Research Article

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Potential for Using of Renewable Energy Sources for Irrigation at Small Agricultural Areas: Case Study Selnica Podravska, Croatia

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Abstract

Renewable energy sources are available for practical usage at almost every location in the world. Irrigation of the agricultural areas requires energy, where renewable energy sources are very appropriate for such usage. Very often agricultural areas are located on isolated and remote areas, where sometimes electric energy from electric grid is not available or it is too expensive. In this situation, renewable energy sources are very suitable for water pumping. This paper will present a real case study of possible application of renewable energy sources for water pumping at a family agricultural farm in Selnica Podravska, located in northern part of Croatia. There is a plan to build an irrigation system for Dwarf French bean (lat. Phaseolus vulgaris L.) for an area of 1978m^2. Available water resource is ground water. Particular renewable energy sources will be considered, as well as their potential for production of electric energy for water pumping.

Keywords: Renewable Energy Sources, Water, Irrigation, Agriculture, Croatia

Introduction

The common characteristic for all crop plants is the requirement for water. Since water income from precipitation, which cannot be reliable and cannot be controlled, i.e. during dry season, irrigation must be provided. Water used for irrigation can be taken from the water supply system, but this method adds extra cost. A much cheaper way is to pump water from near by irrigation canals, or if not available, to use groundwater. When pumps are used for such purpose, they require electric energy which can be taken from electric grid, which often is not available in remote areas where agricultural fields often are. Using electric energy from the grid adds cost too.

Therefore, renewable energy sources provide an opportunity to overcome the spatial limitations of availability of electric grid, and also to reduce cost per energy unit. Using of renewable energy sources not only decreases the production cost for crops, but also decreases the local energy requirements, which ultimately decreases the greenhouse gasses emissions.

Paper presents the possibility of using renewable energy on a family agricultural field in northern part of Croatia. The field is located in the lowl and near the Drava river. The climate conditions of the reviewed area don't offer much possibility for using of wind power for water pumping, but the intensity of the solar energy, as well as number of sunshine hours is enough, so solar energy can be used as source of electric energy [1]. Therefore, in this case photovoltaics (PV) are planned to be used for production of the energy for driving the ground water pumps, which will irrigate the Dwarf French bean field.

Materials and Methods

Irrigated Dwarf French bean (lat. *Phaseolus vulgaris L.*) processable pods yield ishigher than non-irrigated plants, as shown in an earlier researching by Borošić, et al. [2]. Therefore, a study is conducted for a family agricultural farmin Selnica Podravska (Figure 1), Croatia. The plan is to review the possibilities of using a PV system to power a groundwater pump to irrigate a 1978 m^2 large field used for planting of Dwarf French bean.

Figure 1: Geographic location of Selnica Podravska (upper right corner) and the crop field (lower left corner)

Pumps for water pumping can be powered by several types of power sources, i.e. internal combustion engines (diesel, natural gas or gasoline) or electricity. Electric pumps have much better efficiency and lower overall running costs compared with combustion engines pumps [3]. If renewably energy sources are used for drive of electric pumps, such pumps does not produce greenhouse gases.

In accordance with this, using of an electric groundwater pump, powered by using a PV system, has strong justification. The PV system further contributes to decreasing of the irrigation costs and overall production costs of the crop. After the initial installing (investment) expenses and the usual maintenance and replacement costs, such a system has negligible costs [4].

Figure 2 Presents a schematic illustration of the PV irrigation system. Such system consists of the pump, well and the PV system. In this case, the PV system drive the pump which pumps the water from the well and delivers the water to the irrigation field, where pipes for irrigation are located.The irrigation system should be placed right to the crop filed, due to the local loses and cost of the pipeline system.

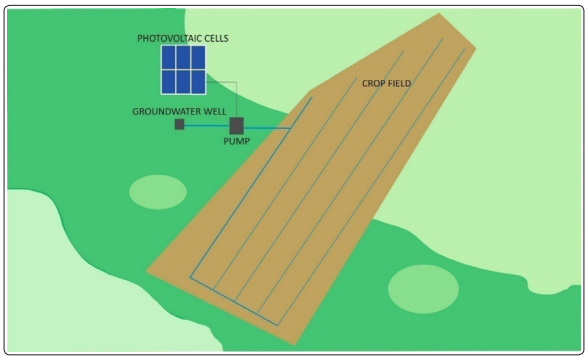

Figure 2: Schematic illustration of PV water pumping systemand case study

Results

A precipitation analysis is a first step for testing of the necessity of an irrigation system. Next step is analysis of the potential for using of solar (PV) energy for powering of the water pump. A precipitation analysis of the last 10 years for the analysed area has been conducted. Therefore, the total monthly precipitation values from the nearby weather station in the city of Ludbreg have been analysed [5]. The important period of the year for bean growth are June, July and August, since the plant develops in June, and the pods grow and fill in July and August [2]. The results are shown on the diagram (Figure 3). In last few years, a trend of lower precipitation values in July and August can be noticed, where the precipitation in June remains more or less similar. Since the values of precipitation in general are lower in July and the air temperatures are generally higher, the evapotranspiration should be taken into the account. Accordingly, irrigation systems have a strong foothold for their setting, i.e.for providing the necessary water for the pods to fill.

