International Conference
on GREEN CONSTRUCTION
Córdoba (Spain), April 8-9 2019

UNIVERSIDAD D CÓRDOBA

Photovoltaic technologies applied to water heating systems

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Introduction

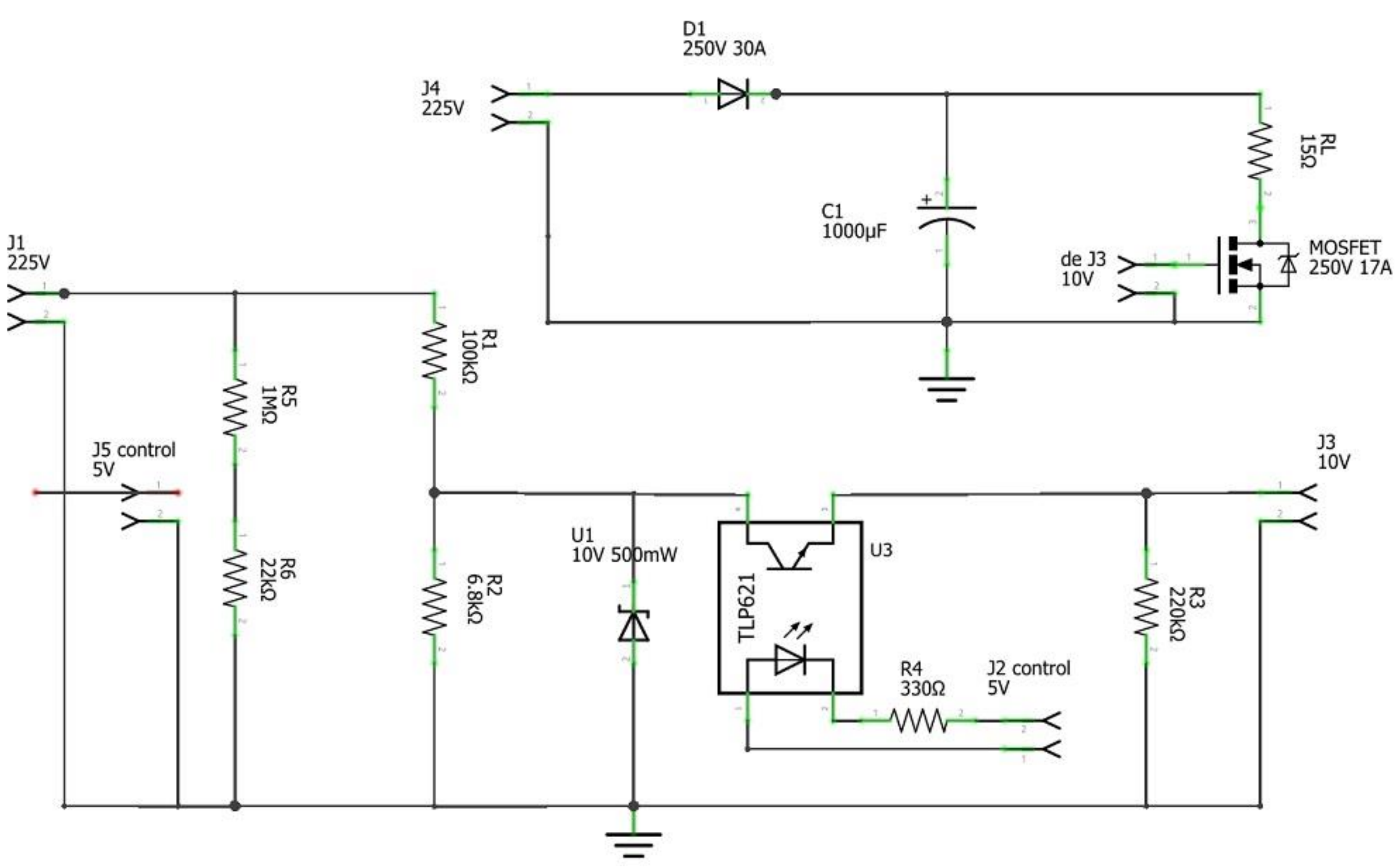
Problems related to the consumption of fossil or nuclear energy have made necessary to change the energy model. In this line, in recent years the use of renewable energy is being promoted. Thus, for example, research into photovoltaic (PV) technology for the harnessing of solar radiation has led to greater conversion efficiency in cells. As a consequence, this technology, which allows efficient and clean direct generation of electric power, has reduced its costs achieving in 2013 parity or cost equality with conventional supply.

Regarding the systems of water heating, the scheme of a conventional solar installation is based on the use of solar thermal collectors, frequently located on roofs, to which the heat transfer fluid (commonly water) is conducted in the central hours of the day. The plumbing installation that completes the system can be complex depending on the geometry of the building and, the more complex the installation is, the greater the maintenance needs of the system become. On the other hand, in summer, solar radiation is excessive, so traditional installations must be covered to avoid damage and breakdowns.

