

EVALUATION OF ENERGY EFFICIENCY MEASURES IN PUBLIC INSTITUTIONS

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Abstract

This paper presents an empirical study on the energy efficiency of kindergartens in the city of Zrenjanin, Republic of Serbia, conducted in 2023. The research evaluated the implementation of basic energy efficiency measures across all 19 kindergartens, focusing on the differences between new and old buildings. A structured questionnaire was sent directly to the official email addresses of each kindergarten, and responses were linked to specific institutions. A survey was carried out covering key aspects such as wall and attic thermal insulation, type of windows and doors, lighting systems, heating and domestic hot water supply, as well as the quality of window and door sealing. Results revealed that energy efficiency is generally poor: only two kindergartens, Alisa u zemlji čuda and Bubamara, both constructed after 2010, met most criteria. Notably, 17 out of 19 kindergartens still use incandescent bulbs, and all rely on electric boilers for water heating, the least efficient option. External wall insulation exists in only five facilities, and roof insulation is present in just one.

Introduction

Energy efficiency represents the ratio between the benefit obtained (product or service) and the energy invested, and it can be improved not only by reducing energy consumption but also by optimizing this ratio. Unlike energy saving, which implies certain compromises, efficient energy use does not reduce comfort or working conditions; it enables the same amount of products or services to be delivered with lower energy consumption, resulting in financial savings. In buildings intended for human occupancy, ensuring the required level of comfort demands energy for heating, cooling, and ventilation. The total energy consumption depends on external factors (such as climate), as well as on the building's own energy characteristics and the duration of the required comfort conditions, the less energy needed to maintain the prescribed indoor comfort, the more energy-efficient the building is [1-3].

The characteristics of buildings in the Republic of Serbia in terms of energy efficiency largely depend on their period of construction. Buildings constructed before 1950 are characterized by massive, thick walls, with average heat losses between 200 and 250 kWh/m². After 1950, construction involved the use of new materials without any thermal requirements, and from 1970 onwards, mass construction of slender and thin structures with large glass surfaces began, which have extremely poor thermal performance, with average heat losses reaching up to 300 kWh/m². Buildings constructed between 1987 and September 2012 exhibit average thermal quality, with heat losses around 150 kWh/m². Studies and experiences with increasing the thermal insulation of exterior walls have shown that it is most effective to target buildings constructed before 1987, where energy savings of up to 70% can be achieved [2-5].

Experimental

The study employed a quantitative, survey-based methodology targeting all 19 kindergartens in Zrenjanin. The questionnaire was distributed via email in 2023 and included 11 structured questions covering the following aspects: year of construction, presence of external thermal

insulation, roof insulation, window type (wooden single/double glazing, PVC, aluminum), lighting type (incandescent, compact fluorescent, LED), heating system (gas, district heating, electric heaters, heat pumps), water heating method, perceived airtightness of windows and doors (rated on a 1–5 scale), and plans for future energy efficiency investments. The collected data were compared across kindergartens based on key characteristics, such as the year of construction, to identify patterns and differences in energy efficiency measures.

Results and discussion

The energy efficiency measure with the lowest impact on institutional budgets is the use of energy-efficient light bulbs (LED or compact fluorescent lamps). Survey results indicated that 17 out of 19 kindergartens continue to use incandescent bulbs, which do not contribute to building energy efficiency. The kindergartens that have adopted energy-efficient lighting are Alisa u zemlji čuda (compact fluorescent lamps) and Bubamara (LED bulbs). These two kindergartens are also the only facilities constructed after 2010, reflecting greater attention to energy efficiency in newer buildings compared to older ones, which were built when energy efficiency was less of a priority.

All kindergartens rely on electric boilers for water heating, which is the least economically and energetically efficient option. Regarding attic insulation, 18 kindergartens reported the absence of insulation, resulting in significant heat loss. Concerning windows, 9 kindergartens (47.3%) have energy-efficient window frames, while 10 (52.7%) do not. However, the presence of energy-efficient windows does not automatically guarantee energy savings; proper installation and quality are essential for achieving efficiency. Using a 1–5 scale to assess airtightness, energy-efficient windows received an average score of 3.77, and less efficient windows scored 2.4, highlighting the importance of window upgrades in Zrenjanin kindergartens.

Only 5 out of 19 kindergartens have external thermal insulation. Furthermore, only 4 kindergartens (Alisa u zemlji čuda, Bubamara, Kolibri, and Snežana) combine energy-efficient windows with external insulation, and only two buildings (Alisa u zemlji čuda and Bubamara) also use energy-efficient lighting. These two buildings were constructed after 2010. For space heating, 12 kindergartens use gas, while 6 rely on district heating (city network: natural gas and fuel oil).

Conclusion

The study showed that the energy efficiency of kindergartens in Zrenjanin largely depends on the age of the building. Newer facilities, constructed after 2010, demonstrate significantly better performance, particularly through the use of energy-efficient lighting combined with high-quality windows and external thermal insulation. Most older buildings still rely on outdated and inefficient heating and lighting systems, with insufficient insulation and window quality. The results indicate that upgrading window frames, installing insulation, and replacing inefficient lighting are key measures to improve the energy efficiency of kindergartens in Zrenjanin, which can substantially reduce energy losses and maintenance costs.

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