HNSJ Humanities & Natural Sciences Journal
ISSN: (e) 2709-0833
www.hnjournal.net
Peer-Reviewed Journal
Indexed at: NSP - SJIF
Impact Factor 2022 = 4.91

RESEARCH TITLE

DESIGN SOLAR ENERGY SYSTEM FOR AGRICULTURAL PROJECT TO CULTIVATE (PURISEM) INSTEAD OF DIESEL SYSTEM AND COMPARE THE TWO SYSTEMS WITH SOME – SUDAN, NORTHERN SUDAN, AL-OBAIDIYA AREA

Anas Mohmad hamad ELneil Abd ELfrag[a], Alfadil aboud alfadil hassan[b]

[a] College of Mechanical Science and Engineering, Sinner University, Sudan
[b] College of Agricultural Science and Engineering, Sinner University, Sudan
Email: saadalfadil22@gmail.com

HNSJ, 2023, 4(5); https://doi.org/10.53796/hnsj4515

Published at 01/05/2023 **Accepted at 18/04/2023**

Abstract

Renewable energy is one of the most important types of energy that people must benefit from in the various requirements of life, and the summary of our study of irrigation using solar energy sheds light on the large amount of resources that must be used in Sudan, especially solar energy, because Sudan has a different climate and the number of solar hours in some Large areas and saves the use of fuel and reduces the total cost and reduces the tension in the environment, and therefore we recommend the development of the use of solar energy more widely in agricultural and various life processes. The farm is located in the state of the River Nile, in the Ubaidiya region, in northern Sudan, between latitudes 22.16 north and longitude 32.30 east. In the different regions of Sudan, by taking studies from the Ubaidiya region and reducing the costs of agricultural projects by using solar energy as an alternative to fuel, the research also aims to use clean energy that is not harmful to human health. Studies have shown that the initial cost of the project is high, amounting to 4710 dollars, and the operating cost is much less than fuel Environmental pollution does not exist like fuel. Therefore, we recommend government agencies and banks to support farmers and encourage them to use solar energy, provide all required assistance, and continue research and development in solar energy and make better use of it.

1.Introduction:

With an increasing population and rapid economic development, the world faces climate change issues, environmental deterioration, and increased energy needs (Al-Omari., et al.2014). In order to reduce environmental pollution, the large-scale utilization of renewable energy sources (solar, wind, hydro energy, ocean energy, biomass, etc.) has become an inevitable development trend. Solar energy is the most abundant energy resource on the earth. With the development of solar power generation technology and global energy interconnections, solar power generation will become the energy with the greatest potential and the fastest growth in the future (Baha, A. (2004).

This research deals with the uses of solar cells in pumping water and generating electric power using solar cells, the importance of solar energy and its use and problems of use. And it also deals with the electric solar pumping systems, and a comparison between different water pumping systems, the use of solar pumps, the types of solar pumping systems and the components of the solar pumping system, determining the need for water and its sources, and the appropriateness of the location of the water source for solar energy.

Because these turbines can directly produce alternating current (AC) power, they lend themselves to applications such as lighting and others infrastructure services when water does not need to be pumped. Similarly, PV technology converts the suns energy in to electricity through electromagnetic means when the PV, module (array) is exposed to sunlight. PV produces direct current (DC) power, and an inverter can be used to convert DC power to AC power. (Kaygusuz, K., 2011).

The energy is one of the main pillars to meet the needs of society, as well as one of the most important elements of integrated economic and social development. With the increase in the population and urban and agricultural expansion, energy consumption is increasing in Egypt and it has become necessary to search for new and renewable sources as alternatives to traditional energy. (Day., et al.2018).

