepted: 2024 28, Sep
Published: 2024 04, Oct

Annotation: This work aims to use renewable energy as clean energy and environmental health and to stay away from pollutants. Recently, and since the industrial revolution, the climate has been increasingly affected by human activities. Fossil fuels are one of the reasons that lead to global warming. The need to search for alternative sources of energy has emerged. Solar energy is one of the alternatives to obtain clean energy. When photovoltaic panels are installed at a specific tilt angle so that they are exposed to the greatest possible amount of solar radiation throughout their operating period. Scientists have found that the

productivity of photovoltaic panels can be increased by making them maintain a vertical angle with the radiation falling on them to a greater extent, and this is achieved through the solar tracker (solar tracking devices) where a smart system was created to track solar radiation that works with two axes, one in the vertical direction and the other OpenAccess

American Journal of Botany and BioengineeringVolume:1|Number:10(2024)Oct2in the horizontal direction, and it was comparedto a fixed system and in different conditions and we obtained the best results with tracking where the use of the solar tracker can lead to an increase in energy production from the solar cell panel by about 30% to 60% compared to the fixed solar panel system and because the climate of Iraq is sunny most days of the year, especially in the summer, where the conditions are suitable for building solar energy systems and relying on them to meet its energy needs

Introduction: "Energy" is the main factor for the development of any country, where a huge amount of non-renewable energy such as oil is extracted, as about 85% of energy production depends on fossil fuels, and since fossil fuel resources are limited and pose a threat to humans through gas emissions, so if we want to provide sustainable energy production, we must use energy from renewable sources such as solar energy. Renewable energy sources are considered the best environmentally friendly energy sources, and solar energy is a renewable, clean, economical and less polluting resource compared to other resources and energy, and the solar panel unit is one of the effective sources through which solar energy is converted into electricity] 1] Various semiconductor materials are used in the manufacture of solar panels, as Si is used to make a solar panel, with an efficiency of approximately 24.5% [2 [. The solar cell is used with a solar tracker to get better performance [3.] Using a solar tracker can increase the energy production of a solar cell panel by about 30% to 60% compared to a fixed solar panel system [4.] 1.2 Solar Cells Photovoltaic systems (or solar energy systems) serve as alternatives to all systems from the energy supply of homes to complex and powerful ones such as in simple electricity in the hands thanks to the phenomenon called the effect of space stations, all of which are available in direct solar energy, but the conversion to electrical current in photovoltaic in certain types of semiconductors, requires complete knowledge of the process according to different terical concepts, such as solar radiation and photons, and the conversion by Solar radiation, semiconductor structure, electrical energy and chemical energy[5]. In terms of the effect of photoelectricity in semiconductor materials, the range of excitation energies in semiconductors is separated by an energy gap. The gap below the valence band is usually occupied by electrons from semiconductor atoms, and the gap above the conduction band is almost empty, as shown in Fig. 8.) When an electron is very excited with an amount of energy similar to the band gap, it jumps to the conduction band, creating a pair of electron holes. In semiconductors, it moves again by recombination, and loses energy. The excited electron begins to add other elements to the semiconductor material, creating an external semiconductor.

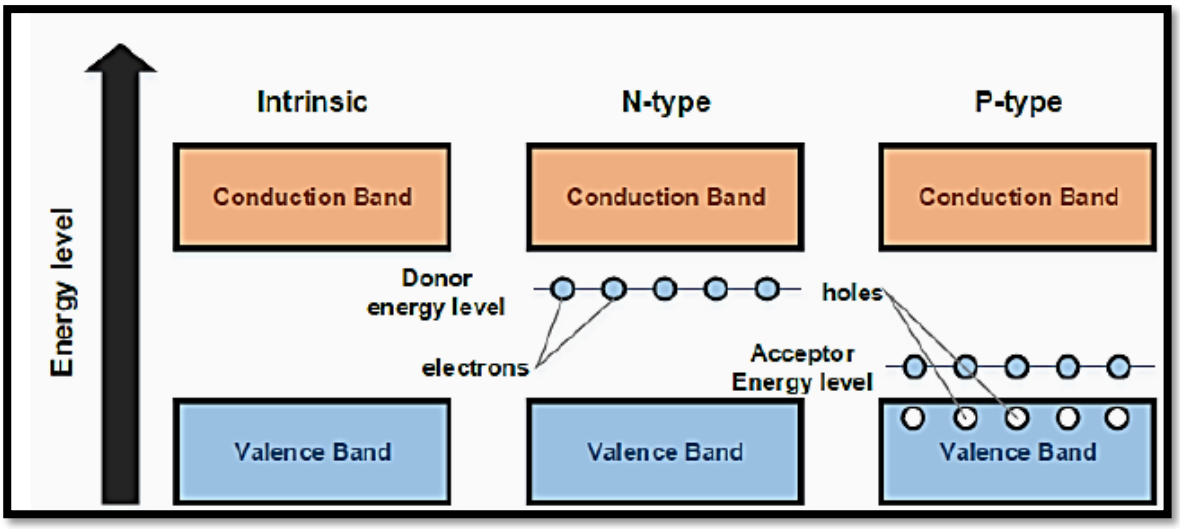

Figure 1 : Excitation energy levels in Semiconductors

Figure 1 also shows that N-type semiconductors have an additional amount of loose electrons from the junction, and the absence of P-type semiconductors in their covalent bonds. This makes the electron the charge carrier for some electrons in the N-type and the holes the main charge carrier in the P-type. When two semiconductors are connected, we have a PN junction. In a PN junction, several electrons are transferred from the N side to the P-side and vice versa for the P-side holes, creating a depletion region between them. This phenomenon is visually illustrated in Figure 14 below [5]; [7] in Figure 2. The depletion region contains On a negatively charged part of the P-type and a positively charged part of the N-type semiconductor this generates an electric field that prevents further diffusion of electrons and holes, and this reaches equilibrium. When exposed For sunlight, hole pairs are created in the depletion region, The electron in sweeps the electrons and holes to the N side and the P side. Connecting the circuit allows the electrons (from the N side) to move and recombine with the holes in the P side, as shown in Figure 3(where the process produces an electric current that drives the load] [8]; [5].

