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ScienceDirect

Procedia Environmental Sciences 38 (2017) 36 – 43

Procedia Environmental Sciences

International Conference on Sustainable Synergies from Buildings to the Urban Scale, SBE16

Energy and Environmental Performance of Solar Thermal Systems in Hotel Buildings

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Abstract

The energy policies in Europe include the reduction in energy consumption of buildings along with their environmental impact, focusing mainly on CO_2 emissions. In this framework, solar thermal systems used for space heating purposes and Domestic Hot Water production will be studied in detail. Solar thermal systems are one of the most popular ways to provide sanitary hot water in hotel buildings, all over the world and in particular in the Mediterranean. This is due to the fact that over the last forty years they have been proven to be reliable and cost effective.
Still, there is more to those systems, than cost efficiency, as it will be discussed in this paper, based on a study carried out for the Greek hotel sector. The analysis of the solar thermal system was done on the basis of technical characteristics and their energy efficiency as well as of the potential energy saving and their environmental impact, focusing mainly on CO_2 emissions. The environmental evaluation of the system studied is expressed by means of an integrated environmental approach, based on environmental rating systems namely LEED and BREEAM.
Goal of the paper is to present the result of the overall evaluation of the solar thermal system and its contribution to the improvement of the building's energy and environmental performance and also discuss how this affects the building's respective certification.

Peer-review under responsibility of the organizing committee of SBE16.

Keywords: Hotel buildings; Solar Systems; Environmental Evaluation; Carbon Footprint Analysis; Rating Systems

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Peer-review under responsibility of the organizing committee of SBE16.
doi:10.1016/j.proenv.2017.03.072

1. Introduction

It is well documented that building sector is responsible for the 40% of the total final energy consumed in the EU. Specifically, the residential sector was responsible for the 27% of the total final energy consumption in 2010, while the tertiary sector was responsible for the 16% respectively. Therefore, the European Parliament approved the Energy Performance of Buildings Directive (EPBD) 2002/91/EC and its recast, the Directive 2010/31/EU. Except from those Directives, the EU set the main goals for energy, transport and GHG emissions not only for 2020 but also for the following decades; 2030 and 2050. The main goal is no other than the gradual reduction of the energy consumption and GHG emissions [1,2].

Recently, Europe faces challenges in the energy and financial sector. The unstable economic circumstances are an intense source of disturbance and a brake on the continued growth of the European countries. The ongoing increase of energy demands, observed in the past years, led to the gradual depletion of fossil fuels. Furthermore, the significant increase of gas pollutants (CO_2, NO_x) has had major impacts on climate and environmental quality (eg. global warming). The need for renewable energy in conjunction with the demand for higher quality of life and reduction of environmental impact is becoming a major aim of developing and integrating technologies that promote the application of renewable energy sources and adopt best practices of rational energy use. Towards this effort, the European Union has a leading role through a series of actions and initiatives (Target 20-20-20), in order to ensure a development on solid economic, social and environmental bases. More specifically, Europe has set a target of 20% of the total energy consumption derive from Renewable Energy Sources [1,3].

In Greece, 18% of the total energy production is based on RES, namely on small and large hydro, wind and solar (PV and solar thermal) systems, while Greece is considered one of the leading countries in installed solar thermal systems [4]. By the end of 2012, an installed capacity of 2,9 GWth corresponding to a total of 4,1 million square meters of collector's area was in operation. Greece has in absolute terms the second largest total installed capacity in Europe, after Germany, and also the second largest per capita installed capacity, after Cyprus [5]. Although, in Greece, hotels represent only 0,82% of the building stock in terms of built area, they have an average specific annual final energy consumption of 407 kWh/m2, almost 10% of the total primary energy consumption of the building sector [6].

Furthermore, an environmental assessment of Domestic Solar Hot Water Systems (SHWS) in residential and hotel buildings took place in Spain. An evaluation method based on the Life Cycle Assessment (LCA) methodology was used to analyze the environmental implications of SHWS considering the production, use, maintenance and end of life stages. As a case study, 32 different types of SHWS of 2 dwellings and 2 hotels, located in the region of Aragon in Spain, were studied. From an environmental point of view, comparing the results obtained in all cases (e.g in terms of kg CO_2 eq), the use of biomass as fuel for the auxiliary source in each SHWS considered, provided the greatest environmental benefit in comparison with the other fuels, usually followed by the use of natural gas [7].

Finally, another case study will be mentioned concerning a high-rise 5 star hotel in Sao Paolo, Brazil where a solar thermal system was installed for space heating and Sanitary Hot Water production. A number of 72 solar panels were used with 310m^2 solar surface. The solar thermal system worked preheating storage tanks within temperatures from 10^{0}C (temperature of the cold water in the worst condition), to 45^{0}C which is the maximum temperature at the tab. The temperature level in the tank was controlled from the central building management system control. With this system up to 65% of the hotel's hot water needs are covered from the solar system. A payback of around 8 years justified the savings in electricity or fuel consumption, making the proposed solar system optimum for high consumption buildings like hotels [8].

2. Solar Combi System Technology

Solar Combi Systems are used both for Domestic Hot Water (DHW) production and space heating. In these systems, the solar collector is responsible for collecting the incident solar radiation, converting it into thermal energy and transferring this energy to a fluid flowing through the collector. The main component in a solar collector is the absorber where collection of the radiation takes place. The heat is then partly transferred to the heat medium (usually water or water-glycol mixture), with the rest lost to the environment. The collector is connected to a piping network, through which the heat medium is transferred either directly to the heating/cooling equipment or to the heat storage from where it can be drawn for later use. The solar collector is placed usually on the roof of the buildings.