



# Impact of Insulation on School Building Energy Consumption

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**Abstract:** The purpose of this study is to quantify the impact of insulation of various parts of building envelopes on building energy consumption. Using DesignBuilder, a series of parametric simulation was conducted to acquire building energy consumption data for a range of U-values of walls, roof, and windows of a primary school "Vuk Karadzic" in Čačak, Serbia. Analysis is conducted for annual heat losses and benefits of the insulation measures of walls, roof and windows respectively. In addition, analysis of heat gain and loss components was conducted for the purpose of identifying strategies for effectively installing insulation on different parts of the building envelope. Obtained results show a possibility measure to improve the energy efficiency of the analyzed school building by decreasing of heating power up to 34 %.

**Keywords:** Heat losses, Heating power, Insulation, School.

## 1. Introduction

Buildings are a major source of energy consumption and greenhouse gas (GHG) emissions, and account almost half of energy consumption and GHG emissions annually in most countries. The use of energy in buildings has increased in recent years due to the growing demand in energy used for heating and cooling in buildings. Without energy buildings could not be operated or inhabited. Improvements could be made with insulation, HVAC, lighting controls and these are significant features that help towards achieving an energy efficient building [1].

Commercial buildings include a wide variety of building types such as offices, hospitals, schools, hotel, etc. These different commercial activities all have unique energy needs but, as a whole, commercial buildings use more than half their energies for heating and lighting. Schools usually have a high level of energy consumption due to their considerable heating requirements and high electricity usage for lighting and equipment. Investment in building and technology, as well as more conscious user behavior, can lead to considerable energy savings. Typical annual heating consumption for some European school buildings are reported as 96 kWh/m<sup>2</sup> in Ireland, 192 kWh/m<sup>2</sup> in Slovenia, and 157 kWh/m<sup>2</sup> in UK [2]. At the beginning of 2009/2010 in the territory of the Republic of Serbia there are 1711 registered primary and secondary schools, while in Čačak region there are 19 primary and 8 secondary schools [3].

Insulation of building envelopes, both opaque and transparent, is the most important strategy for building energy conservation. Insulation of walls, roof, basement walls and even foundations is one of the most essential features of energy-efficient buildings. In addition, as glass is a poor insulator, insulating transparent envelopes, windows and skylights, significantly reduce heat loss and gain during the winter and summer.

A user interface based simulation tool DesignBuilder is used in this study to evaluate the above mentioned energy conversion measures in a primary school building in Cacak [4]. The DesignBuilder calculation method is based on Energy Plus simulation engine. DesignBuilder creates a virtual environment where heating losses of the building are evaluated in order to determine the feasibility of various measures without compromising thermal comfort [5].

## 2. Simulation and variables for parametric studies

The selected school object is a primary school "Vuk Karadzic" in Cacak, Serbia. The building has a total area of 4.236 m<sup>2</sup>, the external surfaces of the facade are 2.700 m<sup>2</sup> and the facade window area is 487 m<sup>2</sup>. Cacak is a city located 140 km south from Belgrade in Serbia, at lat 43.87 °N, long 20.33 °E, with an altitude 250 m. The climate in Cacak is moderate continental, with an average daily temperature of 10.47°. Cacak is mostly exposed to north and northwest wind. The average speed of north wind is 2.3 m/s, and of northwest











