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Upgrading Energy Efficiency For School Buildings In Greece

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Abstract

This article presents the cumulative experience from the design, the study and the application of energy efficiency technologies in school buildings in Greece, implemented within the frame of a funding action by the European Committee and the Greek State. In total 10 school buildings in Crete, Thessaly, Macedonia and Thrace were studied. All of them were approved for funding.
Among the proposed actions both passive measures, to reduce heating and cooling loads, and active systems, to approach maximum Renewable Energy Sources penetration, were involved. Building envelope insulation, replacement of inadequate openings and, in one case, a green roof construction as a pilot application, constitute the implemented passive measures. On the other hand, photovoltaic (PV) panels on roofs, solar combi-system with biomass heaters for the most southern locations (Crete) or single biomass heaters for the northern locations, installation of low energy consumption lighting equipment and introduction of hybrid cooling techniques mainly with the installation of ceiling fans, compose the set of the introduced active systems.
The calculation of the heating and cooling loads was executed with the use of TRNSYS software, for both the existing situation and after the proposed passive systems introduction. The operation of the solar combi-systems was arithmetically simulated using annual time series of mean hourly values for the heating loads and the available solar radiation. A software application was developed using LabVIEW. Finally, a fundamental economic analysis was executed for each introduced technology separately, as well as for the whole intervention. The examined buildings energy efficiency is expected to be upgraded at least in category B. Currently, all the proposed works have been integrated. A measuring system for the monitoring of the operation of the introduced technologies has been proposed, accompanied by a user friendly application. This monitoring system will also be exploited demonstratively for the students, as a teaching supporting tool. The measuring of the introduced systems normal operation will provide a reliable evaluation for the initial calculations and the anticipated upgrading of the buildings energy efficiency.

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Keywords: school buildings energy efficiency; solar biomass combi-systems; building envelope insulation; photovoltaic panels on roofs; passive solar systems

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1. Introduction

Most buildings worldwide exhibit remarkably high specific energy consumption per unit of covered area. Old building envelope constructions, lack of relevant national regulations regarding the building's energy performance or inadequate application of the existing ones, absence of any production technologies of thermal energy or electricity production from Renewable Energy Sources (R.E.S.) and building users with deficient education on the primary energy sources conservation and the rational use of energy constitute common characteristics and attitudes met even in the widely considered developed countries. An ultimate consequence of the above facts is that the building sector contribution to the overall annual energy consumption globally is approximately estimated at 40%.

An effort to rationalize the use of energy in buildings in Europe has begun with the issuance of the European Directives 2002/91/EC and 2010/31/EU on the energy performance of buildings. These directives:

- establish a clear cluster of potential passive and active measures, employing a variety of on a case-by-case applicable technologies, towards the energy saving and production from R.E.S. in buildings
- introduce the buildings energy efficiency ranking, in terms of the energy consumed, establishing simultaneously clear targets regarding the buildings energy performance.

The application of these directives has gradually passed from the central European stage to all the members of the European Union (EU) with the introduction of corresponding national laws. Additionally, focusing on the support of the application of the above directives and, most importantly, on the "energy cultivation" of the European residents, a large number of funding actions have been announced during the last fifteen years, both in a central EU level and in decentralized national funding calls. These calls are targeted on the application of energy saving measures and production from R.E.S. technologies in buildings, favouring, usually, the energy upgrading of buildings open in public and, generally, of buildings accessible to a large number of users or visitors, such as museums, civil buildings, universities and schools. In this way, the demonstration of the introduced energy efficient measures is maximized, contributing, simultaneously, to the cultivation of the public energy conservation attitude.

This paper presents the results of the implementation of energy upgrading passive and active measures in ten school buildings in Greece. All the implemented tasks were co-funded by the European Committee and the Greek State, under a specific relevant call posted and executed in the second half of 2011 by the Greek Ministry of Energy and Environment. The basic structure of the call was the introduction of energy efficient measures in school buildings, aiming:

- obviously at the energy upgrading of the school buildings, practically the direct and apparent benefit of the implemented measures
- at the reduction of the operating cost of the school buildings, relieving, thus, the annual economic balances of the local Municipalities in charge for the maintenance and the economic support of the school buildings operation
- at the introduction of a strong and highly effective demonstration tool for the promotion of the energy conservation concept on the young and easily cultivated school ages, investing, thus, in a future generation with deep "energy culture" foundations.

Practically, by approaching targets in three different fundamental pylons of a contemporary community, namely the energy conservation, the public economy and the education, the potential added value of the proposed energy upgrading tasks can be enormous. Towards this end, an optimum mixture of interventions for each school building should be selected, configured by the size and the age of the building, as well as the available climate conditions, while all the proposed active systems should be effectively dimensioned. Finally, the secure and trouble-free normal operation of all the introduced systems should be ensured, minimizing the required time consumed from the Municipalities technical staff for their maintenance.

A detailed presentation of the work accomplished towards the energy upgrading of the above mentioned ten school buildings, including the initial selection of the buildings' locations, the parameters adopted for the studies implementation, the passive and active measures introduced, the operating algorithms of the proposed active measures and, finally, the achieved results, is presented in the next sections.