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Design and modeling of solar water pumping system in Diyala region

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ABSTRACT

In recent years, solar panels have become increasingly popular for converting solar energy is converted into electrical energy. The solar panel can be utilized as part of a larger solar system that is connected to the power grid or as a stand-alone system. Every day, the world receives 84 Terawatts of energy, yet we only use about 12 Terawatts. For optimal energy conversion, the tracking mechanism will keep the solar panel perpendicular to the sun at all times. In this setup, photo resistors will be employed as sensors. A light detection system, a microprocessor, a gear motor system, and a solar panel will make up the system. When compared to solar panels without tracking equipment, our system will produce up to 40% more electricity. Improvements to the board's efficiency include the addition of a dust sensor. The dust on the board is also detected by the sensor, which activates a pump inside the tank. It uses the Arduino to pump water onto the board to clean it of dust and maintain its efficiency. There is also a water sensor. When the tank's water level falls below a certain level, the attached pump activates.

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1. INTRODUCTION

Solar energy is converted into electrical and thermal (heat) energy using energy technology [1]. For every square meter facing the sun, the sun provides about 1,000 watts of power to the earth's surface. Solar energy is a rapidly rising source of electricity, with the International energy agency (IEA) predicting that by 2050, solar energy will account for roughly a quarter of global energy consumption [2], [3].

Because solar-powered systems are durable, they are frequently considered for use in underdeveloped nations instead of other sources of alternative energy [4]. In poor countries with abundant Solar-powered water pumping has been highlighted as a feasible solution for rural communities that are disconnected from the grid. Solar-powered pumping stations can provide drinkable water without using fossil fuels or requiring the same amount of maintenance as diesel pumps. and have long-term economic advantages [5].

Solid phase peptide synthesis (SPPS) is likewise insufficient for large-scale irrigation, however it can be used for small-scale drip irrigation [6]. A large-scale SPPS is one that provides services to more than 240 persons. Because large-scale irrigation necessitates the use of solar water pumps, they may be very successful in small-scale or society irrigation. massive volumes of water, which necessitates a large solar photovoltaic (PV) array. Because the water is only needed at specific periods of the year, a large PV array would provide unnecessary energy, rendering the system inefficient [7], [8].

A power source is required for a water pumping system to function. When alternating current (AC) power is accessible 2 from the nearby power grid, AC powered systems are generally cost effective and need little maintenance. Water sources, on the other hand, are dispersed over many miles of land in many rural locations, and power cables are sparse. The cost of installing a new transmission line and a transformer to the area is frequently prohibitive [9]. Windmills have traditionally been built in such regions; however, many of them are now inoperable due to a lack of sufficient maintenance and age. Internal combustion engines are used in many stand-alone water pumping systems nowadays [10].

Solar water pumping uses photovoltaic (PV) technology to turn sunshine into power, which is then used to pump water. The PV panels are connected to a motor (direct current (DC) or alternating current (AC)) that turns the electrical energy from the PV panels into mechanical energy, which the pump then converts to hydraulic energy. The capacity of a solar pumping system to pump water is determined by three factors: pressure, flow, and pump power. Pressure can be thought of as the labor done by a pump to move a given amount of water up to the storage tank for design purposes [11]. The amount of labor a pump has to do is determined by the elevation difference between the water source and the storage tank. The water pump will consume a specific amount of energy, which must be supplied by a PV array [12].

2. SYSTEM DESIGN

The system was designed consisting of solar panels, an inverter, a DC motor, an AC motor, a water tank and a water source. The system was assembled and installed in a thoughtful manner.After we design the system,shown in Figure 1 we collect, buy, and put some electrical design components into practice [13]. We've done some experiments on specific pieces, connected the entire circuit, and conducted practical experiments [14].

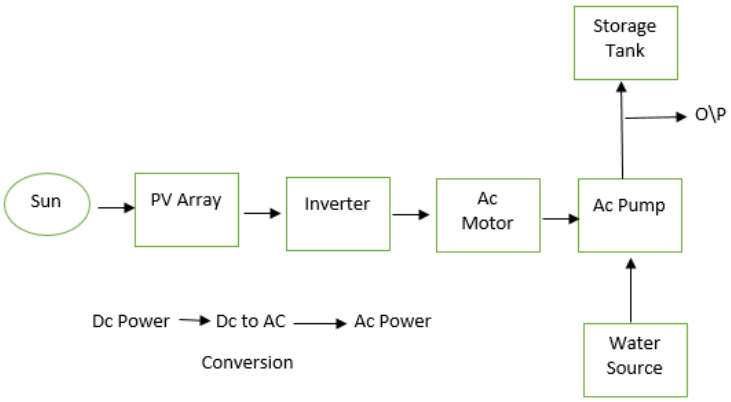

Figure 1. The proposed PV water pumping system is depicted as a block diagram

3. RESULTS AND DISCUSSION

3.1. Solar panel

Recently, most people have turned to using solar panels, especially in rural areas, due to the inability to reach the electric current in those areas. There are many types of solar cells, the following panels were chosen, 10 W polycrystalline silicon solar IEC: 61215 Germany cell as shown in Figure 2. The data sheet for the board is shown in Table 1

3.2. Batteries

Batteries are one of the important elements in solar energy to rely on them during the night, so it was necessary for manufacturers to develop these batteries to have a longer life, and there are many types of batteries, including dry and solution batteries and gel batteries. We used one lead-acid battery 12 V [15]. As shown in Figure 3.