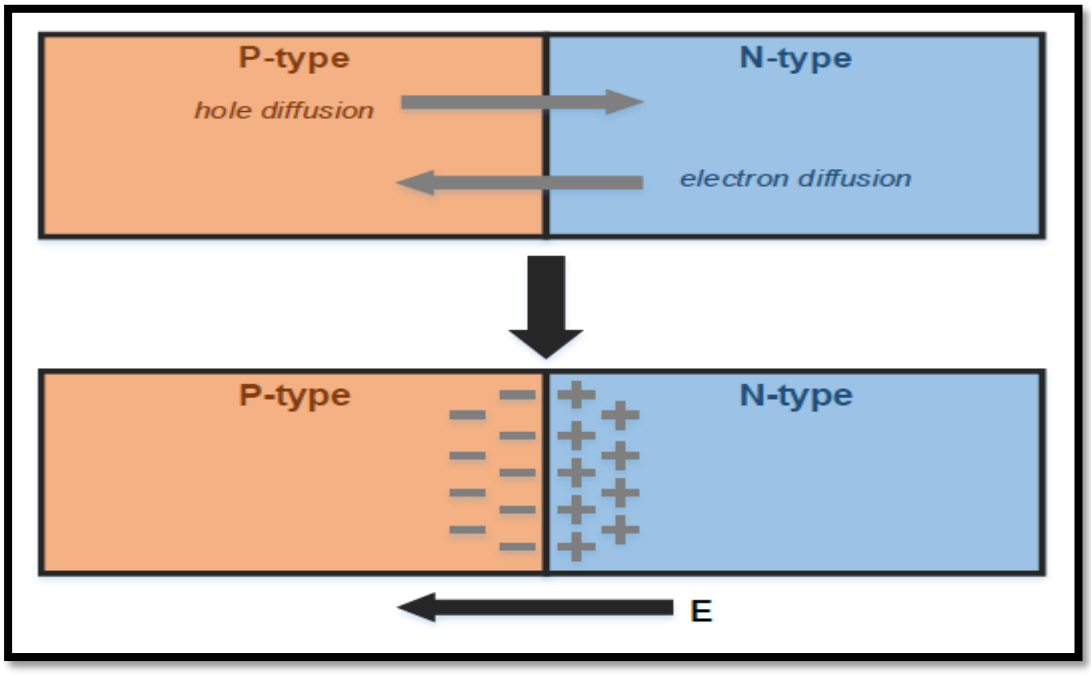

Figure 2: The depletion region and the electric field E at the intersection of the electrons and holes in the P.

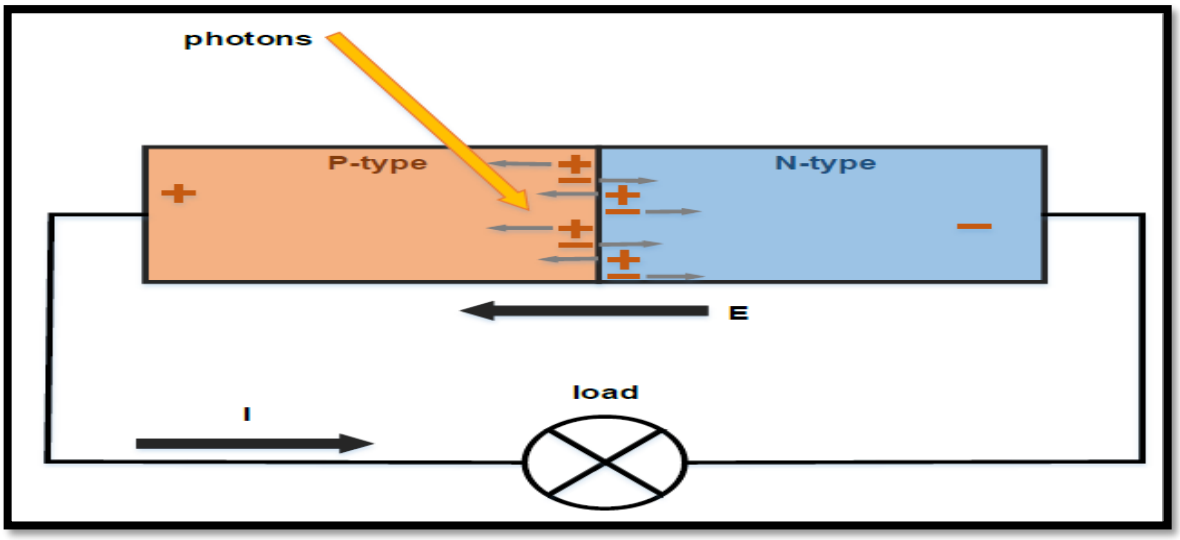

Figure 3: The occurrence of the first electric current when connecting an external circuit to a conductor.

