OFF-GRID SOLAR PUMP AUTOMATION DESIGN AND IMPLEMENTATION

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Abstract

Renewable energy sources are becoming increasingly important. In this study, drinking water automation using the solar panels which be renewable energy sources are made. The system automatically will send water from wells to water tank located at a high place in daylight. The stored water will be sent to the village for drinking water needs. Pump will provide energy from the sun during the day in sunny weather. In cases where not enough solar pump will operate as supported grid. PLC and HMI automation design is made for this system an automatically operating. Thus, the system will be automatic or manual control can be performed. Also, the system data can be continuously monitored by HMI software.

Keywords: Off-Grid Pump, Solar System, PLC, HMI

INTRODUCTION

The use of renewable energy sources is growing[1]. This sources of energy, environmentally friendly instead of fossil fuels began to be preferred[2-4]. 1527 kWh/m^2 Solar panels energy can be produced annual in Turkey[5]. This energy can be used as on-grid connection or to feed directly to devices. In this study, the pump was operated with solar panels. Mostly daytime running these systems are directly run the pump in daylight. There is no energy storage costs. Therefore installation can be made more economical. With established systems, water tanks will be filled located on a high point with water drawn from wells during the day. System, where there is insufficient daylight is configured to run from the grid. Network - Panel Transition will be automatically controlled. In the system, PV, solar pump, inverter, PLC, HMI and other electrical equipment are used. Power consumption, working time, the water level of the tank, pumped water can be continuously monitored via the HMI in systems. In addition whole system is controlled with the HMI. In the following sections, the established system and used equipment will be discussed.

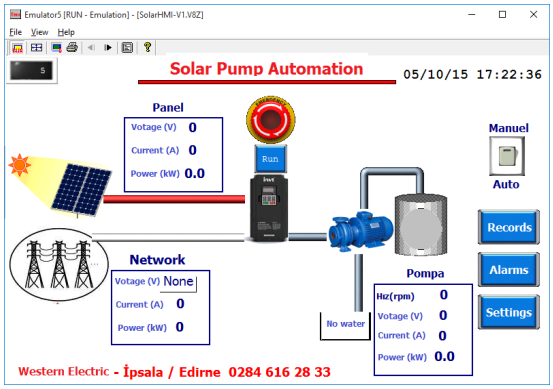

Fig. 1. *Solar Project Structure and HMI Main Screen*

EXPOSITION

This study, the pump draws water from the well for the supply of drinking water it is on providing energy with solar panels. Therefore, by controlling the water level in the tank it is sent to the water tank in the well. In daylight, when the water in the tank have reduced, Pumps powered by solar energy will be constantly reinforced.

When there is insufficient daylight or nighttime and water level in the tank when it came to a critical level, it takes energy from the grid. Water level in the tank will be controlled thereby.

Structure of the system is as shown in Figure 1. At the same time the HMI main screen design is shown figure 1.

The materials used in installation and ideal for development of automatic control methods are discussed in the next section.

SOLAR PANELS

The power of solar panels is selected according to the pump power. 7.5kW power submersible pumps are used in these study to send the water to tank from the well. Efficiently operation, panel power for of the system is chosen as 10.5kW[6]. 42 solar panels, power of each 250W are used. Panels is monocrystalline structure. The maximum current is 8.31A of the panel. The maximum continuous operating voltage is 30.1V. The panels are connected in two parallel lines. Line voltage is 632.1V. The panels are connected to the inverter DC link voltage using a suitable DC fuse. Panel's installation is made as in the picture below.

Fig. 2. *Solar Panels*

INVETOR

Solar invertor, similar structure to the conventional AC motor drive are selected. Difference, can be supplied with DC voltage. Thus, the DC voltage is applied to AC pump is activated. Also, if the position is not enough DC voltage can be operated with AC voltage. However, the AC and DC supply must be disconnected from each other. For this, DC contactor diode and AC contactor separator is used in this study. AC-DC switching is done automatically by the PLC.

Invertor power was selected as 7.5kW. Driver has MPPT feature. In this way maximum efficiency is obtained. Determining the minimum active operating frequency invertor parameters are set. Automatic power balancing between 30Hz and 50Hz are made based on solar energy[7].

PLC

PLC is used to automatically control the system. It is also made in the monitoring process by the PLC. HMI is also used for data displays.

PLC, in the case where sufficient daylight, the pump will be supplied from the solar panel. It case it is not sufficient will be working on-grid.

In low light, Grid-panel switch is made using scan time. While scanning the operation could be made from solar panels. If it is insufficient to switch to the network. After a certain time, the solar panels will be checked again. At night, Pumps will be supplied from the grid because there is no light. The water in the tank will never end the way software is developed.

HMI

HMI is used to control and monitor the data. The following data is monitored via the HMI.