Regarding non-renewable energy, which is often found in a solid stock on the ground, it cannot be benefited from except after human intervention to remove it from it. The use of renewable energy usually does not result in residues such as carbon dioxide or any harmful gases. It does not increase global warming, as happens when fossil fuels are burned or harmful atomic residues resulting from nuclear power reactors. In light of the growing demand for energy as a result of high population growth rates, increasing human needs and the high degree of dependence on modern technology, there has become an urgent need to pay attention to finding alternatives to traditional energy that is depleting, by searching for means to secure permanent and renewable sources of energy, which made most countries turn To seriously think about projects capable of securing energy through inexhaustible sources, and the Lebanese Jakub of the Doulas, the only the Renewable energy is produced from wind, water and the sun, and it can also be produced from wave and tidal movement or from geothermal energy, as well as from agricultural crops and trees producing oils, but the latter has residues that increase global warming.(Kalair., et al. 2021).

Currently, most of the production of renewable energy is produced in hydroelectric power stations by means of great dams wherever suitable places are found for their construction on rivers and watersheds. Methods that rely on wind and solar energy are used on a large scale in developed and some developing countries, and electricity production has become using renewable energy sources (energy). (Solar and wind) has become commonplace lately, especially in countries that have good solar or wind conditions. (Yah., et al.2017).

irrigation is a process in which the land is supplied with water, so that the plant can grow and take its necessary needs from the soil. Solar cells, also known as "solar cells "or" photovoltaic cells" are photovoltaic semiconductor wafers that use sunlight to directly generate electricity. A single solar cell cannot be used directly as a power source. For a power supply, several individual solar cell strings must be connected in parallel and hermetically sealed to form a module. (Abd Elmahmoud., et al.2020)

Solar panels (also called solar modules) Multiple solar cell assemblies are the core part of solar power systems and the most important part of solar power systems Drip irrigation is a network of perforated tubes that irrigate crops in a row. Water is pumped through the pipes using a low-pressure pump, when the pump is turned off, the pipes are emptied. Another common type of irrigation is surface drip irrigation. This type of irrigation can be suitable for small or irregular fields. (Bagher., et al.2015). The objectives of research Use renewable energy as an alternative source of non- renewable energy, economically reducing project costs, reducing harm by using clean energy, benefiting from the sunny weather in Sudan and developing irrigation process, storing solar energy in batteries an using it later, Low maintenance cost, Automatic irrigation regulation and Easy to get and at hand. High initial cost, the inability to use solar panels in all season of the year, relatively large space required, Care must be taken to clean the solar panels regularly, and to remove dust or objects that block the sun rays and Solar panels cannot be used indoors in cramped spaces, or where the sun rays do not reach completely.

2.Materials and methods

2.1 System Description: -

2.1.1 Location: -

The farm is located in the Nile River wall area (Al-Obaidiya) in northern Sudan between latitudes 22,312 deacons and a line 1.23 east long, the study was conducted to design and replace the existing diesel pumping system with an infusion system My sun has an area of 4 acres of persime. **(**Study site information in Al-Obaidiya).

Figure (1) location Al-Obaidiya

Table (1) Study site information.

input information	Description
Target area of acres	4 acres
Well depth	12 m
Water depth	3 m
Demand for water per cubic meter per acre on day	1382
plant type	Purism
Tube length	12m
Diameter of tube	3in

2.1.2 Diesel pumping system (perception system): -

The perception diesel-powered (Chinese) shallow system uses Irrigation area the perception system consists of Diesel machine, water pump and traffic to transport movement from the Labarthe pump length (10 - 14 meters) and pipes Water Transport. The type of washer diesel (Chinese) and the number of operating hours per day is 12 hours and consumes the number of gallons of Jazz In the day, the oil for me is changed, each use is 22 gallons of gas by a number. Kilo oil and maintained in One year at a time and the type of pump. inch. (Powell., et al.2019).

2.1.3 (Solar Pumping System) Proposed System: -

The photovoltaic system or solar system is an energy system designed to provide usable solar energy Through photovoltaic alms consists of several components including solar panels absorbing and converting There are two types of panels, one crystal panels and several blue ray panels. Where cost-effective solar pumping system consists of connected solar panels with electric motor running submersible pump.

