# Case Study: Energy Audit of the High School Dorm "Mirka Ginova"- Bitola

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*Abstract* – **Measures for increasing of energy efficiency in buildings are closely related to Energy Audit. Faculty of technical sciences – Bitola (FTSB) is one out of five companies that were chosen as educators for training of energy auditors. High School dorm "Mirka Ginova" in Bitola is the only state-owned dorm in the city. Preliminary energy audit for the nearby building of the dorm was performed as a part of the training for energy auditors. The calculations were performed by using of ENSI© EAB software.**

*Keywords* – **energy audit, dorm, energy class, ENSI software.**

## I. Introduction

Following recent adoption of EU regulative in the area of energy auditing in the country, [1,2], the first step was to train energy auditors with a purpose of obtaining licenses for energy auditing. One of the institutions licensed for training of Energy Auditors is the Faculty of Technical Sciences in Bitola. In the course of this training, the building of the nearby High School dorm "Mirka Ginova", was used as an example for energy auditing with determination of its energy class using ENSI© EAB software.

The building of the dorm is located in the south-eastern part of the city of Bitola. The object does not have attached building to it, located in averagely urbanized part of the city, next to the city park, bus station and railway station. It was built in 1960 and significant reconstruction and extension took place in 1994. Main entrance of the building is on the south-western side (Fig. 1).

Fig. 1. Location of the high school dorm "Mirka Ginova" in Bitola

## II. Required Data for Energy Audit

Dormitory "Mirka Ginova" in Bitola is educational institution within the Ministry of Education and Science of the Republic of Macedonia, student standard department. The building is mainly divided in 2 parts: north and south part. South part consists mainly of bedrooms, while in the north part, the kitchen, dining room and administration offices are located. South part consists of basement, three floors with wooden roof construction covered with metal sheet roof, while the northern building has basement and two floors also covered with metal sheet roof. The capacity of the dorm is 270 high school students and 26 employees. In the summer months, the dorm is open to accommodate guests of different events in the city. In this period of the year, an average of 100-150 guests are staying at the dorm. Total net area of the building is 3364 $m^2$, while total net volume is approx. 9420 $m^3$.

Last reconstruction of the building consisted of partial replacement of external windows and carpentry and took place in the year 2010.

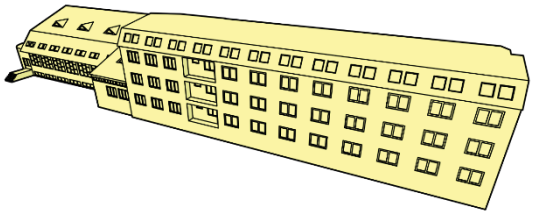

Fig. 2. Appearance of the building from the south-west

Part of the other relevant data for the energy audit, required by the legislative, are given in the following table:

TABLE I
PART OF THE DATA RELEVANT FOR ENERGY AUDIT OF DORMITORY'S BUILDING

| Characteristics of the building construction | Material (concrete, brick, hollow brick) | Total thickness [cm] | Thickness of the thermal insulation layer [cm] | Area of the construction [$m^2$] | Heat transfer coefficient U [$W/m^2K$] |
|---|---|---|---|---|---|
| External wall NORTH | Concrete | 36 | 5 | 31,14 | 0,914 |
| | Brick | 43 | | 297,61 | 1,16 |
| External wall SOUTH | Brick | 43 | | 252,40 | 1,16 |
| | Hollow brick | 27 | | 30,22 | 1,6 |

Prior to entering of data in ENSI© EAB software, a detailed calculation of areas of all surfaces (external building envelope) as well as heat transfer coefficient for all materials was performed. In the following figures, example of calculated

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areas for building's south façade and cross-section of one type of external wall and roof are shown:

At the end, we grouped external walls and windows in three groups according to building construction and heat transfer coefficients.

For the heating of building, hot water radiator heating system with forced circulation (with pump) is used. Heating installation is of a two-pipe system with lower horizontal branching. Two pumps are used for circulation of heating media (water). Boiler house consists of three hot water boiler connected in parallel, with a total of approx. 1100 kW installed heat power. Light oil is used as fuel. As part of the energy audit, a measurement of flue gases emission from one of the boilers was also taken.

Electrical equipment in use consists of more than 10 electric heaters (with total installed electric power of 54 kW) that are used prior to/after heating season (before 15.10 or after 15.04), electric appliances in the kitchen (total installed electric power of 116 kW), electric appliances in the laundry (around 53 kW), electric boilers with installed electric power of 102 kW, 15 personal computers copier machines, 11 air conditioning units (split system) etc. There are also around 180 fluorescent lightning tubes with electronic ballast installed for lamination and 52 light bulbs with total electric power of 5,2 kW.

For the purpose of energy audit preparation, detailed invoices – bills for electric energy and water consumption were collected from the accounting department.

## III. Conclusion

Following recent adoption of EU regulative in the field of Energy Auditing of buildings, the Faculty of Technical Sciences in Bitola is one of country's five licensed training centers for energy auditors, [5]. In the scope of training, practical part, the building of dormitory "Mirka Ginova" was taken as an example and general energy audit was performed on it. Calculations were performed using ENSI© EAB software for quick energy performance calculations.

The results from the calculations categorized the building of the High school dorm "Mirka Ginova" – Bitola as class "E" building. Calculated value of energy consumption is 158,4 kWh/(m$^2$a).

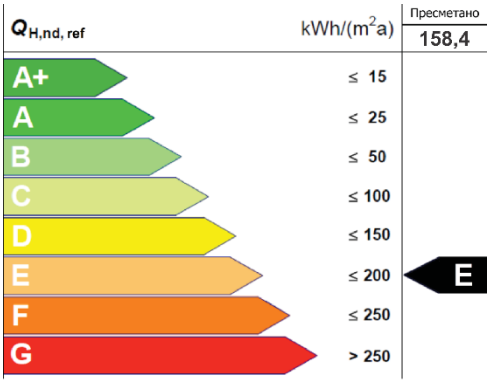


Fig. 4. Calculated energy class of the building

According to the National legislative, [2], all buildings undergoing 'substantial reconstruction' must reach at least "D" energy class.

In the example of preliminary energy audit of the dormitory "Mirka Ginova" – Bitola building, the proposed measured would include:

- Thermal insulation of all external walls in order to reach maximum allowed U-value of 0,35 W/m$^2$K;
- Partial replacement of windows and carpentry in order to reach maximum allowed U-value of 1,7 W/m$^2$K;
- Installation of additional thermal insulation for the roof in order to reach maximum allowed U-value of 0,25 W/m$^2$K;
- Replacement of one of the hot water boiler running on light oil fuel with high efficiency hot water boiler running on wood pellets.
- Replacement of light bulbs and fluorescent lighting tubes with LED lights;

Implementation of these measures would 'raise' building's energy class to "C".

Return on Investment (ROI) period for implementation of these measures was also calculated and it ranges from 2 years (lights replacement) up to 5,5 years (replacement of windows and corresponding carpentry)

## References

[1] Rulebook for energy auditing, official gazette of RM, No. 94/2013.
[2] Rulebook for energy characteristics of buildings, Official gazette of RM, No. 94/2013.
[3] User guide for ENSI© EAB Software, Version 8.1, May 2009, Energy Saving International AS, Norway.