PERFORMANCE COMPARISON OF DIFFERENT WATER HEATER SYSTEMS WITH & WITHOUT SOLAR CONTRIBUTION, IN URUGUAY

1. Summary

Uruguay is promoting a change in the energy matrix betting on the use of renewable energies. The energy consumption for hot water is mainly electrical, representing approximately 30% of electricity consumption of households, and more than 10% of national electricity consumption. Using water heating system with solar energy is not widespread. In part, by the absence of data and research on the subject. This paper models the saving consumption of a typical family of 3 members, by adding a solar heating system. Several consumer profiles are designed. Water-heating costs with a thermo-electric tank or a gas heater are studied and analyzed the savings by introducing solar contribution. It is noted that the time of repayment of investments are high, requiring government subsidies to ensure penetration of solar technology at the household level.

Key-words: water heater systems, performance comparision, solar heater.

1. Introduction

In recent years, it has promoted a change in the energy matrix of the country, strongly betting on the use of renewable energies that allow energy independence of Uruguay. In this context, the government launched a plan to promote the installation of solar panels in homes and so try to reduce electricity consumption for heating domestic hot water (main source of energy used in the country for this purpose).

However, it has not reached a massive use of solar collectors at the family level. Perhaps the most influential reason for this is the high cost of initial investment. On the other hand, other factors such as lack of knowledge on system performance (as it is a technology little known in Uruguay), the lack of securities and uncertainties about the durability of the system and the time needed to recoup the investment and do economic gains from energy savings.

This paper attempts to answer this last question. To calculate the performance of the solar contribution, the global system (collector and backup power source) is studied. A study of energy consumption destined for domestic hot water (shower) of a typical family is then presented, analyzing three scenarios for different water consumption. The energy consumption of a thermo-electric tank regarding a gas heater is compared, with and without solar contribution in both cases.

2. Consumption profile

The demand for domestic hot water depends heavily on cultural factors, climate, socio-economic conditions of the family nucleus and number of members thereof, access to the resource, energy source to heat water, and specific system used. No studies exist on the profile of hot water consumption in Uruguay. To perform the analysis, this paper is based on measurements of said profiles conducted in other countries. However, to reduce the errors introduced by such extrapolation, different scenarios of consumption are studied (number of daily showers, and at what times). It is known that these scenarios are arbitrary, but were chosen trying to cover as much as possible the differences outlined above.

This work considered an ideal comfort for a shower 10 liter per minute for 5 minutes at 38 °C. However, consumption used in modeling depends strongly on the heating system used: thermo-tank or gas heater. While the thermo-tank provides a fixed water volume (approximately) at a temperature given by the setting of the equipment, the gas heater provides an instantaneous heating power fixed supplied to the water flow inlet. Both different technical characteristics generate different (flow and temperature) consumptions.

The consumption depends also on the cold water temperature of the network. There are also no data of this temperature in the country. It will not be the same for those households directly connected to the distribution network, that for those with a water tank on the roof of their home. In this work, RETScreen model for water

distribution temperature from atmospheric temperature was used.

In all cases a type of three family members was modeled. This value corresponds to the average number of members of the Uruguayan families. This value is low given the existing homogeneous dispersion in the local demographic structure.

3. Modeling and Calculations

The calculation of power consumption of a thermo-tank was carried out based on the data of the standard of the Uruguayan Institute of Technical Standards UNIT-1157:2011. A thermo-tank of 60 liters with a cut temperature of 60 °C was considered. The gas heater performance was calculated based on equipment with nominal power of 17 kW, which can also operate at half power (8.5 kW).

In Uruguay there is not a typical meteorological year a hourly scale with which it can calculate the performance of a solar collector. They are: daily global irradiation on horizontal plane, and average air temperature for day and night.

To evaluate the useful heat extracted (and therefore the water temperature at the exit) of a collector-accumulator solar system the model described by ISO 9459-2 was used. A thermosyphon solar heater with a 2 m^2 flat collector surface and an accumulator tank of 150 liters was modeled. Results were compared with modeling with TRNSYS of the same system but with forced circulation and vertical tank.

4. Result and Conclusions

The amount of assumptions and partial data that were used in this work prevent draw firm conclusions. Moreover, results were obtained showing certain general characteristics.

The energy saved when there is a solar preheating is greater in a gas heater than in a electric thermo-tank. However, as electricity is much more expensive than gas, the economic savings is much higher (between 65 and 80% more) with an electric water heater.

However, the cost of a solar water heating system is also very expensive in Uruguay. Therefore repayment times are around 6 years if a thermo-tank is used. In the case of having a gas heater times are even higher, at around 13 years.

The government has given a subsidy that reduces the time of repayment by approximately 35%. This subsidy has been fundamental in promoting the use of solar heating technology, without which a family almost have not considered an investment with such long repayment periods.