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# NATIONAL BUILDING TYPOLOGY AS A SOURCE FOR THE ADEQUATE REHABILITATION POLICY

**Abstract:** Serbia`s Low on Planning and Building has imposed the topics of energy efficiency in building sector, requiring adequate policy making and providing the starting point for improving the current situation in this field. By having more than 3.200.000 housing units without any but statistical classification it has been realized that development of national building typology has to be established in order to have a starting point for further decision making and appropriate activities definition regarding the existing housing stock.

After joining EU TABULA (Typology Approach for Building Stock Energy Assessment) project, methodologies and approaches of the European countries have been analysed providing common experiences, but at the same illustrating the need for identification and classification of local characteristics. In order to gather the adequate data a comprehensive survey has been conducted, providing the starting point for creation of typology. The National Typology has identified typical „model" buildings and defined the levels of improvement ranging from standard (according to the current law) to the low-energy level.

The paper explains the methodology, procedures and local characteristics of the process providing an insight of the activity, illustrating the problems and potentials of the approach.

**Key words:** *residential buildings, typology, energy efficiency, regulations*

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## 1. INTRODUCTION

Following the current trends of energy efficiency, but with significant delay compared to other European countries, Serbia has defined the grounds for structuring this field in the building sector by imposing the new Law on Planning and construction in 2009. In a single article a concept of energy efficiency of buildings has been imposed and need for building Energy Performance Certificates (EPC) issuance declared. In period to follow, a set of sub low documents was developed in order to facilitate the procedure, and starting from September 2012. EPC`s are included as the part of the obligatory construction documentation needed for obtaining the building permit for the new constructions and major renovations. Energy performance of buildings is certified through the calculation of level of annual energy used for heating per square meter of floor area and also is explicated in the form of primary energy and $CO_2$ emission. This procedure, fully compliant with European regulations, departs from current Serbian practice and regulations imposing much stricter requirements for thermal protection of buildings. What is more important, it also changes the design approach from thermal performance of building envelope to total building performance taking into account all losses and gains annually. Regulations have provided a framework for design but the impact that implementation will have especially in the field of existing buildings treatment is largely unknown. Construction activity, due to the current economic situation in Serbia has decreased dramatically with less than 1% [4] of new buildings being constructed annually shifting the interest of energy efficiency towards the treatment of existing building fund. It has been realized that a comprehensive survey of building fund has to be performed in order to define a starting point for the evaluation the potential of energy savings through the process of rehabilitation. Research has been focused on residential building typology.

## 2. DEVELOPING THE METHODOLOGY

Structuring the building fund and definition of the relevant typology is mainly influenced by the availability of relevant data. The most accurate data could be derived from the National Census, which, in Serbia has been conducted every ten years. The methodology of Census defined in the 1950s has been improved but does not reflect the full spectrum of information needed for analysis of building fund. Last census has been conducted in the autumn of 2011, and was based on several questionnaires partly covering the building characteristics. Questions were organized in two ways: one to be answered only by the tenants usually giving the info about the structure of the residential units: the construction year of the apartment (building), the area of the apartment, the number of rooms, installation

status (types of installation equipped: electrical, plumbing, sewage systems), fuel used for heating, and another which are dealing with building category and can be partly assessed by the enumerator: type of the building (free standing single family house, free standing duplex house, semi-detached house, terraced house with at least three attached residences each with own entrance, multifamily house with 3–9 apartments, apartment block with 10 or more apartments) and external wall material (rigid or soft). This is actually the first time that any information dealing with urban characteristics of the buildings have been collected on national level.

The information that has been gathered can be very useful, (although full availability of the data for the public is planned for the December 2012.) but it does not facilitate the assessment of the quality of energy performance of buildings nor provide necessary information for defining the rehabilitation strategies leading towards the evaluation of the national energy savings potential. It was, therefore decided that, for the purpose of this research, an independent survey, based on statistically relevant sample should be conducted enabling the creation of national residential building typology upon which the energy performance of building stock can be assessed. It was also realized that this activity would have to try to structure and evaluate all specific architectural and urban parameters in design and construction reflecting the local characteristics of Serbia.

As the starting point methodology has been following the model adopted within the IEE Project TABULA [5], using the information gathered in the previous DATAMINE project, but having in mind specificities of Serbia. The European approach largely depends on the information that can be retrieved from the EPCs being issued according to the national procedures and by various local or national databases and registries of buildings, method which is not applicable in Serbian case For this reason we had to formulate the procedure of data collection which will, based on the EU partners experience, enable us creation of national typology.

## 2. 1. SERBIAN SPECIFICS

Like many other European countries Serbia has, in the period of World War II been characterized by considerable devastation, especially in urban areas. Change of political system, that followed, marked by the Socialist policy of development and planned economy tried to change the structure of the country, and cities, by forcing urbanization as a symbol of modernity and progress. This meant that very few large-scale reconstruction processes in the urban areas had happened, but development of „new" cities had taken place instead. Massive migrations to urban areas were encouraged requiring sufficient supply of apartments. This production has been done mainly through development of new suburbs consisting of multi story buildings often constructed by state owned, mega companies, using the tech-

nology of recognizable prefabrication systems. These „dormitories" had unified architectural language, construction and material characteristics and often were marked by residential towers with more than 150 units. Slowing the socialist economy and gradual change towards the market orientated one, reflected the construction process, mainly by orienting it towards the smaller scale construction and interventions in existing urban tissue of „old towns".

