AUTOMATED DRIP IRRIGATION SYSTEM POWERED BY PHOTOVOLTAIC PANELS USED FOR AGRICULTURAL CROPS

TĂBĂRAȘU A-M.[1], GĂGEANU I.[1], ANGHELACHE D.[1], MATEI Gh.[2]
[1]National Institute of Research – Development for Machines and Installations Designed for Agriculture and Food Industry – INMA Bucharest / Romania
[2]University of Craiova
E-mail: anamariatabarasu22@yahoo.com

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ABSTRACT

Climate change, water scarcity and higher energy requirements and electric tariff compromises the continuity of the irrigated agriculture. Precision agriculture (PA) or renewable energy sources which are based on communication and information technologies and a large amount of data are key to ensuring this economic activity and guaranteeing food security at the global level. Several works which are based on the use of PA and renewable energy sources have been developed in order to optimize different variables of irrigated agriculture such as irrigation scheduling.

In general, 70% of global water consumption goes to agriculture, for crop irrigation. Irrigated agriculture represents 20% of the total cultivated land (global average), but brings 40% of food.

INTRODUCTION

A solar panel (also solar module, photovoltaic module or photovoltaic panel) is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each panel is rated by its DC output power under standard test conditions, and typically ranges from 100 to 320 watts. The efficiency of a panel determines the area of a panel given the same rated output - an 8% efficient 230 watt panel will have twice the area of a 16% efficient 230 watt panel.

Because a single solar panel can produce only a limited amount of power, most installations contain multiple panels. A photovoltaic system typically includes an array of solar panels, an inverter, and sometimes a battery and or solar tracker and interconnection wiring [9].

Irrigation has a strategic importance for Romanian agriculture, being a factor in ensuring safe and high agricultural production in global warming, combating the process of depopulation and environmental degradation, and at the same time supporting and developing rural areas [3].

Today, drip irrigation has spread exponentially and continues to grow. If until recently, drip irrigation was seen as a solution for annual crops (vegetables or even cereals), today there are no more intensive or super intensive orchards of fruit trees that are not equipped with drip irrigation facilities.

In modern agriculture (whether it is vegetables in the solarium, in the field, fruit trees, vines or cereals), water control is crucial, given the need for crops worthy of supporting a population that is in a rapid growth rate. Free, inexhaustible solar energy is also used to protect classical depletable energy resources. Solar energy is converted into dc electricity, stored in batteries and then converted into dc energy. necessary to supply the water pumping elements [4].

The flow of solar radiation that reaches the earth's surface has an energy potential that corresponds to the impressive amount of 172 billion GW, which is about 20,000 times more than energy consumption in 2000.

This energy source could permanently provide the necessary for a growing consumption. However, seen from a practical point of view, respectively of the real volume that can be used, it becomes a very complex problem, a complexity that resides in 3 directions:

• uneven global distribution and dependence on geographical position, inclusive climate;

• alternating days with nights that create discontinuities;

• low energy flow density (maximum 1400 W / m2), which requires the use of large catchment areas, and which means the removal of land for other uses, including agricultural land, as well as high costs. Solar energy is of interest to sectors such as: habitat for home heating, agriculture for irrigation and greenhouse heating, and industry for heating halls [3].

There is a growing interest in solar-powered irrigation solutions around the world, noticeable in the increasingly frequent requests from agricultural institutions in developing countries for installation, finance and training. In May 2015, the Food and Agriculture Organization of the United Nations (FAO) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH hosted an exploratory workshop to better understand the potential of SPIS for developing countries. Representatives from 19 countries shared their experiences with solar pumping technologies – from large to small-scale, from tropical to arid climate zones, for vegetable gardens, orchards and livestock watering, using surface and groundwater. There is an increasing demand for irrigation due to the need for higher food production for a rising world population and decreasing supplies of freshwater in the context of a changing climate. High diesel and electricity costs and often unreliable energy services affect the pumping requirements for irrigation for small and large farmers. In many rural areas, grid electricity is not, or is only sporadically, available. Using solar energy for irrigation water pumping is a promising alternative to conventional electricity and diesel-based pumping systems [2, 6].

MATERIAL AND METHOD

The use of solar energy in various applications has become more widespread, the irrigation sector is one of its most suitable uses, more and more agricultural producers are turning to this solution, attracted by the fact that they no longer have additional costs related to energy or fuels, and the maximum amount of water is delivered just when it is most needed.