Solar irrigation pumps work better on sunny days and have lower yields in the dark days. We considered 7% of the days each month to be final, while the rest are sunny (July – August- September - October), and any storage tank is used for the system, also enable benefit of rain water in these months, originally the need for irrigation water in this period is simple as show in the table below.

It's an economic change, and usually the solar pumping system consists of an pv-free, an energy converter, and Controller, electric motor and water pump figure below shows system. (Sontake., et al.(2016).

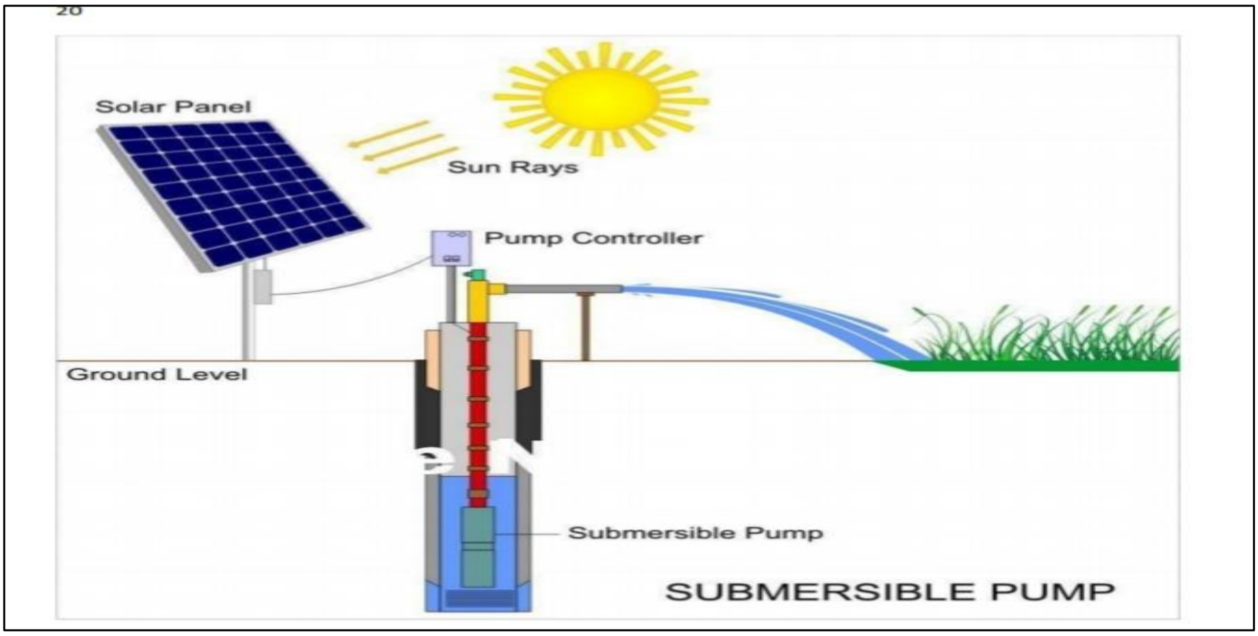

Figure (2) Solar water pumping system proposed system.

2.1.4 Water source: -

The source of the available water may be groundwater or surface water or rain water, and our source here is water underground and we will design on it and to be able to look at the level of water fixed and moving in well.

2.1.5 fixed water level: -

The fixed level is the distance from the water surface to the top of the well. Over time depending on season. (Cantor, Kenneth., et al. (1987).

2.1.6 Dynamic water level: -

The dynamic level is the distance from the top of the well to the surface of the water. When the pump is running, we measure the water level dynamic during pump operation because it usually decreases when the pumping running and the water level may change it depends on the season so we need to do some observations level the water is the same for the whole year. (Lansey., et al.1994).

2.1.7 Determining of the amount water required: -

Determining the amount water required for irrigation is greatly affected by the climate of the region, as well as the type of crop and for design a suitable pumping system with solar energy. Field visits to the study site were conducted to find out the amount of water the amount of water required to irrigate the area per month was determined based on the availability and intensity radiation data collected through visits to the area the table below shows the number of irrigation sessions per month for each feddan and the required amount of water, it was noted that the maximum is 423 cubic meters per month on the feddan the season. (Blaney., et al.1962).

