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Research Article

Intelligent Watering by Using Solar Energy System

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ABSTRACT

In this study, Kirkuk and its surrounding areas are evaluated to determine whether solar energy can be utilized for irrigation. PV panels create their own power (300 W). A meter is used to measure the depth of a well (h) (60, 70, and 80 m). Graphics demonstrating the link between solar radiation, angle of solar radiation, and sun brightness in each month were generated using data from Iraq's Meteorological Organization and Seismology. Graphs depicted the volume flow rate at each depth. A study found that using PV panels to generate power increased volume flow rate, in addition to being more efficient throughout the day and in the summer (summer season). The depth of the well and the rate of flow are inversely proportional to one another. Because the flow rate of the system is suitable for most crops grown in the agricultural area of the city, solar energy generated by a photovoltaic (PV) panel may be used for irrigation in Kirkuk.

1. INTRODUCTION

In addition to being a solution to today's energy crisis, solar electricity is also a more ecologically friendly alternative to fossil fuels since it is renewable. [1]. Since solar radiation is free, pollution-free, and widespread, it is an important renewable energy source. Many research have been done to see whether solar energy can be used for both home and industrial purposes, among them:

PV programmes developed by Basheer N. [2] vary from other PV systems because they are more suited to Iraq's climate. There are no computations required in the Visual Basic application. It was found that the program's design was accurate, based on a comparison of theoretical and experimental data. Maya Su Kyi [3] and her colleagues developed and assessed a calculation to determine the water pumping efficiency of a solar panel system. The study area is located at 21o-58'-30" north and (96o-5'-0" east) from Mandalay. A single acre of asparagus may be watered by the PV system on a daily average water demand of 25 m3/day. RC Srivastava and Harsha Pandey utilised the Angstrom-Prescott model (= a+b) to predict sun exposure in several Indian locales. Notation n denotes the number of hours of daylight. W.hr/m2/day is the standard unit of measurement for global radiation, with the mean value being H. Any of the existing models may be used to create an Angstrom-Prescott programming paradigm. Muzatik, et al. investigated the Angstrom-Prescott model based on global radiation [4][5]. To estimate monthly mean values in Terengganu state (Malaysia) from (2004-2007), If radiation data from that time period were lost, a unique linear model based on the Angstrom model was used, and it was shown to be a good source of radiation.

To irrigate an area of cherry trees, an automated irrigation system was employed by two motors, one located in a deep well to move water from that well into a tank, and the other located on top of the tank. To transfer water from the storage tank to the irrigation system by drip, a second electric motor is needed [6]. The maximum power consumption of the motors was calculated using high-efficiency solar panels in this investigation. Motors might be powered by solar panels. The system of tracking was also employed to boost the system's efficiency. In addition to the sensors of soil moisture. There are (48) solar panels on the system, and it generates (3840 W). Developing a self-irrigation experimental model powered by microcontrollers and solar energy is investigated by M. A. Murtaza et al [7]. As a result of this method, farmers may modify the water flow to their paddy fields based on soil moisture and temperature readings. It is possible to save a lot of water with an autonomous irrigation system if utilised appropriately. These parameters, as well as temperature and electric charge, were modelled using a mathematical approach to increase their accuracy. Reduce the solar cell error ratio by using a mathematical connection [8].