In addition, during the cold season, after the interruption of irrigation, the electricity obtained from the photovoltaic panels can still be used to supply electricity to the location that serves the farm, or even to heat it.

Romania has one of the largest agricultural potentials in europe. Beyond the fact that the pollution of some agricultural lands is still at a low level having a major advantage for organic farming we also have a high hydrological potential. Unfortunately because of the destruction of the old irrigation system and in the absence of coherence, or viable solutions, a large part of the agricultural area was deserted.

Also, the national energy system (sen) is the one that includes all the networks and power stations in the country and even if it may seem extensive, it is actually quite limited, especially when we talk about agriculture. Equally, connection costs as well as the implicit bureaucracy often discourage farmers from making such connections, depriving them of the electricity needed to put water pumps into operation [12].

Solar photovoltaic (PV) system is a solar technology which directly converts solar energy into electricity. PV therefore, generates power from sunlight and that power output is limited to the timeframe when the sun shines. Solar photovoltaic has brought numerous job opportunities around the world through manufacturing, trade, installation and maintenance. It also provides off-grid electricity to areas far away from the grid such as rural areas. It does not produce any emissions during operation and therefore positively contributes to climate change mitigation. It also helps reduce the dependence on energy imports [10].

Concentrating solar power technology, also known as concentrated solar thermal is a solar system that generates solar power through the use of devices (mirrors or lenses) to concentrate sun's rays to heat a receiver to high temperatures. The heat is then transformed into electricity known as solar thermal electricity (STE). This thermal electricity derived from the Sun does not produce any greenhouse gas emissions; it is therefore among the leading technologies in reducing the effect of climate change.

Solar heating and cooling technology (solar thermal technology) collects the thermal energy from the sun which is then used to provide hot water, space heating and cooling for residential, commercial and industrial processes/applications. The amount of temperature required to provide the heat demand depends on the type and design of the collector. In 2012, International Energy Agency (IEA) published a Roadmap for solar heating and cooling in which it set a target of solar energy to supply almost one-sixth (16.5 EJ) of the global total energy used for heating and cooling by 2050 [8, 10].

Drip irrigation is a form of irrigation that saves water and fertiliser by allowing water to drip slowly to the roots of many different plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. It is done through narrow tubes that deliver water directly to the base of the plant. It is chosen instead of surface irrigation for various reasons, often including concern about minimising evaporation [11].

Fig.1. Drip irrigation [10]

RESULTS AND DISCUSSIONS

The composition of drip irrigation facilities as in the case of other localized methods includes both materials common to all pipelines and device materials, equipment specific to the watering method. Their positioning in the hydrotechnical schemes is done taking into account functional considerations, thus resulting in location variants depending on the quality of the water irrigation, land slope, soil characteristic, type of drip used, arrangement size, price available etc. In order to be cost-effective, the drip irrigation system must have water quality protection and control devices, pressure and volume measuring and control apparatus distributed in the network, equipment to allow the application of chemical treatments and FERTILIZATION through irrigation water and watering equipment that adapt to growing conditions and relief by ensuring quality watering. Figure 1 shows the components of a drip irrigation system for small areas that is the subject of the study of this paper [4].

During the day, this system will capture solar energy with the help of photovoltaic cells and through the charging controller will store electricity produced in related batteries. The cc-ca inverter will supply the submersible pump to bring the water from the well into the tank as long as the maximum level sensor is not activated, at the same time the pump will operate as long as the water level in the well does not fall below the minimum level (pump float is a contact normally closed as long as the water drowns the pump, the contact opens when the water level in the well decreases). The solenoid valve will be ordered to open when weather and temperature conditions are met (the chronothermostat being an element of order) and last but not least the minimum tank level (in the absence of water from the tank the solenoid valve will not be ordered) [1,4].

To implement system automation irrigation conditions were taken into account:
- watering will be done only at night, conditioned by ambient temperature;
- ensuring the protection of the overflow tank;
- ensuring the protection of the submersible pump at waterless operation;
- ensuring the protection of the solenoid valve in the absence of water in reservoir [1,4].