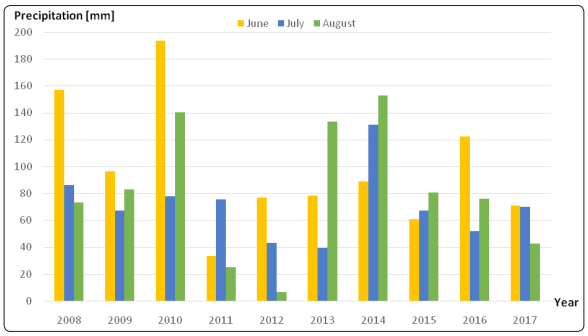

Figure 3: Precipitation analysis for the months June, July and August for the weather station in Ludbreg

PV potential was determinate by online service PV-GIS, provided by the European Commission, Joint Research Centre [6]. The mean monthly irradiation has been calculated using the PV-GIS online tool and presented in Figure 4.

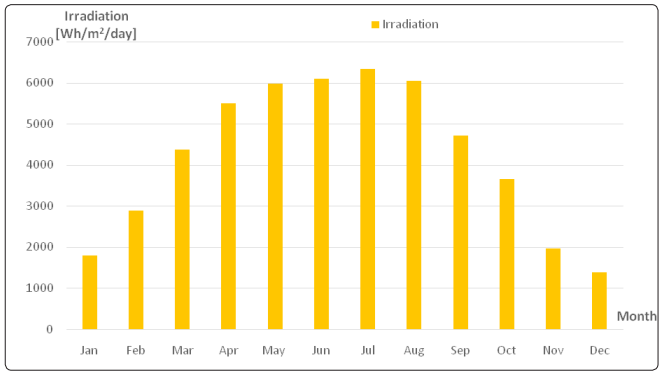

Figure 4: Calculated irradiation values in Wh/m²/day for the analysed location in Selnica Podravska

Discussion

Within the climate changes, generally speaking the precipitation values show a downward trend. Similar climate conditions are perceived for analysed area. The precipitation values in the months of July and August for the recent years are getting lower. As other crop, Dwarf French bean, in the yield development phase depends on water, or the pods are getting smaller and the number of pods decreases. The available energy from the sun in the months of June, July and August, where irrigation is required, is above 6000 Wh/m²/day, which is enough for powering every irrigation system.

Due to the big potential, i.e. lot of available insolation, such PV powered irrigation system can be used for crop irrigation at other farms. Despite of the stochastic nature of precipitation, there is a possibility for her harvesting into the water tanks and using for irrigation when there is no precipitation.

Conclusion

The purpose of the paper was to review the possibilities of using a photovoltaic powered groundwater pump to irrigate a Dwarf French bean field in Selnica Podravska, Croatia. PV systems are a great renewable energy source often used to power such small irrigation systems. They offer not only cheap electric energy, but they also contribute to decreasing the greenhouse gases emissions. A concept solution for the problem has been proposed.

Further development of this irrigation system means developing and sizing of the whole irrigation system, with the power of required PVsystem and pump for water pumping as well as the irrigation pipelines. An economic analysis will be undertaken, to calculate initial costs and the running costs for the system, with great care taken in profit ability and sustainability of the system for the family business.

References

1. El-Shimy M, Durin B (2016) Techno-Economic Evaluation and Sizing Optimization of Solar-PV and Wind Energy Sources for Irrigation Water Pumping, *The international congress Energy and the Environment* 2016, in Opatija, Croatia.
2. Borosic J, Romic D, Dolanjski D (2000) Growth and yield components of Dwarf French bean grown under irrigation

conditions, Acta Horticulturae 451-460.
3. Albers T (2013) Powering the Pump: Diesel versus Electric Motors, Pumps & Systems. https://www.pumpsandsystems.com/topics/motors/powering-pump-diesel-versus-electric-motors, 04.12.2018.
4. EL-Shimy M, Abdo T (2016) Irrigation water pumping (IWP) systems - comparison between photovoltaics and conventional energy sources, *Časopis Inženjerstva Okoliša (Journal of Environmental Engineering*), pp.7-20, 2016
5. DHMZ: Precipitation data for the weather station Ludbreg - 2008.-2017., 2018.
6. European Commission: Photovoltaic Geographical Information System - Interactive Maps, Monthly global irradiation data. 2007. http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php#, 03.12.2018.