3.3. Inverter

As demonstrated in Figure 4, this inverter 3 it connects to a transformer and transforms DC electricity from a battery to 12 V AC power. To provide 220 V, we can connect the solar to the transformer. However, we use a battery with an invertor to deliver this power at night [16].

Figure 2. Solar panel

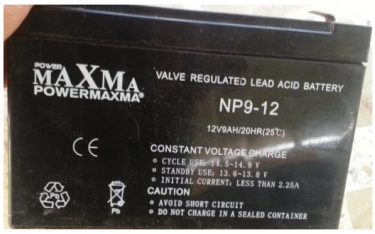

Figure 3. Lead-acid battery

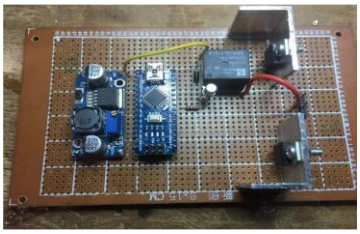

Figure 4. Inverter

Table 1. Specifications of solar panel

Unit	Quantity
Maximum Power	10 W
Short circuit current	0.652 A
Voltage at Pmax	17.0 V
Current at Pmax	0.588 A
Power tolerance	+- 3%
weight	1.2 KG
Maximum system voltage	1000 VDC

3.4. Water pump

We used a pump (M.A.A.S) with an ac voltage of 220 V/50 Hz, a power of 20 W, a head of 1.8 m, and a flow of 1000 l/h. Motors of many types are used to power water pumps. AC induction motors are less expensive and more commonly available around the world. However, an inverter is required to convert DC output power from PV to AC power [17]. As shown in Figure 5.

3.5. Dust sensor

By detecting the dust concentration, this dust sensor provides an excellent a measurement of the air quality in a certain place counting the low pulse occupancy time (LPO time) in a specific time unit determines the fine particulates matter level (PM level) in the air. PM concentration and LPO time are connected. This sensor can provide trustworthy data for air purifier systems because it reacts to particles with a diameter of one meter [18], as shown in Figure 6.

Figure 5. Water pump

Figure 6. Dust sensor

3.6. Water pump with a small DC submersible motor

Water pumps are used for several purposes, including agriculture, irrigation and cooling, depending on their capacity and the target used for them. The pumps that are used in wells must be of good quality. A submersible pump (also known as a submersible motor or an electric submersible pump (ESP)) is a pump that has a hermetically sealed motor that is located near the pump body. Its function is to feed water to the solar panel, clean it, and connect it to the Arduino through a dust sensor [19], as shown in Figure7.

3.7. Arduino rain/water sensor

Water sensors have many benefits, one of these benefits is knowing the amount of rain falling, and there are also sensors that are placed in the soil when the soil dries out, giving an order to the Arduino for the purpose of instructing the system to turn on the water. Companies manufacture many moisture or water sensors and in our work we have used, determine the amount of water in the reservoir and when there is a water shortage.as in Figure 8 The Arduino controls the well pump automatically [20].

Figure 7. Small DC submersible water pump

Figure 8. Arduino rain/water sensor

3.8. Servo motor E2001

The servo motor is one of the important motors with many uses and ease of control, so companies have worked to develop these motors. Servo motor diverse and each type has a specific function and the optimal use and available to us we used This motor has a 12-volt DC torque of 20 kg, and we used two motors for two vertical rotation as shown in Figure 9 [21].

3.9. Light dependant resistor (LDR) sensors

In the development of modern technology and the urgent need for a control system, scientists had to develop light sensors to become more suitable. It is a specific type used to sense light and consumes less energy and gives a signal to the motor in order to change its direction as in Figure 10, Here we are using four sensors to track sun position [22].

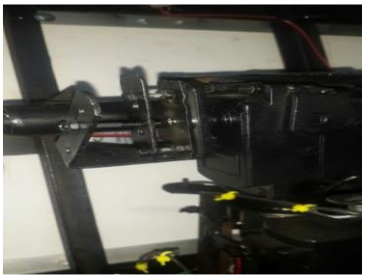

Figure 9. Servo motor E2001

Figure 10. LDR sensors

3.10. Arduino Nano

Recently, the field of artificial intelligence and the dependence of man on machines had to develop the processor microcontrollers have developed a lot recently and have become more rapid and responsive, and there are many types of them that have been used Arduino Nano in Figure 11 was used one for tracker and one for dust sensor and DC pump [23]. We manually built the identical parts after designing the system. We also purchased the identical electrical components (solar panel, controller, inverter, water pump, circuit breakers, clap meter, wires, graduated cylinder, test equipment, sockets and other tools). The final project is depicted in Figure 12 [24].

