



Potentials and limitations for energy refurbishment of multi-family residential buildings built in Belgrade before the World War One



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ABSTRACT

After the new set of regulations related to the problem of energy efficiency of buildings has been adopted, energy efficiency became the primary issue of the present building practice in Serbia, referring both to new buildings and to existing ones, among which refurbishment of buildings built before the World War One requires a special attention. Multi-family houses from that time represent today about 1% of the total building stock. Rarity of the buildings of this age and their structures caused that a large number of them are listed as cultural heritage, so any intervention on them, including those which are the result of adjustment to modern needs and building rules, becomes especially sensitive and complex. In particular, this refers to energy improvement measures which, according to the new regulations, are an inevitable part of any building intervention. Having in mind all the mentioned aspects, and focussed on the relevant examples of multi-family houses from Belgrade dating before the World War One, the potentials and limitations for their energy refurbishment were investigated.

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1. Introduction

Following the concept of energy performances of buildings that represents the basis of modern regulations in the field of thermal protection of buildings adopted in 2011, Serbia has taken the first steps towards improving energy efficiency of buildings. This was the year that was declared in Serbia as “the year of energy efficiency”, when the new energy efficiency regulations were enacted [1,2], based on the first version of EPBD [3]. While the *Rulebook on Energy Efficiency of Buildings* closely regulate energy performance of buildings and the corresponding calculation procedures by defining energy requirements for the new and existing buildings, the *Rulebook on the conditions, content and method of issuing certificates of energy performance of buildings* introduces mandatory energy certification of buildings.

This set of regulations, for the first time in Serbia, addresses the issue of energy consumption of both new and existing buildings, which represent a major consumer of the total energy generated in the country. Having this in mind, improvement of their energy efficiency by refurbishment becomes important for reduction of total energy consumption. Evaluation of potential energy savings that could be obtained by a process of rehabilitation of the

existing building stock created the need for undertaking an assessment of its quality. Therefore the extensive research was conducted by a group of authors from the Faculty of Architecture, University of Belgrade, within the IEE Project TABULA¹. It was aimed at defining the structure of the total housing stock in Serbia, primarily the characteristics of the thermal envelope that are relevant for energy performance of buildings, as a basis for the proposal of potential energy savings at the national level.

One of the criteria for classification of the housing stock was related to the period of construction. The oldest construction year class that was established included buildings built before the World War One. In spite of the fact that such buildings are scarcely present in the total building stock, these houses have a special value as testimonies of Serbian architectural past, so many of them are listed as cultural heritage. As a consequence, the process of their harmonization with modern standards in the field of thermal protection becomes a sensitive and complex problem.

Being the capital and the largest city in Serbia, having a rich and long-lasting history, Belgrade includes all relevant examples of the building types. In this sense its housing stock could be understood as referential. Although at the time of its origin Belgrade was a representative of the old European settlements, these historical facts are not visible through its architecture today. History of the

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¹ IEE project: TABULA—Typology Approach for Building Stock Energy Assessment, www.building-typology.eu.



Fig. 1. Examples of pre-WWI multi-family buildings from Belgrade.

city has been marked by wartime destructions, fires, floods and other devastations, resulting in a small number of preserved buildings from the past. Among them residential multi-family buildings built prior to the World War One represent only one percent of the housing stock of the whole city, which practically corresponds to the total Serbian housing stock of this type of houses. These are the circumstances that distinguish Belgrade from other European capitals.

The European model of urban development of the city started in the first half of the 19th century. As it was recorded in 1966 by the *Cultural Heritage Preservation Institute of Belgrade*, buildings dating before that time are extremely scarce [4]. On the other hand, most of the preserved buildings of the whole period of construction come from the time of the second half of the 19th century until the beginning of the World War One. What was the structure of the building stock of Belgrade in the early 20th century could be concluded on the basis of the census from 1906, which indicated the presence of 83% of ground floor houses, 16% of single-storey and only 1%, or a total of 60, multi-storey buildings [5].

With respect to the mentioned aspects, this article aims at investigating the potentials and limitations for energy refurbishment of the building heritage dating before the World War One, observed on a selected multi-family set of buildings from Belgrade which correspond to the characteristics of the established building types and can be seen as representative models of the total housing stock in Serbia.

2. Selection of the sample of Belgrade residential architecture prior to the World War One

Recently conducted research of building typology of the housing stock in Serbia showed that existing pre-WWI multi-family residential buildings were massive, low-rise structures with pitched

roof [6]. They have often undergone several makeovers, vertical or horizontal extensions, replacements or reinforcements to particular segments of the construction. On the other hand, due to the unavailability of the original design documentation, it is often very difficult to identify the authentic construction features. Typical for these houses are subsequent conversions of the loft area into apartments, although this was not common at the time of construction. Consequently, about one third of the loft space of these buildings is used for living at present (Fig. 1).

Having this in mind, a working class housing complex from Venizelos' Street in Belgrade was selected as an appropriate model for investigation of energy refurbishment potentials (Fig. 2). Although the research pointed out that predominant building type of the existing pre-WWI multi-family residential buildings was the row house and the selected buildings were somewhat lower than those typical for this period, the main reasons for this choice is based on the fact that, up to now, the selected complex underwent just small-scale alterations. The original structure and character of the buildings have not been substantially changed, apart from the fact that the originally uninhabited loft areas were transformed into the living space over time. This intervention was neither uniform nor planned, but was carried out on the initiative of individual tenants at the moments suitable for them.

Erection of the complex was financed by the Belgrade municipality. It was built in 1911. according to the design by the first woman architect in Serbia, Jelisaveta Načić. Planned for living of the poor civil servants and workers, this was the first settlement of social housing in Belgrade. Since this was a social housing development, the applied materials and elements of form were modest. Nevertheless, the designer's skill helped to avoid a potential impression of penury such a house might give [7]. The complex enjoys the status of a cultural monument, which could

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