In figure 3 Photoelectric effect Y . The photoelectric effect (The effect shown is called the photoelectric effect) It is the basis of photovoltaic technology. It is the basis of photovoltaic technology that harnesses solar energy using semiconductor materials. Types of solar cells The most common type of solar cells is silicon (Si) 23. Due to the properties of solar cells and their availability. Silicon material is chemically purified into crystalline silicon form c-Si from silica sand, either polycrystalline or monocrystalline. The production of c-Si solar cells depends mainly on the behavior of silicon junction. PN technology is the most widely used crystalline silicon cell due to its moderate cheapness. The types of solar cells can be limited to their different generations, as follows:

1. Non-crystalline silicon solar cells.
2. Bio-based solar cell.
3. Buried contact solar cells.
4. Cadmium telluride (CdTe) solar cell.
5. Cadmium toxicity.
6. Concentrated photovoltaic cells.
7. Copper indium gallium selenide solar cells.
8. Dye sensitized solar cells.
9. Germanium gallium arsenide solar cells.
10. Hybrid solar cell.
11. Solar concentrator cell.
12. Micromorph cells Tandem cell.
13. Monocrystalline solar cell
14. Multifunctional solar cell
15. Nanocrystalline solar cells
16. Perovskite solar cell
17. Photoelectrochemical cell
18. Polymer solar cell
19. Polycrystalline solar cell
20. Quantum dot solar cell
21. Thin film solar cell

1.4 Solar cell converters **:**The incident solar radiation can be thought of as discrete "energy units" called photons. In Figure) Light is a part of the electromagnetic spectrum with R 4(showing the approximate limits of the bands and wavelengths. The wavelength λ, λ they travel All are ugly Light C has a frequency, υ, and the refractive index is oC in a vacuum.

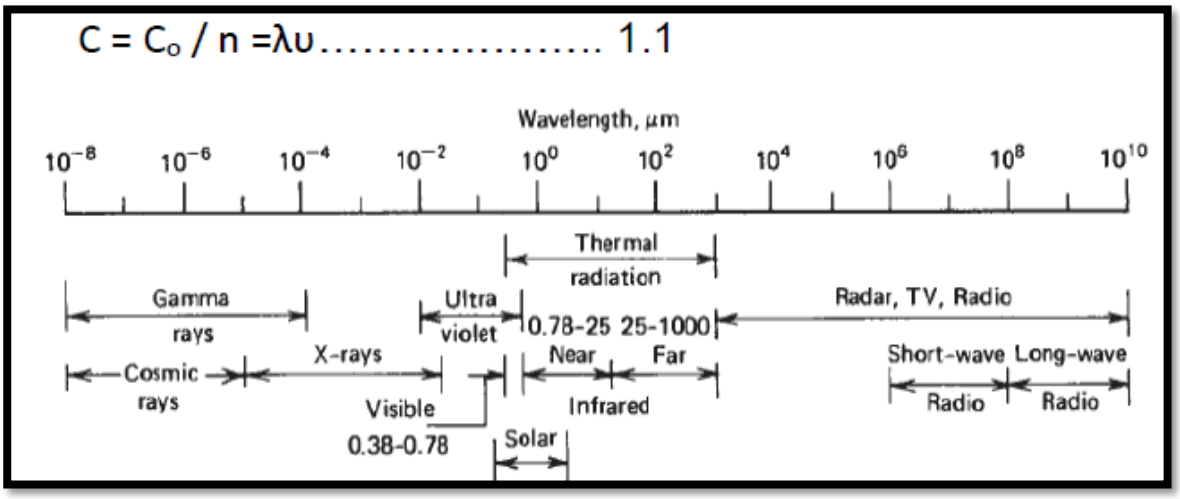

Figure 4: The spectrum of electromagnetic radiation The energy of a photon or particle, which can be considered as a "unit of energy" with zero mass and zero charges, is given by: E=h.v…… 1.2

Where h is Planck's constant.) J s 34 - 10 × 6.6256 (It follows that with increasing frequency, v, and decreasing wavelength, λ, the photon energy increases. More energetic photons have higher frequencies and shorter wavelengths. More energetic solar cells are formed. From single crystal silicon. A photon is absorbed by the crystal lattice of the silicon atom in the incident solar radiation, and if the energy is high enough, it releases an electron from the outer shell of the atom. This process results in the formation of a hole-electron pair, where there is a deficiency in the hole-structure crystal. The electrons disappear outside the crystal in a natural way when electrons combine with holes. The process of re-composition can be reduced by building a potential barrier in the cells, junctions or thin layers where there is a fixed charge[8].

Fixed Solar System

Solar panels are devices made of semiconductor materials that convert sunlight falling directly on them into electrical energy. Fixed solar systems are installed in the direction of the sun. Solar panels must be placed in such a way that they form an angle of inclination with the photovoltaic plane to extract maximum energy from the panels so that they can be illuminated at very steep angles by solar lights. [11] ;[12]

1.6 Solar Energy Tracking

The incoming sunlight from the sun is collected by solar panels and they actively work to convert that energy into electricity. Solar panels are made of several individual solar cells. These solar cells act as large semiconductors and use a large area PN junction diode. When solar cells are exposed to incident sunlight, they convert the energy of sunlight by PN junction diodes into usable electrical energy. The photons generated by the solar panel surface eject the electrons that are cut off from their orbits and free them, and the fields, and cause an electrical current, and here the direction of the solar cells pulls the free electrons in the metal contacts can generate electricity. The more photovoltaic cells there are in the electrical output of the solar panels and the better the quality of the solar cells, the greater the total power that the solar panels can produce. A solar tracker is a device that directs the load toward the sun. In some areas, using solar trackers can

increase electricity production by up to a third, and up to 40 percent, compared to fixed-angle modules. The conversion efficiency of any solar application is reduced when the modules are constantly adjusted to the optimum angle while improving yields, because the improved efficiency is the use of solar trackers. Given the large factory income, the tracking tool can make a big difference [8] [13]

1.7 Classification of Solar Tracking System It is classified into, the most prominent of which are those that t There are many classifications of solar tracking system in the form of) , or according to the passive or active system, in single and dual axis 5 (the most prominent classifications of the solar energy system Tracking System [14].