Table (2) required amount of water.

Month	Number of watering times required per month	The amount of water required in a cubic meter on the hair on the feddan
January	4	312
February	4	312
March	6	468
Abril	6	468
May	6	468
June	6	468
Juley	3	234
August	3	234
September	3	234
October	3	234
November	5	390
December	4	312

2.2 Design and calculation: -

2.2.1 Solar powered pumping system: -

[The maximum demand for the amount of water required per day during the year is equal to = Quantity of water * area in (acres)]

$468 * 4 = 1872 m^3 /day$.

The number of hours $1872 \rightarrow 24\ hour$

$$Q = \frac{\text{Rw(ma)} \times \text{acres}}{hr\ of\ day}$$

Q = Amount of water required in operating hours (m^3/day) R_w(max) = The maximum demand for the amount of water required per day during the year (m^3)

hr of day = number of day hours (24) $Q \rightarrow 4\ hour$

$$Q = \frac{1872 \times 4}{24} = 312\ m^3 /day$$

2.2.2 Power required: -

$E = 2.7 \times Q \times H$

E = Energy Required, H= azimuth

$H = \Delta Z + Hf$

Δz= depth of well, Hf= azimuth friction

$$Hf = \frac{L \times f \times Q^2}{3 \times d^5}$$

f = 0.008 friction coefficient

L= the total length of the tube L=15m, D = 3 inch = 0.0762 m the tube diameter = d

$Q = \frac{312}{24}$ = 13 m^3/day = $\frac{312}{3600 \times 24}$ =3.6×10$^{-3}m^3$ /s.

$Hf = \frac{15\times0.008\times(3.6\times10^{-3})^2}{3\times(0.7625)^5}$

$Hf = 0.201$

$H = \Delta Z + \mathrm{H}$

$H = 12 + 0.201 = 12.201m$

$E = 2.7 \times Q \times \mathrm{H}$

$E = 2.7 \times 312 \times 12.201 = 10278.12w$att.

2.2.3 Total or overall energy: -

$\boldsymbol{ET = \frac{E}{\mu}}$

Efficiency of subsystems μ = 8.0

$ET = \frac{10278.12}{0.8} = 12843.9\ wh$

2.2.4 Number of panels: -

No of modules = (ET/ (SPH x module power))

ET= total energy, SPH = Number of sunny hours, Load the board = Module Power =100 Watt.

Panel specifications (100 W, 12 V, 6 A)

$SPH = 8hour$

$Noofmodules = \frac{12843.9}{8} \times 100 = 16.05\ \approx 20$

Suppose the motor voltages = 240 V.

2.2.5 Connect panels: -

Number of panels connected in series = 240/ $modulevoltay$

$$\frac{240}{12} = 20$$

2.2.6 Charging regulator capacity: -

If all panels continue in a row

Size of charge controller = number of panels in parallel × module current ×1.3 No of panels in parallel =1 Size of charge controller = 1 × 20 × 1.3 = 26 A

3.6.7 Current transformer capacity: -

Inverter size =$laod/p.\ f$

$p.\ f$ = 0.9

Pregnancy = total \operating hours

= $\frac{12843.9}{4} = 3210.98\ w$

Transformer capacity = $\frac{3210.98}{0.9}$ =3567.8 w

3. Economic Costs Calculation: -

3.1 Costs of pumping water using diesel:

3. 1.1 Primary cost:

Table (3) Initial Diesel Costs

Cost Description	Cost $
Diesel Engine Price 24Hp	625
Installation price	62.5

Initial costs = 687.5 $

3.1.2 Operational costs: -

3.1.2.1 Fuel (diesel): -

The engine consumes in 4 hours the number of 1 gallon of gas and the engine is used per year. 2 days at a rate of 4 hours per day

The price of one gallon = 4.4$

And it consumes 53 gallons in a year, its price is 232.2 $

3.1.2.2 Oil: -

The oil is changed every use of 55 gallons of gas. After 3 kilos of oil in a year

price of 3 kilos of oil = 15.6 $.