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To irrigate dragon fruit orchards in Indonesia, Widiastuti and D S Wijayanto employed wind and solar power [9]. The system of irrigation by drip, powered by a pump of (120 W) and a turbine of (5 blades), was used. Filling the irrigation tank with 3000 m2 of fruit may be done using the water pump's power. A cost-benefit analysis was used to examine whether or not such a system may be financially viable. On a horizontal surface in Iraq, researchers Ali M. Al-Salihi, et al. [10] examined the effects of sun radiation. Climate data was gathered on city-level temperatures, length of the sunrise, and the city's relative humidity levels. Solar radiation on the horizontal surface in the cities of Rutbah and Baghdad was reliably approximated using a correction coefficient ranging from 89 to (97) percent. while Baghdad's error rate was 0.035, the error rate in Rutbah's data was 0.063. Solar farms may be built up in distant places at a low cost, according to S. K. Mohammed and E. H. Jasem [11]. In order to satisfy the demands of the rural house, the system generates capacity 1000 watt of solar energy (equals about 5 Amps), which is adequate for the agricultural pump. For three overcast days, the system requires just 10 square feet of space and costs $18k less than a conventional gasoline generator of the same size. In all, it cost (2535 $) to heat the home and poultry house, and (3040 $) to heat the house protected. When designing a wind turbine tower, Fattah and his colleagues [12] looked into the influence of several kinds of composite materials. Analytical ANSYS simulations were used in this project. [13-19]

Mathematical relations and solar panel design criteria are used in all of the aforementioned research to determine the quantity of solar radiation that can be gathered. Irrigation in Kirkuk and the surrounding area might benefit from solar power, according to a new study. Calculated in two stages, the solar system's flow rate The sun's radiation is used to determine the current and voltage, which are then used to calculate the volume flow rate using a second set of formulae from literature.

2. METHODOLOGY

2.1 Mathematic formulas for converting solar power to electric power

Photovoltaic (PV) cells have an I-V characteristic, which may be calculated mathematically using a variety of methodologies and formulae. One such equation is as follows:

$$I = I_{pv} - I_s \left[exp\left(\left(\frac{q}{k\,T_c\,a} \right) V + R_s\, I \right) - 1 \right] - \left(\frac{V + R_s\, I}{R_p} \right) \qquad (1)$$

Where:

I = the total direct current (DC) produced.
Ipv = an abbreviation for photovoltaic current.
Is = the saturation of dark current in the cell.
q = charge of the electron = (1.60217 10-19 C).
k = Constant Boltz Man = (1.38 x 10-23 J/K).
Tc = the temperature at which the solar cell is operating.
a = the ideality constant of a diode.
V is an abbreviation for voltage.
Rs = stands for series resistance.
Rp = Shunt resistance is denoted by the symbol Rp.

Using [12], the DC output power (P) may now be calculated with ease:

$$P = V.I \qquad (2)$$

2.2. The volume flow rate calculation

Calculating the volume flow rate may be done by using the following simple formula [13]:

$$Q = 367\,\frac{\eta_p\, P}{h} \qquad (3)$$

Where:
Q is the volumetric flow rate (in liters per hour)
ηp = specified pump efficiency
P = the amount of electricity generated by the PV
h =the depth of the well (m)
Following are the figures (1, 2, and 3) that demonstrate how the angle of solar radiation fall influences the quantity of power produced by a photovoltaic (PV) panel: solar radiation, the fall angle of the solar radiation, and the theoretical and actual sun brightness. In this sequence, there are 14 to 15 and 16 in total.

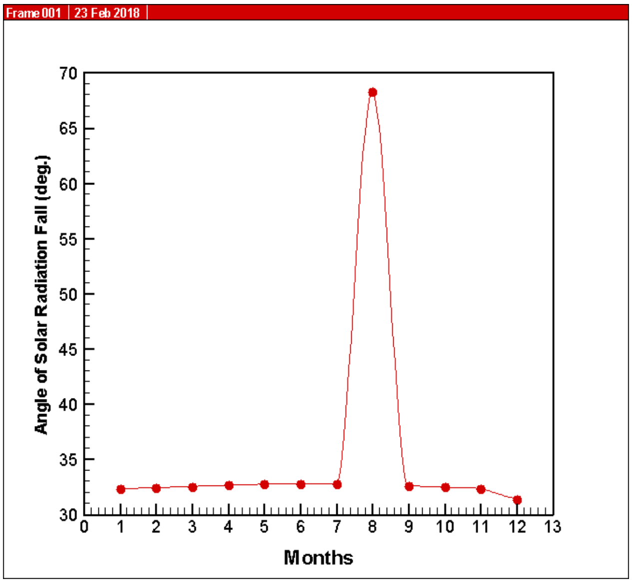

Fig.1. shows how the angle of radiation fall in Kirkuk changed during the course of the year.

