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The Role of Photovoltaic Water Pumps in Development of Agricultural Sector

Somayeh Dehhaghi [a*], Shahla Choobchian[a]

[a] *Department of Agricultural Extension and Education, Tarbiat Modares University, Tehran 14115-336, Iran.*

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A B S T R A C T

Agriculture is a main part to global warming through greenhouse gases because of activities such as deforestation, soil treatment and methane emissions from livestock. It is also one of the main users of fossil fuels; it means contributing further to greenhouse gases emissions. Both increased energy demand and reduction of fossil fuel reserves, have encouraged the interest for development of new technologies as renewable energies (RE). Renewable energy started to become a feasible solution. One of the most important kind of RE is solar energy. The solar devices will be able to help improve health and local economies. Solar water pump can be one of the most important and applicable devise in farms specially where there is no existing power line. Photovoltaic water pumps are very reliable and require little maintenance. In this regard, the present study has been conducted to investigate the role of photovoltaic water pumps in development of agricultural sector.

1. Introduction

Global warming and environmental problems have had an increasing importance in international debate, attracting the attention of scientific studies[1]. The demand for energy has been increasing [2] [3]. Both increased energy demand and reduction of fossil fuel reserves, have encouraged the interest for development of renewable energies. Renewable Energy Sources (RES), such as hydropower, biomass, geothermal, wind and solar, produce environmental benefits by reducing greenhouse gas (GHG) emissions and increasing the health security. Due to this, RES in the last decades have had a growing impact in global energy production [4] [5].

The energy consumption in agriculture is a worldwide concern, because the CO2 emissions from fossil fuels, which are generally used as an energy sources for various applications in agriculture, are rapidly increasing.

In last years, many scientific studies have addressed the introduction of RES in farm, analysing the environmental effects or the technical characteristics of energy plants or fuels produced[6].

2. Renewable Energy and agriculture

One of the challenges faced by sustainable agriculture is that the majority of farms still rely on fossil energy. Agriculture is a main part to global warming through greenhouse gases because of activities such as deforestation, soil treatment and methane emissions from livestock. It is also one of the main users of fossil fuels; it means contributing further to greenhouse gases emissions[7]. Each year, agriculture emits 10 to 12 percent of the global total of estimated greenhouse gas (GHG) emissions[8].

On the other side, the cost of agricultural products is dependent on fuel prices[7]. Fossil fuels such as oil are non-renewable, so finding alternative ways of fertilizing the land and controlling pests that do not depend on chemicals, will normally involve the use of renewable resources. Such methods reduce farmers' vulnerability to the rising price of oil [9]. Three energy inputs (diesel fuel, fertilizer and electricity) account for more than three-quarters of farm energy use [9]. It is therefore appropriate to assess alternative sources of energy for the future of agriculture[7].

One of the most important energies, which is used on farms, is electricity. Since the sources utilized for producing electricity are limited and their prices gradually increase, researches for new alternatives for irrigation systems become more important[10].

Electricity is often produced by fossil fuels. The combustion of these fuels releases pollutants into the atmosphere such as carbon dioxide (CO2) which creates acid rain. CO2 from burning fossil fuels is a significant component of greenhouse gas emissions. These emissions could change climate and contribute to global warming[11].

Renewable energy technologies are being used in a variety of applications on farms[10]. Using solar Photovoltaic (PV) technology for generating electricity on farm can be an important step towards increasing the promotion and sustainability of personal business. Solar PV is scalable and can be easily to use. Each day Earth reaches the amount of energy from the sun. All the energy stored in Earth of fossil fuel is equal to the energy from only 20 days of sunshine. Solar PV is applicable in agriculture in a number of ways, saving money, increasing self-reliance, and reducing pollution[4].

3. Why Solar Energy

The sun is the most plentiful energy source for the earth. Sunlight is origin of wind, fossil fuel, hydro and biomass energy. Solar energy falls on the surface of the earth at a rate of 120 pet watts, (1 pet watt = 1015 watt) [12].