3.1.3 Maintenance costs: -

Table (4) Operation Cost Diesel

Cost Description	Cost $ per year
Jazz cost	233.2
Oil cost	15.6
Maintenance cost	84

Operating costs = 332.8 $.

3.2 Solar energy costs: -

3.2.1 Primary costs: -

For a 4 horsepower 3inch solar irrigation system, including installation and maintenance, 4,710$.

3.2.2 Operational costs: -

There are zero operating costs for photovoltaic pumps.

4. Conclusion

Generating electric power using solar energy is economically feasible compared to traditional energy hence reduced electric bill. It is possible to deliver water and electricity to remote areas at much lower costs than delivering it to those areas with normal electrical power. The dependence of farmers and agricultural investors on generators to generate electric power due to the shortage of national Electricity. The increase in environmental pollution affecting human, animal and plant health as a result of the use of generators to generate electricity and return on investment. It is possible to invest in remote and rural areas for a period of more than twenty-five years, through the use of solar energy to generate electrical energy due to the long life of the system. The solar energy system does not require any maintenance except cleaning it from dust to increase its efficiency where it is the cost of solar energy systems is high at the time of construction, so that they are economically feasible from the perspective of the distant future. To be used compared to the electrical power gene- ration system, which is low in cost at construction, but has High costs on the long-term perspective when using.

Reference: -

1.Ellabban, O., Abu-Rub, H. and Blaabjerg, F., 2014. Renewable energy resources: Current status, future prospects and their enabling technology. Renewable and sustainable energy reviews, 39, pp.748-764.

Baha, A. (2004). Pumping Oilsand Froth International Pump Users Symposium. Published by Texas A. & M. University, Texas, USA.

2.Kaygusuz, K., 2011. Energy services and energy poverty for sustainable rural development. Renewable and sustainable energy reviews, 15(2), pp.936-947.

3.Day, J.W., D'Elia, C.F., Wiegman, A.R., Rutherford, J.S., Hall, C.A., Lane, R.R. and Dismukes, D.E., 2018. The energy pillars of society: Perverse interactions of human resource use, the economy, and environmental degradation. Biophysical Economics and Resource Quality, 3, pp.1-16.

4. Kalair, A., Abas, N., Saleem, M.S., Kalair, A.R. and Khan, N., 2021. Role of energy storage systems in energy transition from fossil fuels to renewables. *Energy Storage*, *3*(1), p.e135.

5. Yah, N.F., Oumer, A.N. and Idris, M.S., 2017. Small scale hydro-power as a source of renewable energy in Malaysia: A review. *Renewable and Sustainable Energy Reviews*, *72*, pp.228-239.

6. Abd Elmahmoud, M.S.E.H., 2020. *Reviewing Solar Radiation and its Applications inSolar Collectors and Solar Cell* (Doctoral dissertation, Sudan University of Science & Technology).

7. Bagher, A.M., Vahid, M.M.A. and Mohsen, M., 2015. Types of solar cells and application. *American Journal of optics and Photonics*, *3*(5), pp.94-113.

8. Powell, J.W., Welsh, J.M. and Farquharson, R., 2019. Investment analysis of solar energy in a hybrid diesel irrigation pumping system in New South Wales, Australia. *Journal of Cleaner Production*, *224*, pp.444-454.

9. Sontake, V.C. and Kalamkar, V.R., 2016. Solar photovoltaic water pumping system-A comprehensive review. *Renewable and Sustainable Energy Reviews*, *59*, pp.1038-1067.

10. Lansey, K.E. and Awumah, K., 1994. Optimal pump operations considering pump switches. *Journal of Water Resources Planning and Management*, *120*(1), pp.17-35.