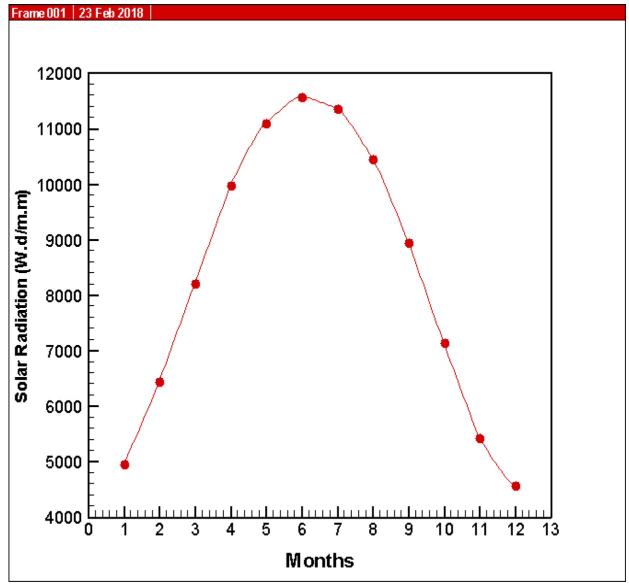

Fig.2. year-to-year variation in solar radiation for Kirkuk

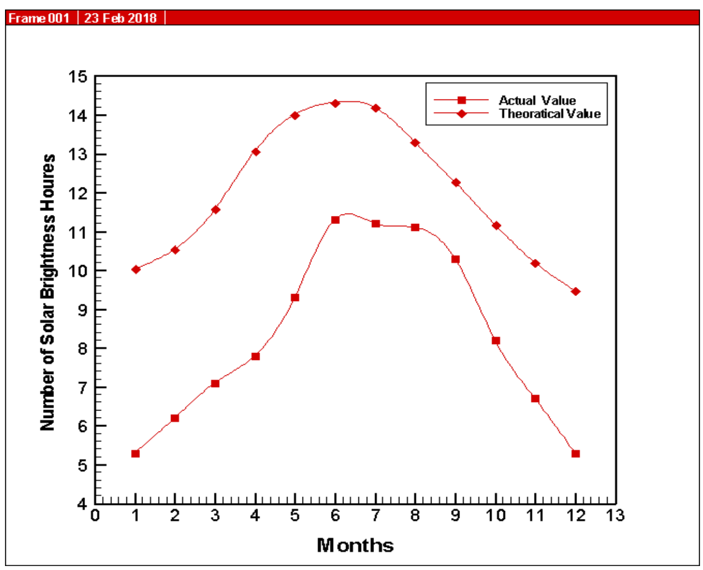

Fig.3. shows the number of hours of sunlight that Kirkuk experiences each year.

Table (1) throughout the course of a year, the changing of current (A) and voltage (V) per square meter of PV panel in Kirkuk city is shown using the equation (1).

TABLE I. PV PANEL CURRENT AND VOLTAGE/M2 FOR KIRKUK CITY ON A MONTHLY BASIS[17]

	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Curr. (A)	359.6	336	542.5	600	635.7	639	660.3	705.25	354	461.9	297	254.2
Volt. (V)	6014	5376	6153.5	6000	6293	6105	6308.5	6370.5	5910	6076	5745	5859

PV-panel output is (100 W), pump-efficiency is 70%, there are 3 - well depths to be tested (h=60,70,80 m) and these assumptions were used to arrive at results.