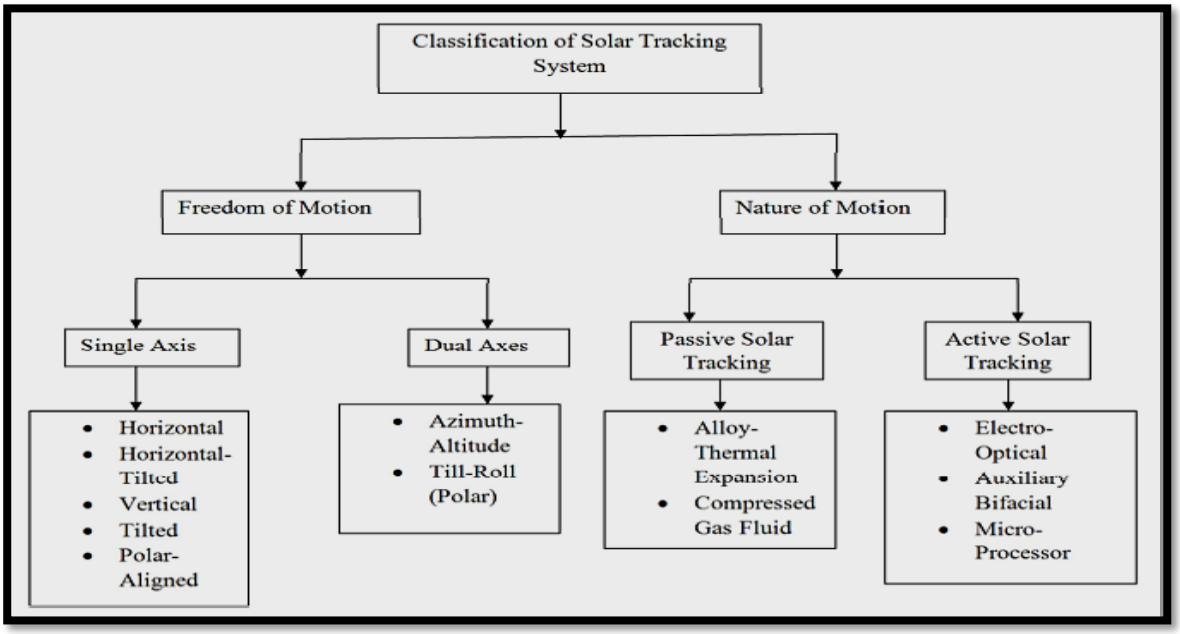

Figure (5) Solar tracking system classifications

The main types of solar tracking systems are single-axis and dual-axis. The two systems, in addition to the fixed system, represent the forms of solar systems. In the figure5) Electricity is generated directly from solar energy as in, The RT 6(The above-mentioned systems differ in terms of mechanics and efficiency, as each of them has its own structure and thus to the efficiency of generation. They also differ in terms of manufacturing cost and complexity of installation. Solar Tracker , The main types of solar tracking systems are single-axis and dual-axis. The two systems, in addition to the fixed system, represent the forms of solar systems Electricity is generated directly from solar energy as in, The RT 6(The above-mentioned systems differ in terms of mechanics and efficiency, as each of them has its own structure and thus to the efficiency of generation. They also differ in terms of manufacturing cost and complexity of installation, each of them has many types [15] ;[16] ;[17].

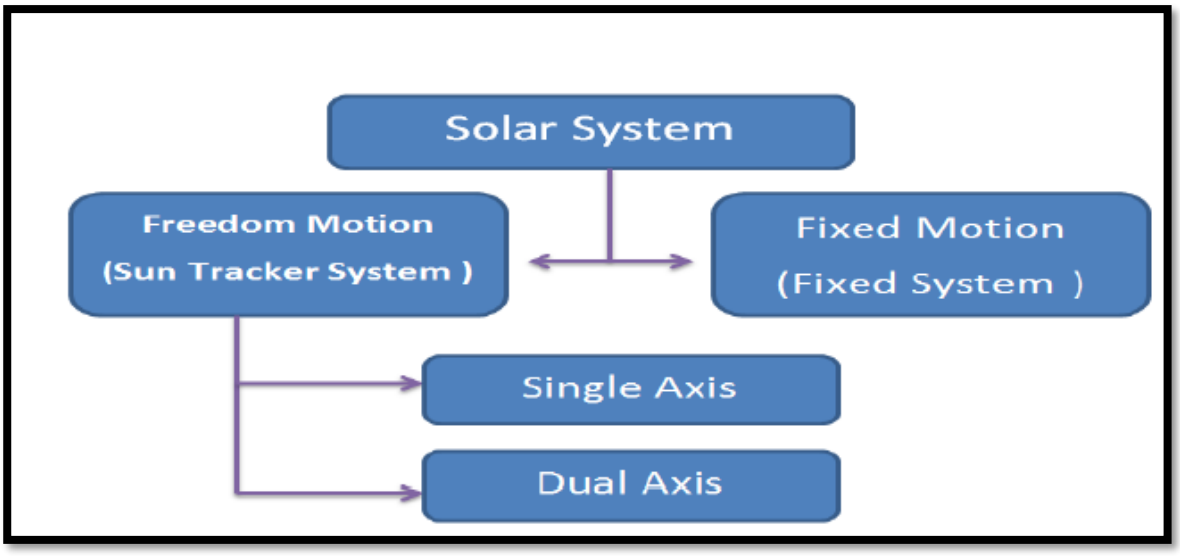

Figure 6 : Solar System

1. Sensor: LDR (Light-Dependent Resistor), LDR (Figure 7) is a sensor that reduces its resistance when light hits it. This type of sensor is widely used in space light sensing circuits in open-loop analyzers, for example to regulate street lights, in light tracking systems, in spectrum [18] [19]

