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Investigation of the Energy Saving Potential in Existing School Buildings in Greece. The role of Shading and Daylight Strategies in Visual Comfort and Energy Saving

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Abstract

The overall potential for energy saving in existing school buildings in Greece is considered to be significant. The use of daylight in school buildings has been the subject of study in the past, since the proper use of daylight in schools is liable to improve student performance and to provide energy savings. It is also believed that natural lighting has affected the design of school buildings more than any other building type while the main problem is located on quality rather than on quantity issues. The paper investigates the extent to which the implementation of certain interventions to the building envelope of existing schools, can improve their energy performance and at the same time ensure thermal and visual comfort. A Primary school in the C climatic zone is used as a case study in order to examine energy performance and daylight issues for a relatively new school building with unfavorable orientation. The effect of alternative interventions such as the implementation of thermal insulation, the use of ceiling fans, the implementation of external shading, and the improvement of thermal characteristics of openings are being examined. The evaluation is performed using appropriate energy performance and daylight simulation tools.

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Keywords: school buildings; energy performance; daylight

1. Introduction

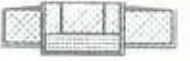



The present study investigates the implementation of energy saving, visual and thermal comfort measures on existing school buildings in Greece. The study examines issues related to the school building stock and investigates certain energy and environmental upgrade scenarios for an existing school building in the C climatic zone.

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1.1. Background

The school building type in Greece has evolved through time and mainly comprises the old stone buildings built before 1960, buildings with linear alignment of classes facing an open or closed corridor, type ATHINA with classrooms clustered in units of three, as well as certain types similar to ATHINA. According to official data, 59% of the buildings are up to 30 years old while a percentage of about 42% is considered relatively new since they have been constructed after 1985. Data on the energy consumption for heating for each building type in the three climatic zones in Greece demonstrate a large diversity of energy consumptions¹ (Table 1). In the last few years new building types have been implemented by the School Buildings Organization and new specifications have been put together concerning functional and building issues^{2, 3}. Additionally, the realization of the importance of energy conservation and sustainability issues concerning school buildings has led to the compilation of a bioclimatic design guide for school buildings, which includes guidelines both for existing and new buildings.⁴

Table 1. School types and energy consumption for heating¹

School Type	Schematic layout	Year of construction	Energy consumption for heating kWh/ m2		
			Climatic zone A	Climatic zone B	Climatic zone C
Old stone building		Before 1960	10	48	146
Type with open corridor		1960-1980	15	46	122
Type with closed corridor		After 1980	12	41	115
Type ATHINA		After 1980	5	27	86

The energy consumption in school buildings in Greece is a result of energy consumption for heating, lighting and equipment operation. Although not enough information is available concerning energy issues for school buildings on a national level, it has been reported that about two-thirds of the school buildings fail to meet the standard requirements regarding their thermal envelope construction due to insufficient insulation, single glazing etc. It has also been reported that compared to other types of buildings, schools present lower heating and cooling needs during peak demand periods which usually coincide with school holidays⁵.

According to the results of a study carried out in 1995, the average annual energy consumption on a national scale, based on measurements in school buildings in different climatic zones, was reaching 270000 MWh. According to a study carried out in sample of 238 school buildings across Greece, the average energy consumption for heating is 66 Kwh/m², for cooling 2 KWh/m², for lighting 16 KWh/m² and for the use of various devices 8 Kwh/m². The total average energy consumption is 92 KWh/m². This amount, which often reaches 100- 200 KWh/m², is considered to be very high in relation to the generally mild climate in Greece. Moreover, this consumption does not meet actual needs, since in most of the schools comfort conditions are often not met.¹

According to a recent energy survey⁵, in order to assess the energy performance of schools on a national level, a total of 500 schools covering the existing building stock in all three climatic zones (A–C) of Greece, according to an older climatic zone classification. The average age of the buildings in the sample was 36.5 years though a significant percentage (33.6%) dates over 40 years. This is representative of the national average age distribution of the national building stock. Analyzing the data of the whole sample the average thermal, electrical and total energy consumption was found equal to 57, 12 and 69kWh/m², respectively. All schools are naturally ventilated with a central heating system, and some use local heat pumps for space cooling in office spaces. Although the heating system operation (with heating systems including mainly central oil-fired boilers) is assessed as “satisfactory” for

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