3. RESULTS AND DESCUSSION

In this work, data from a solar-powered irrigation system in Kirkuk was studied and analysed. From 7 AM to 5 PM, Figure 4 shows how the power output of a PV panel changes throughout the course of the day. Each day, the PV panel generates (300 W) of electricity, and the results are based on that amount of power. As the sun rises in the morning, the rate of change in power increases, and then decreases as the sun sets, until it is no longer noticeable. During the course of the year, solar radiation (or time spent in the sun) increases the power of a PV panel. The PV panel's maximum power output was measured between (12 and 1 pm). The system electricity generated value will reduce as a result of a reduction in solar radiation. Summer months have the highest electricity production relative to the rest of the year, notwithstanding the overall trend. Systems' efficiency is measured by their ability to produce a certain amount of water per unit time.

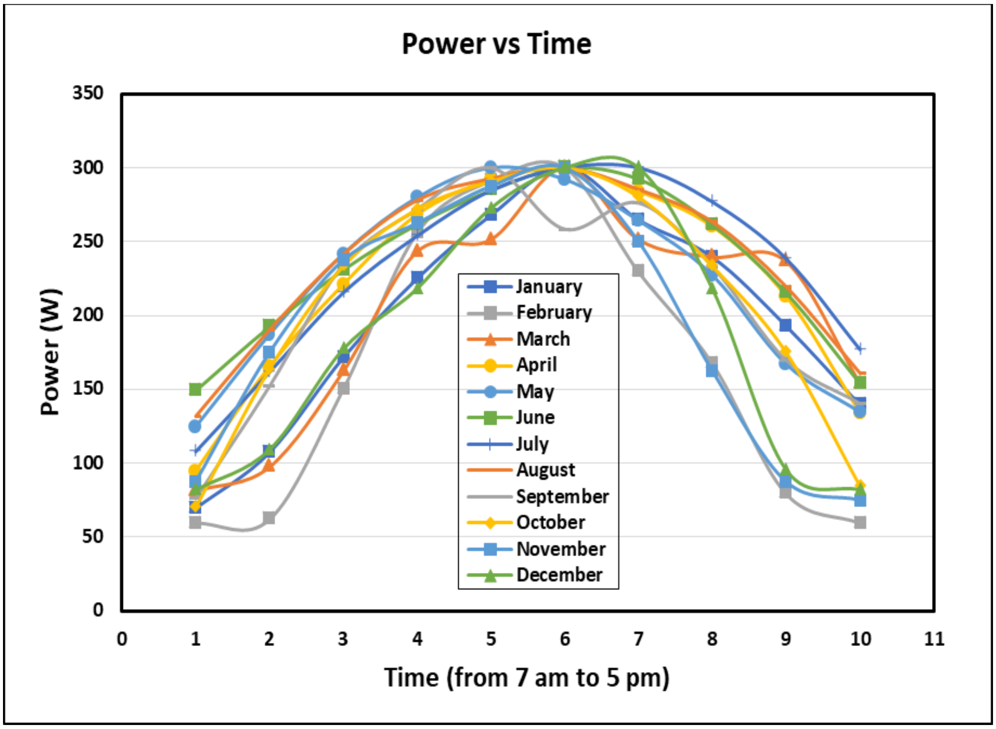

Fig.4. For (h=60 m), the power output of a PV panel varies with time.

Each month, 10 hours of data was collected over the course of a year. The water depths in the wells were calculated based on an estimate of the water depth in Kirkuk city (60, 70, and 80m).

Figure (5) time in (L/hr) for a time interval of 60 milliseconds (h = 60 m), with the time on the horizontal axis progressing from 7 a.m. to 5 p.m. (indicated with 10 on the figure horizontal axis). Assuming a PV panel power consumption of (300 W), the total length of time spent each day is (10). A rise in volume flow rate occurs when the quantity of solar radiation (or time) rises. A maximum flow rate of 1284 L/hr may be achieved between two locations (12 and 1 pm). The system's water flow diminishes as the amount of solar light decreases.

When the water level rises from (h=60m) to (h=70m), the maximum flow rate will be reduced. As shown in Figure (6), the greatest (Q) value in this case is (1100 L/hr), which is about 14 percent lower than the value obtained from a 60-meter-deep well. The same connection between flow rate (volume) and time may be seen, with the value of flow rate increasing with time up to 1 pm and then declining after that.