In agriculture, solar energy is being increasingly applied. Solar applications include pen cleaning, greenhouse heating, solar crop drying, solar water heating systems, solar water pumping systems, etc [13, 14]. The solar devices, will be able to help improve health and local economies. [15].

Solar energy that is sensitive to environment, clean and requiring no maintenance is an appropriate alternative renewable energy source especially for some countries like Iran having a high amount of annual solar irradiation rate (more than 300 sun days).

4. Solar pumping Systems: A solution to Water Management

Agriculture has the largest water consumption at global level. Irrigation average of agricultural lands is almost estimated 70% of the water used worldwide. In several developing countries, irrigation represents up to 95% of all water uses, and plays a major role in food production and food security. Future agricultural development strategies of most of these countries depend on the possibility to maintain, improve and expand irrigated agriculture [9].

Renewable energy started to become a feasible solution, offering farmers and rural residents environmentally friendly power sources to pumps water, especially because insecurity of energy and fuel prices are increasing, Technologies utilizing solar energy for powering the water pump are becoming more common, offering competitive advantages over traditional fuel-driven generators [16]. Solar technologies produce electrical or thermal energy. Photovoltaic (PV) cells that transform sunlight directly into electricity are made of semiconductors such as crystalline silicon or various thin-film materials [13].

Energy of pumps used for the agricultural irrigation is generally provided from electrical energy or fossil fuels. Since fossil fuels begin to annihilate besides its increasing of prices and hazards to environment alternative energy seeking efforts has become inevitable also in agricultural sector [16].

In Solar photovoltaic (SPV) technology the solar radiation falling on a device called solar cells converted directly into electricity. This technology doesn't have any environmental pollution. Solar pumping systems are ideal for lifting water for drinking and irrigation without harming the environment. These pumps can be installed easily[9].

Solar power pumping is principally based on PV technology which convert solar energy to electricity for lifting water[17]. These systems have been studied by researchers in many years. Photo irrigation system has advantages than flooding irrigation. Some of these are:

- Decreasing moisture stress [18].
- Bringing utilization of water sources more efficient
- Preventing erosion and growing of weeds only by irrigating the requested areas[19].
- No operation cost [19, 20].
- Providing opportunity for local energy sources and exhibiting a parallel point of view with water requirement [21].
- No noise produced
- Long lifetime [22].
- Easily relocated, moved, or expanded
- Zero pollution

And also, it has some disadvantages:

- Their high initial capital costs
- The variability of the yield of the solar panels according to the prevailing weather conditions and in high temperature efficiency decreases [19].
- Photovoltaic systems are very economical in providing electricity on farms and agricultural operations.

In fact, water pumping is one of the simplest and most appropriate uses for photovoltaic. From crop irrigation to stock watering to domestic uses, photovoltaic-powered pumping systems can be used. Most of these systems have the added advantage of storing water for use when the sun is not shining, eliminating the need for batteries, enhancing simplicity and reducing overall system costs[23].

A typical solar powered pumping system contains the following equipment (Fig 1&2):