- Solar panels DC voltage,
- Solar panels power,
- Grid voltage
- Grid power
- Grid current
- Pump Status
- Pump speed (rotation)

In addition to monitoring the HMI data are kept on record. Get the data recorded, consists of warning, error, and system data.

Designed HMI screens are as follows figure.

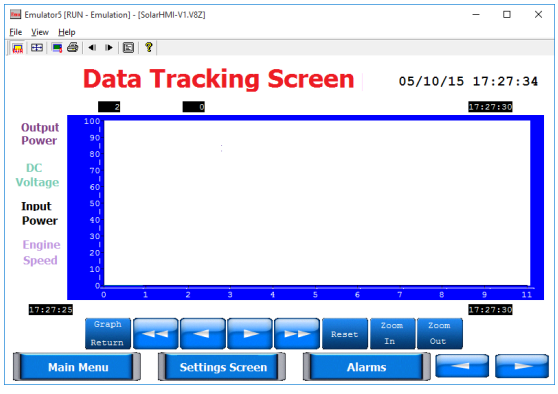

Fig. 2. *Data Log Screen Trend Graph*

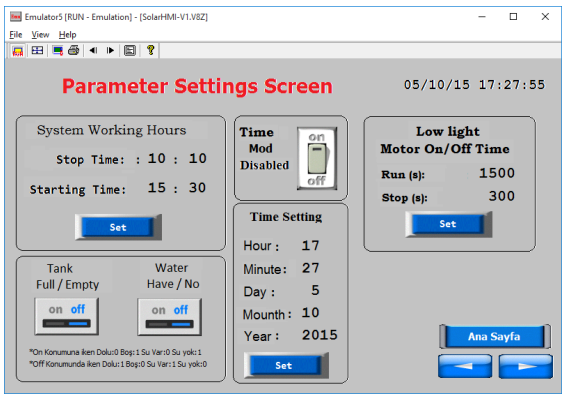

Fig. 3. *Setting Screen*

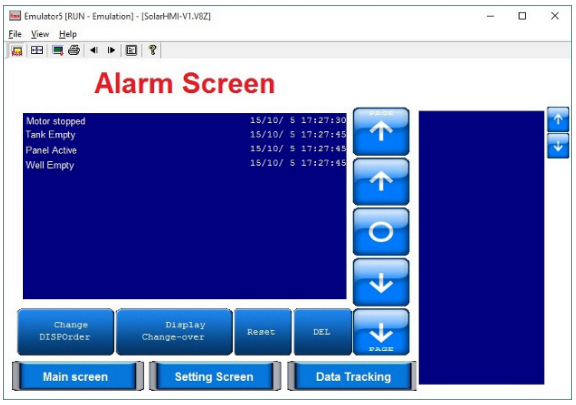

Fig. 4. *Alarm and Information Screen*

ELECTRIC PANEL

A panel design to make all electrical connections and electronic components and HMI panel assembly is made. There are AC fuse, DC fuse and a low-voltage fuses in panel for system protection. In addition, information on water levels in wells and tanks are connected externally to the panel. This information is used for external modules.

CONCLUSION

In this study, drinking water automation are made using the solar panels. In this project, the pump's power is supplied from the panel in the light of day. In cases where there is insufficient daylight, it will run from the grid. Transition is made automatically by the PLC. Moreover, the visual form of data control and monitoring means is provided with the HMI. In terms of effective use of renewable energy sources, this project is important. Also, the installation cost, not energy storage costs, are low. The complete system is $ 15,500.

This study is designed and applied to Yenikoy, Uzunköprü, Edirne, Turkey. Data collected by the system, productivity analysis will be performed.

REFERENCE

[1] Carrasco, J.M., et al., Power-electronic systems for the grid integration of renewable energy sources: A survey. Industrial Electronics, IEEE Transactions on, 2006. **53**(4): p. 1002-1016.

[2] Sims, R.E., H.-H. Rogner, and K. Gregory, Carbon emission and mitigation cost comparisons between fossil fuel, nuclear and renewable energy resources for electricity generation. Energy policy, 2003. **31**(13): p. 1315-1326.

[3] Johansson, T.B., Renewable energy: sources for fuels and electricity. 1993: Island press.

[4] Boyle, G., Renewable energy. 2004: OXFORD university press.

[5] Bakanlığı, T.E.v.T.K. Power Sun. 2015 [cited 2015 5.9.15]; Available from: http://www.enerji.gov.tr/tr-TR/Sayfalar/Gunes.

[6] CSUN. Solar Panels. 2015; Available from: http://www.csun-solar.com/products-mono-mudules.html.

[7] INVT. Solar Invertor. 2015 [cited 01.07.2015; Available from: http://www.invt.com/en/product/detail.aspx?NC=119003001001&ID=100000063766598.