If the depth is extended any more, the maximum volume flow rate will be significantly reduced. Q = 923 L/hr is roughly 16% lower than the flow rate at the 70m well depth, as seen in Figure (7) As in the preceding paragraph, but with fewer monthly statistics in 2013, we find the following pattern.

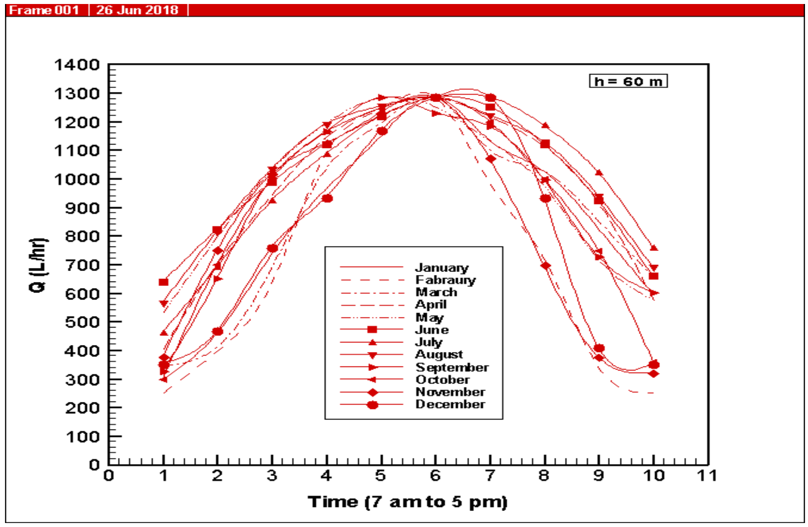

Fig.5. (h=60 m) volume flow rate fluctuation over time.

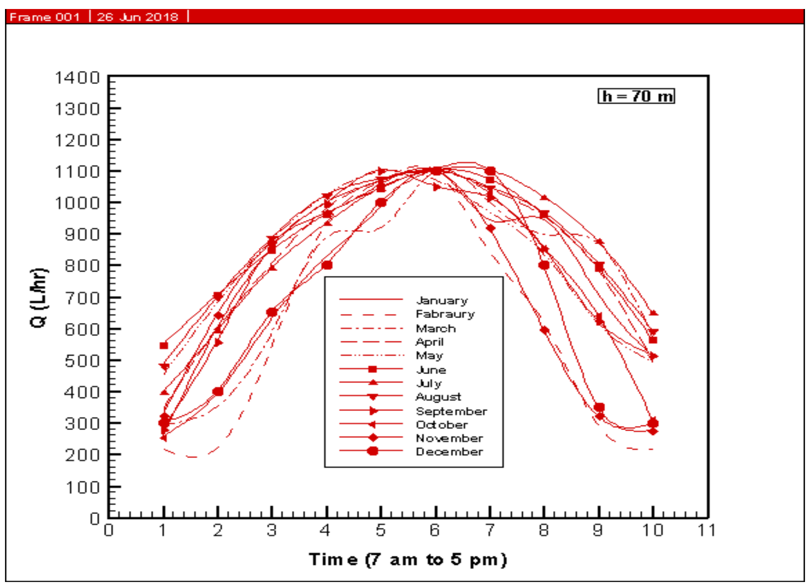

Fig.6. time-varying volume flow rate (h=70 m).