However, in the new scenario of photovoltaic costs, the traditional system, previously described, begins to compete at a disadvantage with new water heating systems based on photovoltaic electricity. These devices are composed of the PV solar panels, the water tank, and the heater with resistance. Specifically, the heating of the water is performed by means of a resistance and an electronic control system.

Material and methods.

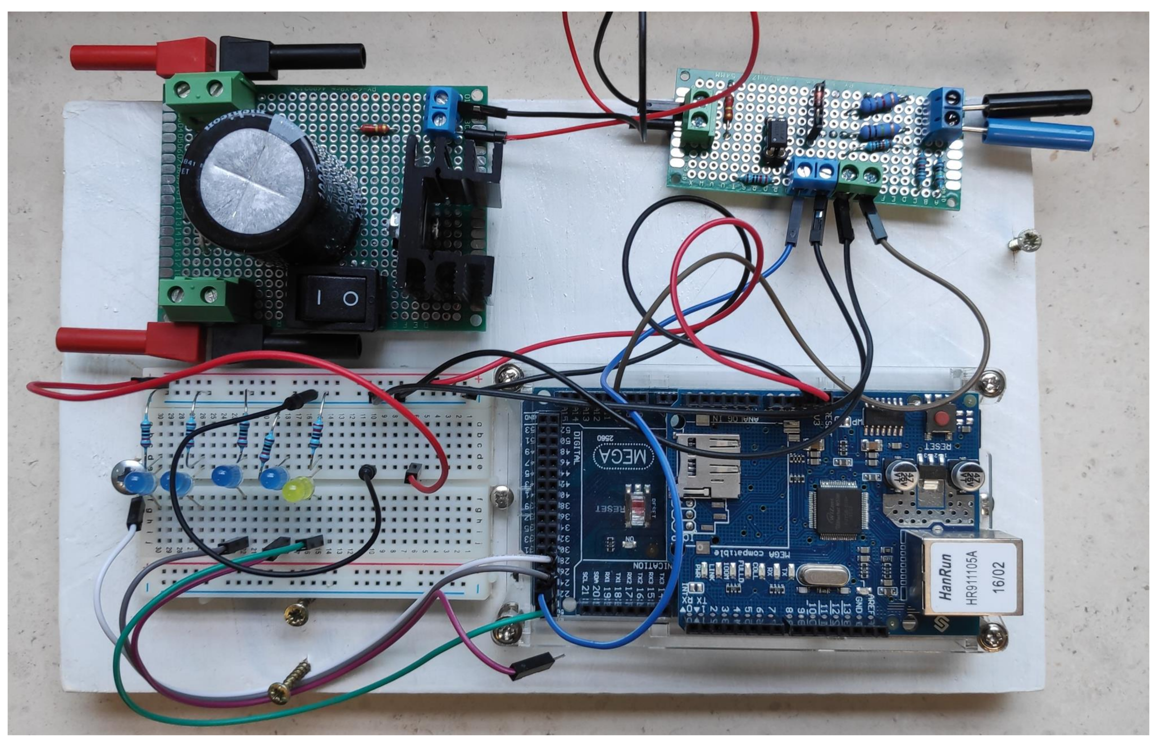
This paper presents the preliminary results obtained from an experimental facility built ex professo in the Hydraulic Engineering laboratory of the University of Cordoba (Cordoba, Spain) consisting of a photovoltaic unit, an experimental electronic impedance adaptation system, a sanitary hot water tank and a monitoring and control system.



The photovoltaic system has five monocrystalline modules Munchen Solar 330, inclined 25º and oriented to the South. The photovoltaic system operates at 1650 Wp, with 230.95 V open circuit voltage and a 9.11 A short-circuit current. This system will feed a 15 Ω heating resistor of 15 Ω located inside a 300L capacity insulated tank. In order to utilise the maximum available photovoltaic power and adapt the output impedance of the PV collectors to the resistance, a MPPT electronic circuit based on a 0.001 F capacitor and a MOSFET-n IRPF 250 have been designed.

Power control is performed by means of an ESP 32 circuit that permanently monitors the voltage at the terminals of the capacitor to pilot the transistor gate as well as the electrical current supplied by the PV system.

A recirculating pump has been installed to measure hot water production. This pump renews the water content in the tank every night and replaces it with cold water. The night-time control of the recirculating pump as well as the monitoring of the temperatures inside the tank is also implemented by means of an ESP 32-based electronic board. WIFI and BlueTooth connection of the proposed electronics makes the entire experimental device accessible from the cloud.



Conclusions

This work will present the study of the energy costs associated with this type of facilities as well as the comparison of theoretical values with experimental ones. Results demonstrate the existence of economic advantages associated with the heating of water for sanitary use by means of photovoltaic solar energy.