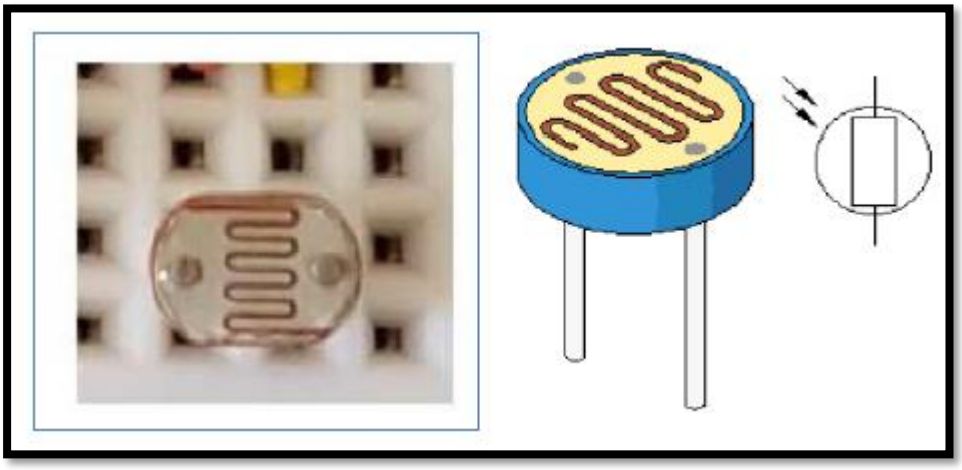

Figure: 7 sensor

2. Arduino Arduino is an open-source microcontroller that can be programmed, erased, and reprogrammed at any time. The Arduino card was designed, easily in introduced in 2005 to provide hobbyists, students, and professionals with an inexpensive and easy way to create devices that interact with their environment using sensors and actuators. Easy to use on simple microcontroller boards, it is an open-source computing platform used to build and program electronic devices. Like other microcontrollers, it is also capable of acting as a miniature computer by taking inputs and outputs to a variety of electronic devices and controlling [21];[22] [20]

Figure 8: Arduino ON board

Previous studies**:** In 2018, Ian F. Ibrahim Adabara, Abdulrahman Shaibu Hassan and Lum Y. T. developed a sun tracking system, and used a stepper motor for the biaxial movements of the panel to track the maximum sunlight energy points. One motor tilts the panel on the vertical axis at an angle of 45 degrees, and the second motor rotates the panel at a point on the horizontal axis by 360 degrees. A microcontroller chip is used to control the device and an LED light sensor in a dual-axis design 23.] Amadi HN in 2018 designed, implemented and evaluated the efficiency of a dual-axis solar tracker, using a dual-axis LDR sensor, DC gear motors, and a microcontroller (PIC16F877A) to ensure continuous electricity supply for rural use. It was realized that the proposed system is more cost-effective and produces 31.4% more energy than a single-axis tracking system, and 67.9% more energy than a fixed-mounted PV system [24.]

● Timothy Laseinde and Dominic Ramere in 2019 designed and developed a maximum power point tracking algorithm, using a multi-axis feedback tracking system with a servo motor that increased the output of the solar array by 23.95%. A microcontroller (ATMEGAR328) is used with photoresistor sensors [24] In 2019, Jamilo Ya Mohammed et al. reviewed the voltage systems, where they compared solar tracking systems, worked with single-axis and dual-axis systems, and compared them with the fixed system. They concluded through their research that the axis tracker is better than the fixed system and that the dual-axis tracker is better than the single-axis tracker. In LDR, stepper motor, microcontroller, and gearbox [25.] In 2019, Hassan Muslim, MATLAB-based algorithm for solar tilt angle estimation (SIA) was proposed to increase power generation in different case studies: Najaf, California, and New Delhi PV. In. The optimal tilt angles were proposed for each month and year. The irradiance calculation for the optimal tilt angles was determined. For Najaf city, the annual solar radiation gain from the solar panels is about 18% and high gains for the winter months with very small gains for the summer months [26.]

2.1 Introduction

This test was conducted in November because in this month the weather changes to have one sunny day, one partly cloudy day and one cloudy day. By applying the operating circuit in the figure (which includes the Arduino microcontroller,) 2 with four light sensors (, LDR there are also four electrical resistors and two servo motors, to be a dual-axis solar tracking, the real device in Figure (10) This device is equipped with a fixed solar photovoltaic system placed on top of the building, where the solar photovoltaic is installed at an angle of (30 degrees) with the ground, towards the south, to compare with the sun tracking system. The device takes the position towards the east and

tilts down. When the solar radiation reaches the sensors ( ) LDR it will alert the Arduino to move the motors to focus the sun on the photovoltaic energy. In this regard, the Arduino will continuously compare the LDR readings to drive the motors to focus the solar energy continuously on the photovoltaic cells. After the light rays disappear at sunset, the device will stop and the reason is that the LDR will give zero for each comparison, the next day when it returns When the sun rises, the LDR will sense the light rays and alert the Arduino to compare the LDR readings to drive the motor to move the light voltage to the east and tilt down again.