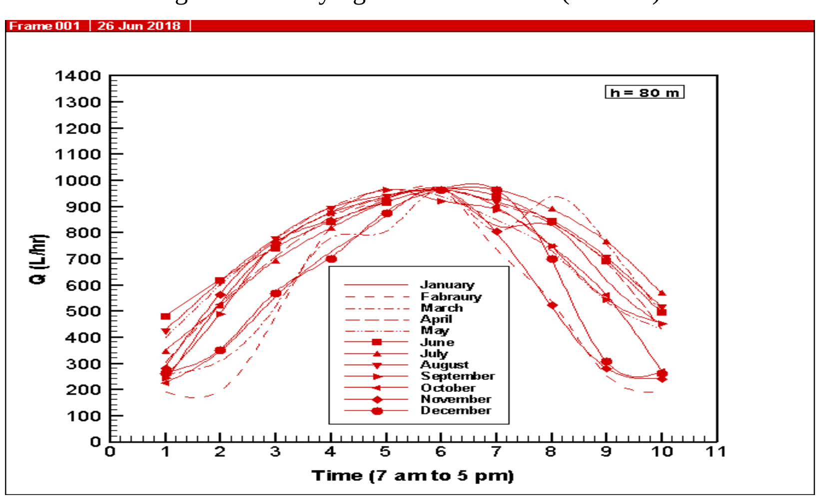

Fig.7. time-varying volume flow rate (h=80 m).

Figuring out the link between volume flow rate and hole depth (h) is shown in Figure 8. (Q). Because the estimated well depth is inversely related to the volume flow rate, System performance improves as the water level decreases.

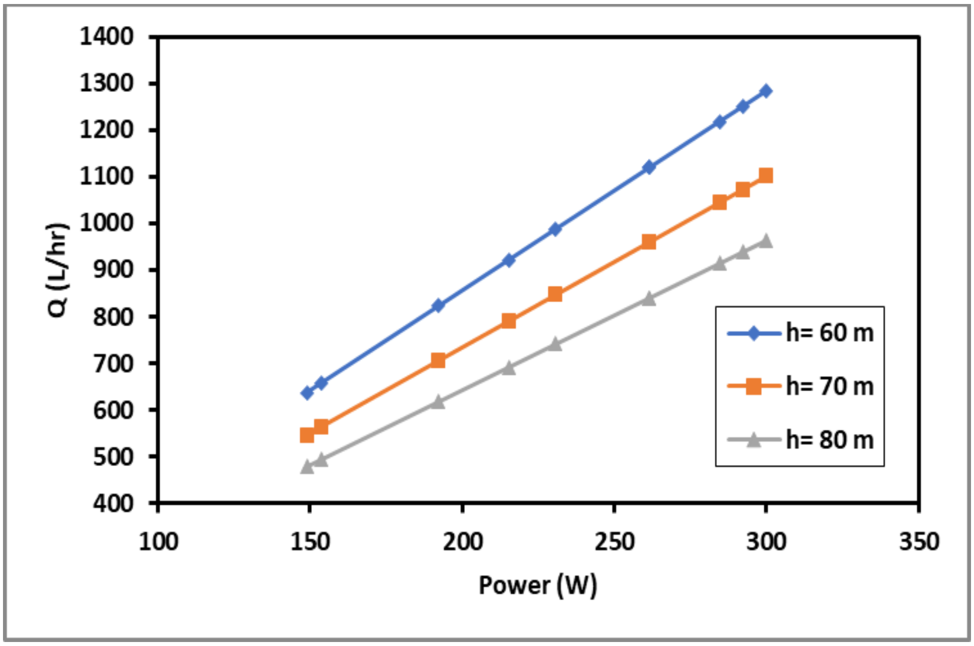

Fig.8. flow rate of a well is affected by its depth.

4. CONCLUSIONS

The following conclusions may be drawn from the data gathered in the study:

1. The solar water pumping system ensures that there is always enough water available, even in the winter.

2. During the middle of the day and in mid-year, when the PV panel power is increased, the volume flow rate increases, making the system more efficient (summer season).

3. When compared to 60m, the depth of the hole has an inverse relationship with the volume flow rate, with a 14 percent decline in water flow rate for h=70m and a 16 percent dip in water flow rate for h=80m.

4. In order to enhance the amount of water that can be utilised to irrigate crops in the agricultural region, it is feasible to boost the PV panels' expected power output.

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Conflicts Of Interest

No conflicts of interest to be disclosed.

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