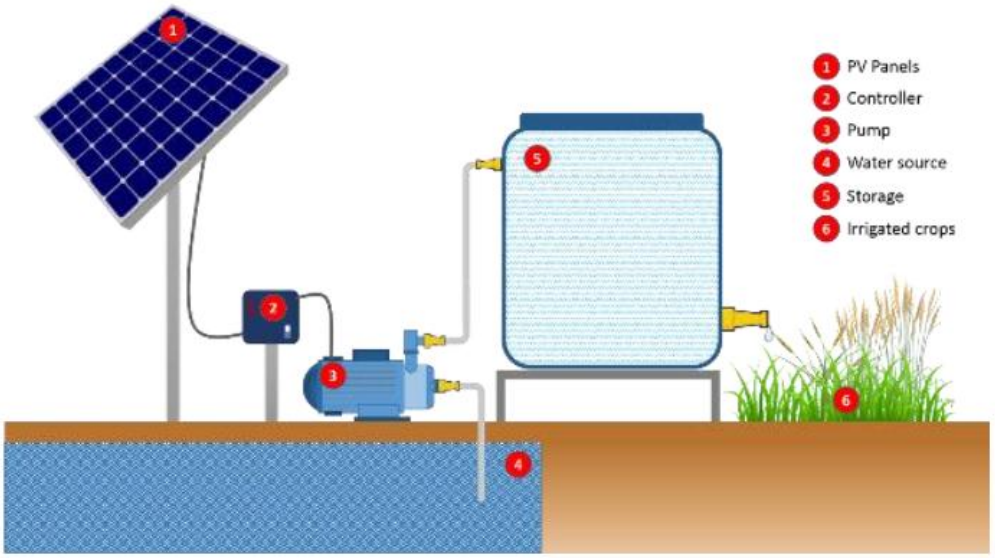

Figure1:Typical off-grid surface solar pumping system sketch[24]

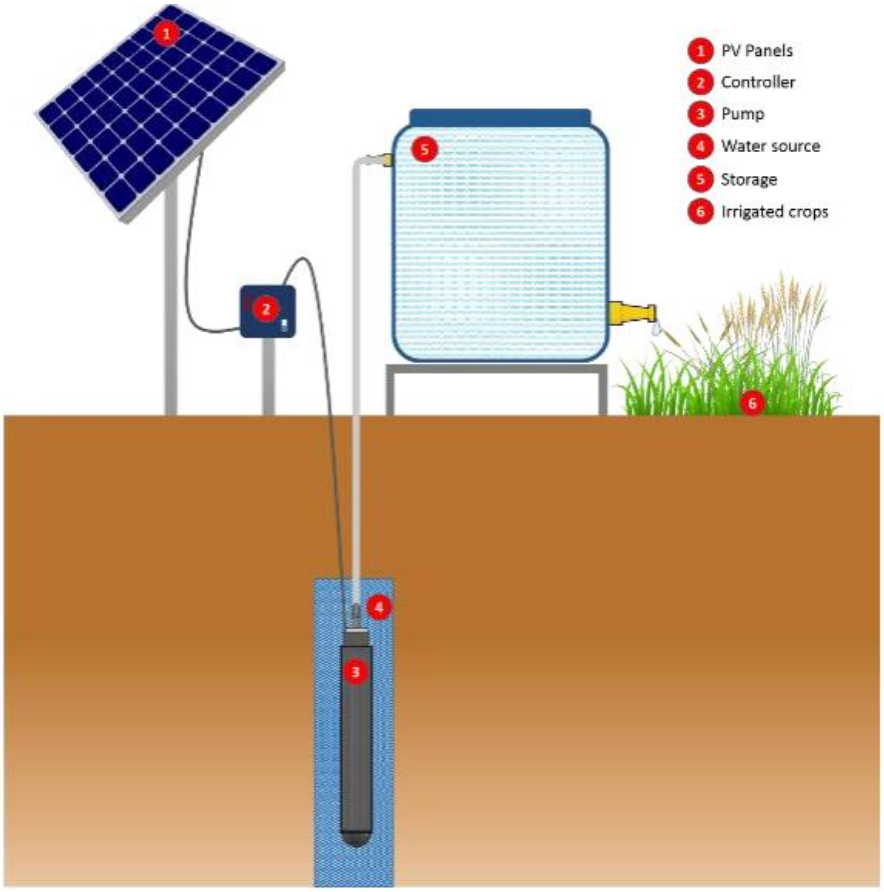

Figure2:Typical off-grid submersible solar pumping system sketch[24]

5. Conclusions

Demand of agricultural is increasing due to mechanized farming and sharing in other sectors, particularly in the developing countries. We need to be realistic about the energy which agriculture can replace our current use of fossil energy. Impacts of the implementation of on-farm RE have been studied by researchers due to develop agriculture and farms. RES is viable. Besides, on-farm renewable energy production could lead to a higher environmental awareness among farmers and thus more economically and environmentally sustainable agricultural practices.

Solar energy is the only source of truly renewable energy for the next few billion years. The solar photovoltaic systems play an important role in the agriculture sector for reducing fossil fuel consumption. The advantages of solar systems such as solar water pumps can make them applicable. It just needs to be well-known.

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