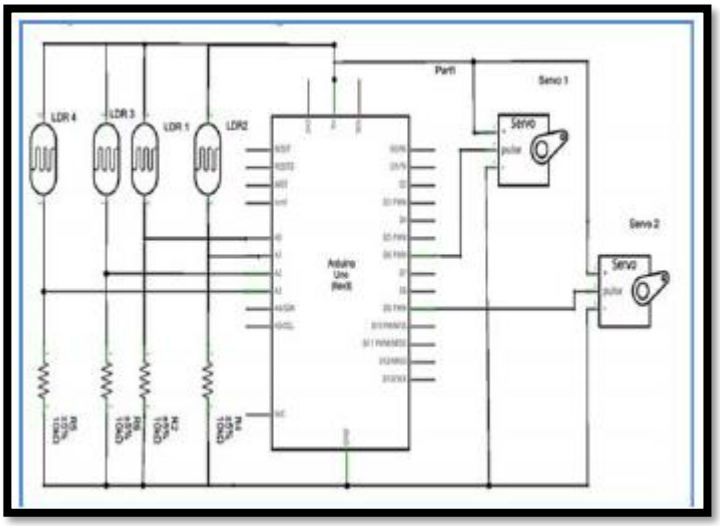

Figure (9) Operating circuit

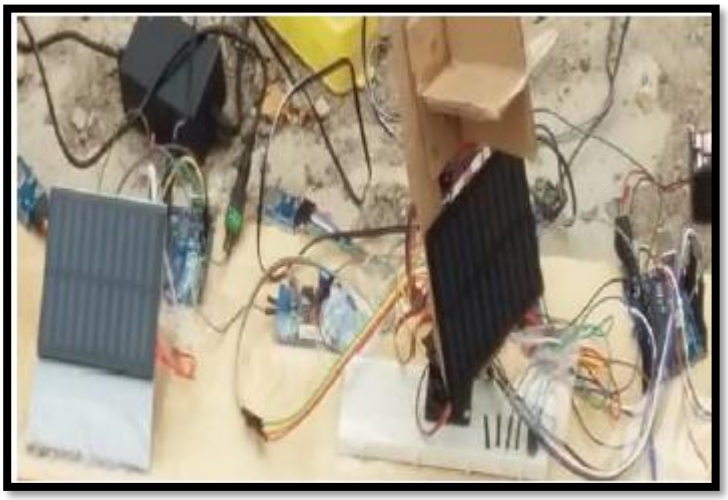

Figure (10): The actual shape of the device.

Field work

2.2.1 On a sunny day: Comparison between the different voltages with time for the two systems (fixed system and tracking) In Figure (11) we notice that the voltage in tracking is clearly superior. In Figure (12) the graph shows the comparison between the different currents between the two systems with time, we notice that the current in tracking is clearly superior. Figure (13) represents a comparison of the power of the two systems with time, and we notice that the power is greater in the tracking system than in the fixed system, and here the sky has no clouds.

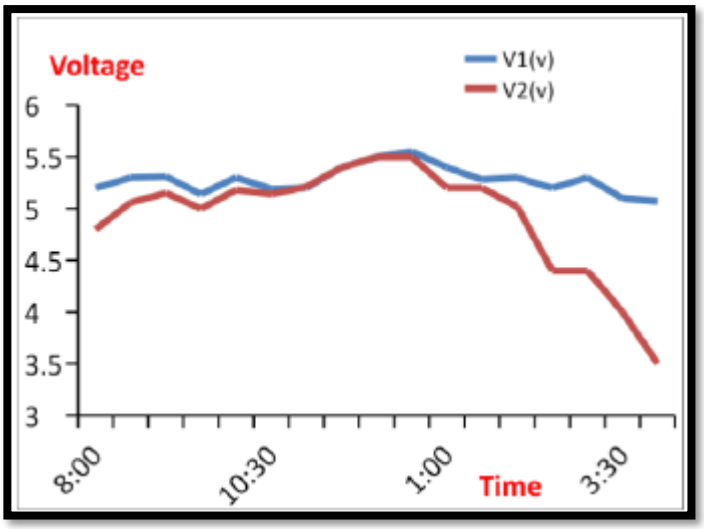

Figure (11): Voltage for tracking system, (V2): Voltage for a constant system for a sunny day.

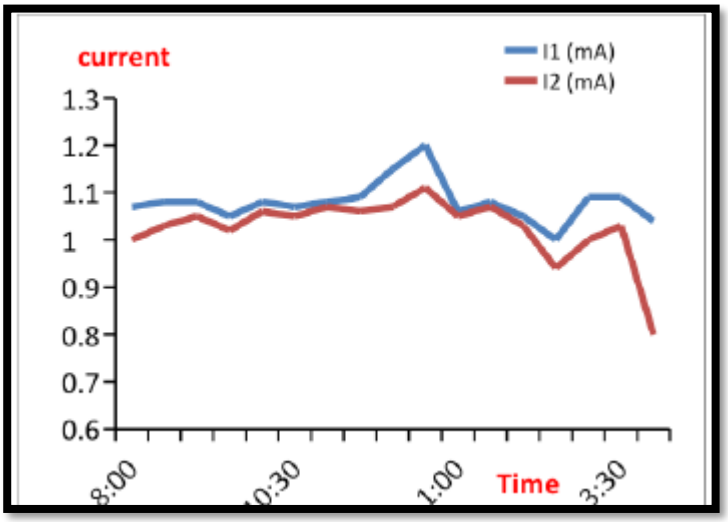

Figure (I2):(11) for a tracking system, (I2) for a fixed system for a sunny day.

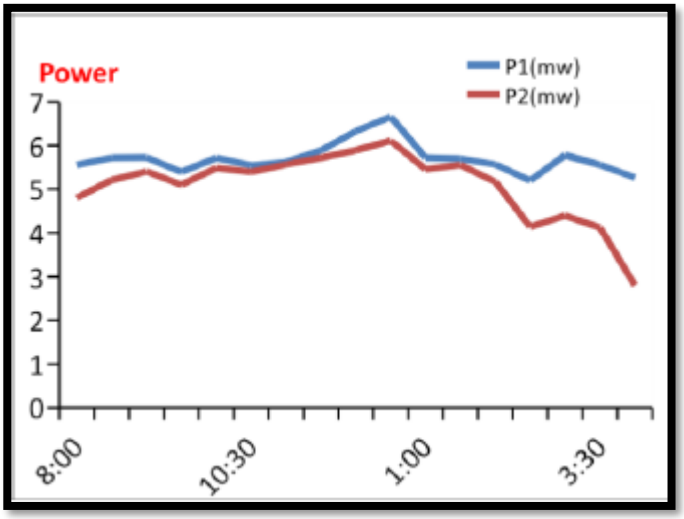

Figure 13) Power P1 for tracking system, Power P2 for fixed system for sunny day **2.22**On a partly cloudy day: So if the sky is partly cloudy sometimes, The different voltages of the two systems, fixed systems and tracking systems, were compared with time as shown in the graph in Figure (14). We notice that the voltage in the tracking is clearly superior. In Figure (15) the graph shows

the comparison between the different currents between the two systems with time. We notice that the current in the tracker is clearly superior. Figure (16) represents a comparison of the capacity of the two systems with time, and we notice that the capacity is greater in the tracking system than in the fixed system.