Figure 11. Arduino Nano

Figure 12. The final project

4. RESULTS FROM MEASUREMENT

Through the results achieved from the project and proven in practice, we conclude the following ; i) in the measuring field [0-250], there is a voltage measuring apparatus, ii) a device for detecting the strength of current in a measurement field [0-25], and iii) a graduated cylinder for determining the amount of water to be used [25]. Using a graduated cylinder at a tilt angle of 40o for the solar panel, periodic measurements of the solar panel voltage and current, as well as the amount of water flowing for one minute, were taken [26], [27]. The Table 2 and Figure 13 explain the relationship between the solar radiation intensity and flow of water.

The Table 3, Figures 14 and 15 explain the relationship between solar radiation intensity, voltage and current.

Table 2. The solar radiation intensity and flow of water

Flow of water Lit/min without moving solar panels	Flow of water Lit/min with moving solar panels	Solar radiation intensity
0	3.66	63
1.7	4.38	113
2.7	4.95	200
3.4	5.7	276
3.9	6.71	350
5.52	8.91	463.1
8.29	9.2	580
8.29	9.51	678.8
8.85	9.67	763
9.1	9.65	846.1
9.1	9.7	910
9.3	9.7	951.7
9.36	9.75	975
9.45	9.75	978.8

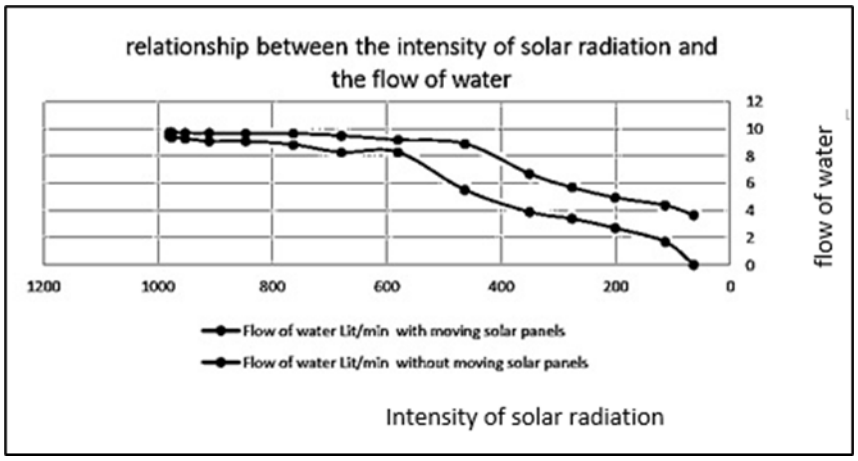

Figure 13. Shows relationship between the intensity of solar radiation and the flow of water

Table 3. The solar radiation intensity, voltage and current

Current	Voltages	Solar radiation intensity
2.8	33.2	987.8
2.8	33.2	975
2.8	33.1	951.7
2.8	32.9	910
2.8	32.5	846.1
2.8	32.2	763
2.8	31	678.8
2.8	25.7	580
2.7	17.8	463.1
2.5	16.4	350
2.3	15.9	220.4
2.1	14.6	113
2	10	63

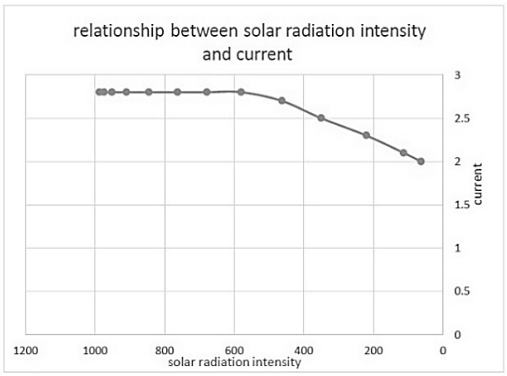

Figure 14. sun radiation brightness and current its relationship

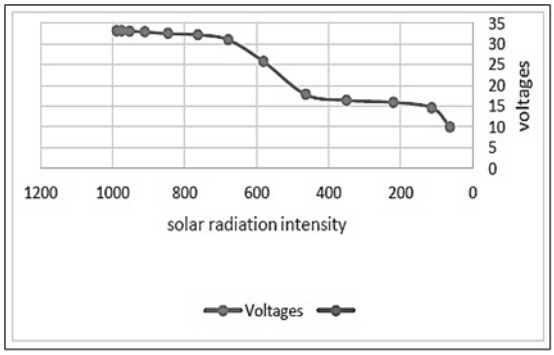

Figure 15. demonstrates the link between the intensity of solar radiation and the voltage

5. CONCLUSION

Solar power is a clean, pollution-free, and source of clean energy. PV water pumping technique is a safe and cost-effective agriculture crop irrigation a non-electric and non-diesel alternative to electric and diesel water pumps. The latest climate change drought in the land, and for the purpose of reducing irrigation water, we must use modern irrigation systems. If we adopt this initiative in our daily lives, we will be able to save money on electricity, provide study materials for our pupils, and protect the environment. The project was converted from an educational to a practical endeavor. To boost storage, other types of batteries called deep cycle batteries are used. Connect inductance to the inverter's output to smooth the output wave and convert the square wave to a sine wave.

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