Energy performance analysis and environmental impact assessment of a single family solar water heating system for the Mediterranean climate

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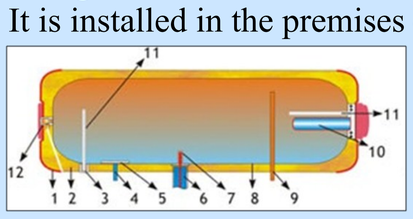
Introduction

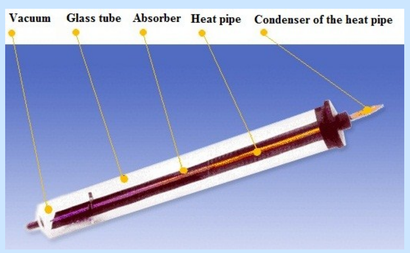
Improving the energy efficiency of buildings and reducing the GHG emissions from them, through the use of renewable energy technologies, is a key objective in the European Initiative on Smart Cities.
By the end of 2012, an installed capacity of 78.3 MW_{th} was in operation in Albania, or 0.037 m^2/inhabitant. The corresponding oil equivalents and CO_2 reductions of all operating solar water systems was respectively 8.4 kTOE/year and 27 tCO_{2eq}/year.
In the present work the energy evaluation of a new type of solar collector installed in a single family system for the Mediterranean climate, is carried out. Also, the assessment of its environmental impact is performed. Recorded data obtained from the acquisition and the storage data system, are exploited.

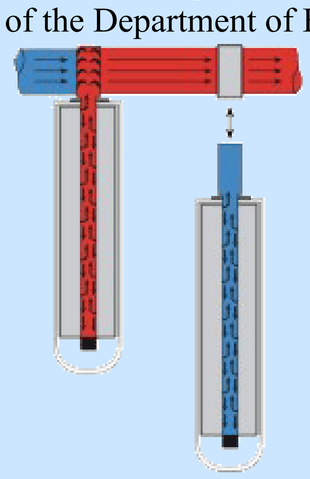
Materials and methods

Measured parameters include:
1. global solar irradiance on tilted collector surface
2. air temperature near the solar collector
3. cold water temperature
4. hot water temperature
5. hot water temperature near the consumer
6. mass flow rate of the heated water.

In Figure 1 is shown the solar water heating system and its components used in the present study.
It is installed in the premises of the Department of Energy, F.M.E.- P.U.T.

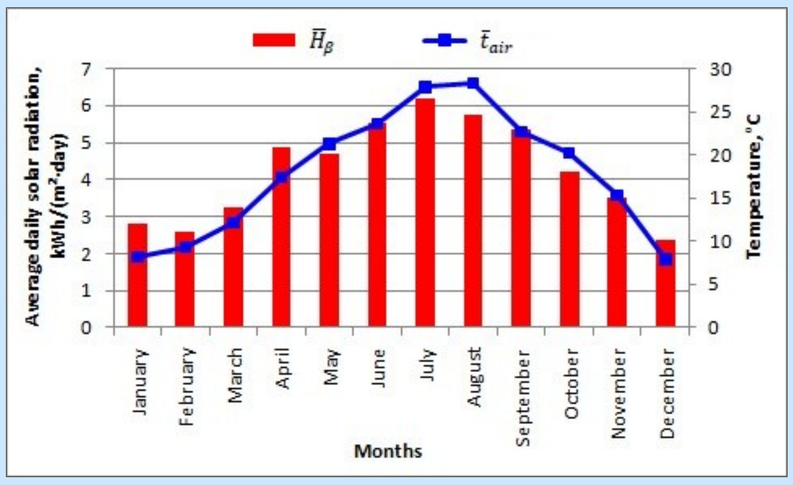






Results

In graph 1, monthly values of the daily global solar radiation on the tilted solar collector and the ambient temperature near the collector are shown.

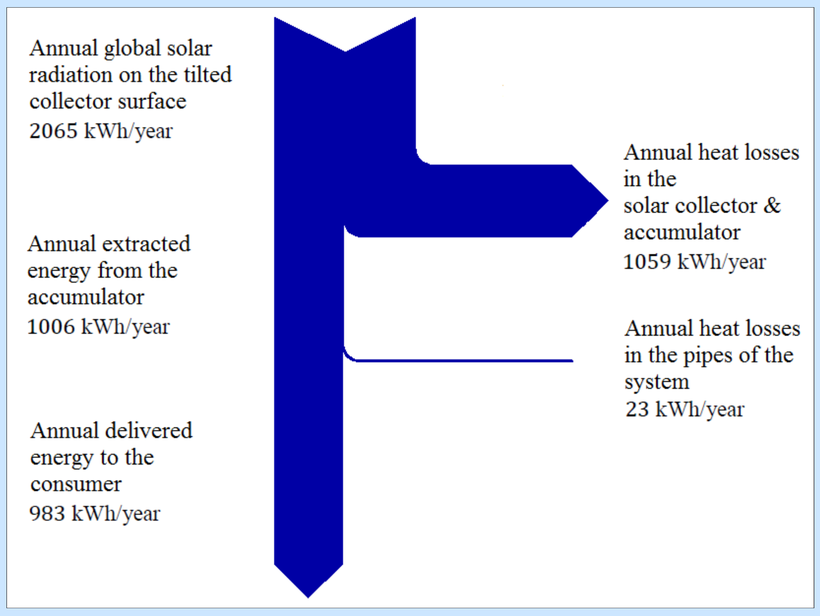


In graph 2, monthly values of solar yield are shown.

In graph 3, monthly values of the system efficiency are shown.

In graph 4, monthly values of avoided CO_2/m^2 are shown.

In Figure 2, the annual energy balance of the solar water heating system is shown (single family system).



Conclusions

The whole year energy performance analysis of a single family solar water system with heat pipe evacuated tube collector was carried out using a field trial installation in the city of Tirana, Albania. The system was designed and operated considering the real conditions during a 12-months period. With the aim to define the solar contribution, the immersion heater is turned off.

a) Results showed that for an annual global solar radiation on the tilted collector surface of 2065 kWh/year, a total of 1006 kWh/year was extracted from the accumulator, while 983 kWh/year was delivered to the thermal consumer.
a) The annual solar yield was 671 kWh/(m²·year).
b) The annual average system efficiency was 0.515.
c) The annual avoided CO_2 emissions was 238.6 kg $CO_2/(m^2 \cdot year)$.

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