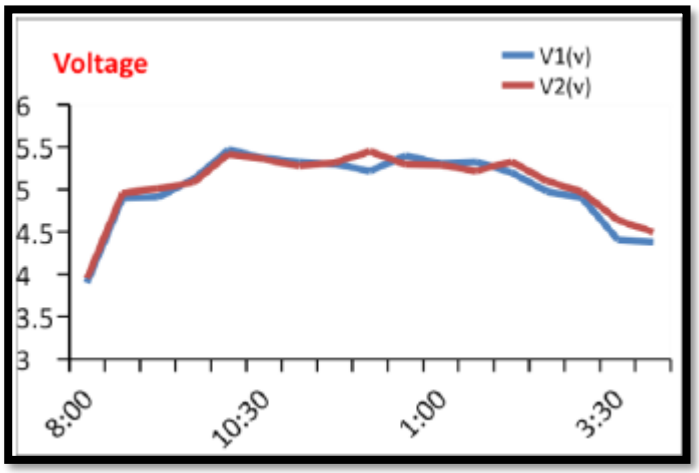

Figure (v1):(17) Voltage for tracking system, (v2) Voltage for fixed system for cloudy day

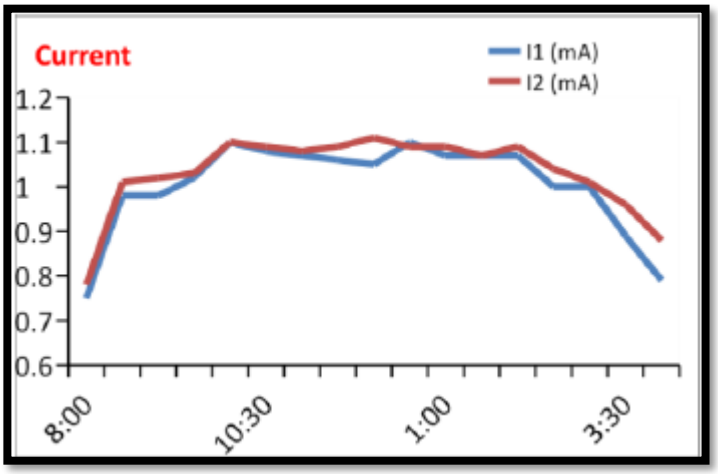

Figure 18: Current (I1) for a tracking system, current (I2) for a constant system for a cloudy day.

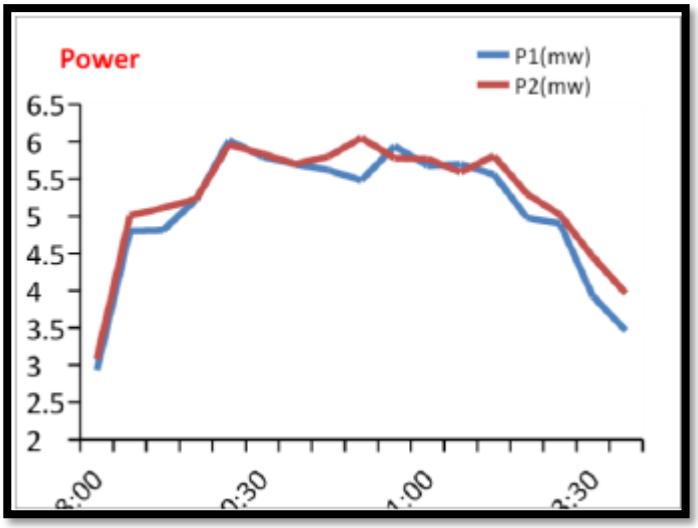

Figure (19): Power (P1) for tracking system, power (P2) for stationary system for cloudy day

3.1 Results:

From Table 1, we note that for a sunny day, the total cell energy in the tracking system is 10.96% of a fixed system. As for a partly cloudy day, the total cell energy in the tracking system is 4.63% of a fixed system. On a cloudy day, the total cell energy in the tracking system is 3.4% of a fixed system. The total cell energy in the tracking system on a sunny day is 6.48% of a partly cloudy day. The total cell energy in the tracking system on a sunny day is 10.79% of a cloudy day. The total cell energy in the tracking system on a partly cloudy day is 4.61% of a cloudy day. The total cell energy in the fixed system for a sunny day is 0.17% of a partly cloudy day. The total cell energy in the fixed system for a sunny day is 3.6% of Cloudy Day The total cell energy in a stationary system for a partly cloudy day is
-3.42% of a cloudy day

Ratio %	total power		
(|P2-P1|/ P2)*100%	P1(mw) Fixed system	P2(mw) Tracker system	day
10.96 %	86.35	96.98	sunny
4.63 %	86.50	90.70	partially cloudy
-3.4 %	89.46	86.52	cloudy

Table 1: Total energy and percentage of energy gain for the fixed system and the tracking system.