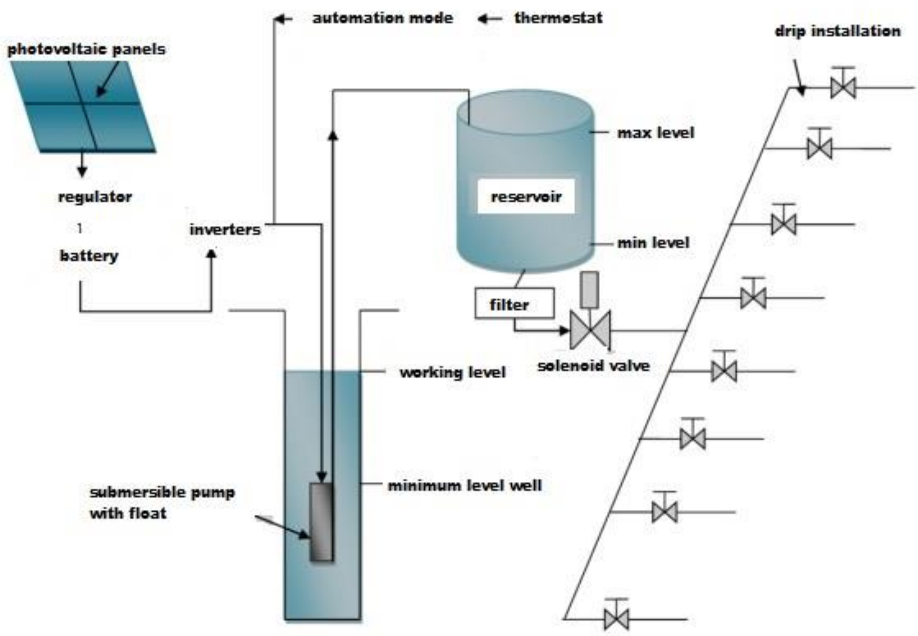

Fig. 2. Schematic diagram of the automatic drip irrigation system [4].

Given the conditions imposed for irrigation, it was decided to automate the system according to time and depending on the automation using a chronothermostat as a control element. For the practical realization of the maximum and minimum tank level, the same type of float was used (identical to the pump float that supports the working current and voltage). For the chronothermostat, a digital electronic thermostat was used for the programmable apartment heating plants, by hours, days, months, the execution element being a contact that supports the current and voltage of the solenoid valve. The automation module (fig. 2) uses classic control elements with contacts and relays whose wiring diagram is shown in figure 3 [5].

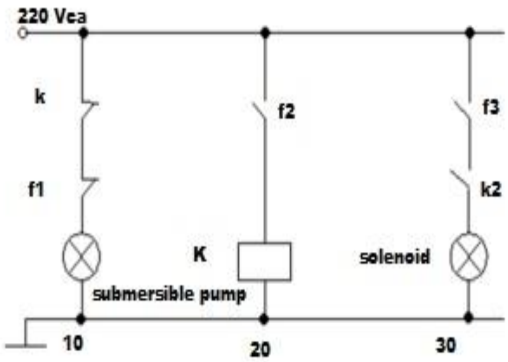

Fig. 3. Simplified wiring diagram by classical automation:
K - relay coil; k1 - cnd chronothermostat; f1 - when level float minimum well; f2 - when float maximum tank level; f3 - cnd float minimum tank level [4].

When the inverter supplies power to the submersible pump, if contacts f1 (minimum well level float) and k (maximum level float tank level coil contact) are not closed the pump will not operate. In the event that the water level in the well decreases, contact f1 opens and the pump no longer operates, identical to the situation in which the tank is filled, contact f2 (maximum tank level float) is closes by feeding the coil K, which opens the contact k [7].

The solenoid valve opens when the contact f3 (minimum tank level float) is closed, ie there is water in the tank and the chronothermostat closes the contact k1, ie the weather and temperature conditions are met [5,9].

CONCLUSIONS

The use of drip irrigation techniques leads to a healthier development of plants, thus avoiding the use of pesticides, fungicides, consequently to obtain organic crops.

The use of a photovoltaic system to supply the electrical consumers of the drip irrigation system contributes to the protection of the environment by protecting the resources of polluting conventional fuels and the use of inexhaustible, free and non-polluting solar energy.

In conclusion,that solar energy can offer lasting solutions to many problems facing the world today which include climate change (the leading problem of the 21stcentuary), energy poverty, environmental protection, and drought among others. I would highlighted in the literature, farmers in the U.S., EU and Asian countries are forefront in adopting solar technologies but most of the farmers in certain regions have less adopted the solar technologies for agriculture despite the fact that these technologies have immense benefits.

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