Discussion: The tracking system is more expensive than the fixed system and the Arduino programming process is difficult in addition. Here the system was built in an easy and inexpensive way to reduce the problems of placing the system on the buildings. The results for different types of weather. All are sufficient for the tracker to work well and in Iraq the intensity of solar radiation We have in different weather conditions, in addition to the possibility of manufacturing the solar tracker is simple and easy and provides us with the possibility of obtaining clean and environmentally friendly electrical energy and meets the requirements of the need in Iraq**.**

REFERENCE

1. A. Zahedi, “Energy, People, Environment, Development of an integrated renewable energy and energy storage system, an uninterruptible power supply for people and for better environment,” Int’l Conf. on Systems, Man, and Cybernetics, 1994. 'Humans, Information and Technology', vol. 3, pp. 2692-2695, 1994.
2. Hanif Ali Sohag and other ,” An Accurate and Efficient Solar Tracking System Using Image Processing and LDR Sensor,” International Conference on Electrical Information and Communication Technology (EICT),2015
3. Yusie Rizal, Sunu Hasta Wibowo, Feriyadi,” Application of solar position algorithm for sun-tracking system,” International Conference on Sustainable Energy Engineering and Application, Energy Procedia 32 (2013)pp. 160 – 165

4. A. K. Saxena and V. Dutta, “A versatile microprocessor based controller for solar tracking,’’ Photovoltaic Specialists Conference, vol. 2, pp. 1105-1109, 1990
5. Nam N. ,” Solar Tracking System”, Thesis, Degree Programme of Electronics, Helsinki Metropolia University of Applied Sciences, 2016
6. Nipun, "Difference Between p-type and n-type Semiconductor," 19 October 2015. [Online].URL: http://pediaa.com/difference-between-p-type-and-n-type-semiconductor/. Accessed 2 May 2016
7. Wikimedia Foundation, Inc., "Depletion region," Wikimedia Foundation, Inc., 5 May 2016. [Online]. URL: https://en.wikipedia.org/wiki/Depletion_region. Accessed 27 May 2016
8. John A. Duffie and William A. Beckman,” Solar Engineering of Thermal Processes”, Fourth Edition, New Jersey, Canada, 2013
9. Askari M. Bagher, Mirzaei M. Abadi, Mirhabibi M. ,” Types of Solar Cells and Application”, American Journal of Optics and Photonics, Vol. 3, No. 5, pp. 94-113, 2015
10. Xiaoxia W., Jinfang Z. ,” Research on renewable energy power generation complementarity and storage distribution model”, International Conference on Energy Engineering and Environmental Protection (EEEP2016), 52, 2017
11. A. Manzella,” Geothermal energy”, EPJ Web of Conferences 148, 00012 (2017), Institute of Geosciences and Earth Resources - Pisa, Italy, 2017
12. R.J. Fuller,” Renewable Energy and Sustainability– An Evaluation”, Solar 2005 - ANZSES Conference, Dunedin, Dec 2005
13. Arbaj N. Aga, Sanket G. Govekar and AsifAli S. Jamadar,” Sun Tracking Solar Panel”, International Research Journal of Engineering and Technology (IRJET), Vol. 5, No. 3, 2018
14. Jamilu Y. Muhammad, Mohammed T. Jimoh, Ibrahim B. Kyari, Mohammed A. Gele, Ibrahim M.,” A Review on Solar Tracking System: A Technique of Solar Power Output Enhancement”, Engineering Science, 4(1): 1-11, 2019
15. Hachimenum N. Amadi and Sebastián G.,” Design and Performance Evaluation of a Dual-Axis Solar Tracking System for Rural Applications”, European Journal of Electrical and Computer Engineering (EJECE),Vol. 3, No. 1, 2019
16. Ibrahim A., Abdurrahman S. Hassan, Lombe I. ,” Design and Implementation of an Automatic Sun Tracking Solar Panel without Light Sensors”, International Journal of Electrical and Electronic Science, Vol. 5, No. 3, pp. 77-83, 2018
17. S. Aziz and S. Hassan,” On Improving the Efficiency of a Solar Panel Tracking System”, International Conference on Sustainable Materials Processing and Manufacturing SMPM 2017, (218 – 224), (7) 2017
18. Derci F. da Silva and Daniel A.,” Light Dependent Resistance as a Sensor in Spectroscopy Setups Using Pulsed Light and Compared with Electret Microphones”, journal Sensors, vol. 6, p.p. 514-525, 2006
19. Wendy F., Jesús E. Miranda-Vega, Moisés R., Oleg S., Julio C. Rodríguez-Quiñonez and Lars L.,” Comparison between Different Types of Sensors Used in the Real Operational Environment Based on Optical Scanning System”, journal Sensors, 18, 1684, 2018
20. Leo L. ,” Working Principle of Arduino and Using it as a Tool for Study and Research”, International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, April 2016

21. Manisha V. ,” Working, Operation and Types of Arduino Microcontroller”, International Journal of Engineering Sciences & Research Technology, vol. 6, No. 6, 2017
22. V. Brahmeswara Rao, K. Durga Harish Kumar, N.V.Upendra Kumar, and K. Deepak,” Arduino Based Two Axis Solar Tracking by Using Servo Mechanism”, International Journal for Modern Trends in Science and Technology, Vol. 3, No. 2, 2017
23. Ibrahim A., Abdurrahman S. Hassan, Lombe I. ,” Design and Implementation of an Automatic Sun Tracking Solar Panel without Light Sensors”, International Journal of Electrical and Electronic Science, Vol. 5, No. 3, pp. 77-83, 2018
24. Timothy L. and Dominic R.,” Low-cost automatic multi-axis solar tracking system for performance improvement in vertical support solar panels using Arduino board”, International Journal of Low-Carbon Technologies, vol. 14, 76–82, 2019
25. Jamilu Y. Muhammad, Mohammed T. Jimoh, Ibrahim B. Kyari, Mohammed A. Gele, Ibrahim M.,” A Review on Solar Tracking System: A Technique of Solar Power Output Enhancement”, Engineering Science, 4(1): 1-11, 2019