Throughout all this time, individual initiative, was not banned but also not regulated and usually realized through erection of single-family houses, located mainly in rural areas and at the outskirts of the cities. This meant that settlements of this kind were not covered by planning regulations and buildings were usually constructed without building permits, therefore very few regulations followed. This trend has been largely increased in the period of 1990s, following the breakup of Yugoslavia, as the vast number of refugees has come to Serbia, mainly to urban areas, having to rely on non-institutional solution for their housing needs. As the result of such housing policies uneven and very often non-controlled development has been at scene with constant decline of rural settlements and population and great increase of urban ones with occasional high residential densities recorded.

In order to analyse such a diverse building fund a set of starting parameters were defined covering the several areas that are influencing the typology:

**Architectural and planning parameters**

Classification based on these aspects included eight types of buildings and was developed according to the following postulates [3]:

– The relationship between the building and its lot with special attention to the socialist period housing projects. This period has been characterized by large-scale construction in „open" blocks with unified, usually identical buildings.

– The location of the building with respect to the neighbouring structures.

– The classification according to the number of apartments: one family, multifamily (up to 4) and collective dwellings. As a separate type a high rise residential towers were identified.

This classification (Fig. 1) was done having in mind the thermal properties of the buildings as well as possibilities for rehabilitation and represents a new approach for Serbia.

**Parameters influencing the thermal performance of envelope**

Parameters analysed are covering several aspects of building form, structure and appearance and were analysed according to the following premises (Fig. 2):


Figure 1: Classification scheme: building types for single-family and collective dwelling

– Shape of the building explicated through ratio between envelope and corresponding volume resulting in three categories: compact, elongated, non-compact.

– Quantification of „openings" on the envelope illustrating the relationship between number and types of windows and facade face, appearing in three categories: small percentage of individual openings (less the 50% of the facade), high percentage (more than 50%) and window ribbons (typical appearance of the construction from 1960s and 1970s)

– Using of loft and basement spaces that defined the existence of such a space and way it has been utilised.

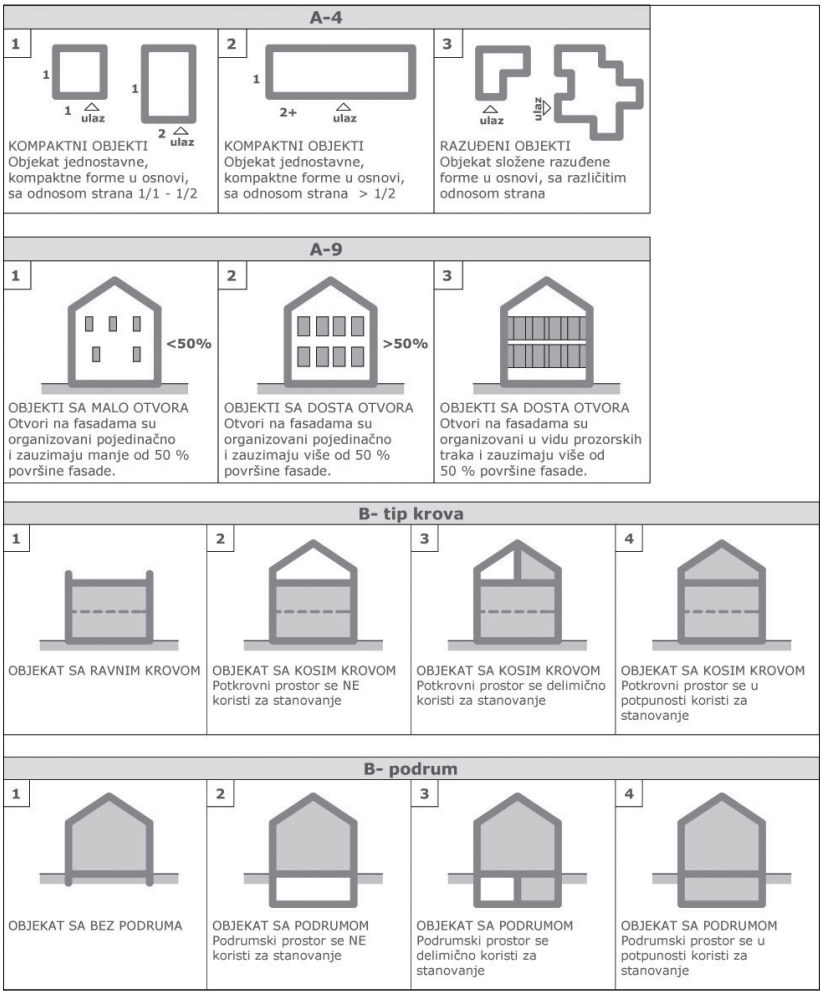


Figure 2: Classification scheme: building geometry type, percentage of openings, usage of loft and basement

**Construction year class**

Construction period does not directly influence performance nor classification but provides a cross referencing towards the significant regulations and construction techniques applied. In details, classification has been characterized by:

– The introduction of thermal regulations (estimated time of applying the certain regulations is approx. 2 years which represents the average design to construction period in Serbia)

– Socio-political events:
  – World War I and II, especially period from 1945–70 that has been characterized as the most dynamic and fruitful changing the face of country.
  – Transforming of economic system and breakup of Yugoslavia from the early 1990s meant that state controlled construction process was not in force and that whole construction activity has shifted towards individual initiative.

– Changing of the planning doctrine from large-scale development (mass construction) to single building construction followed by reaffirmation of traditional city matrix.

The chosen periods were therefore chosen as: before 1919, 1919–1945, 1946–1960, 1961–1970, 1971–1980, 1981–1990 and 1990-present.

## 2. 2. THE STATISTICAL SAMPLE

All these analysis have to be applied on certain statistically relevant sample in order to gather the data for further analysis and estimations. As has been previously mentioned an independent survey by the third party professional firm has been conducted. In the design phase of the process it has been decided, due to the limited financial resources that a two step procedure is to be applied. Design of the sample was done in the way that it respected the uneven distribution of housing in urban and rural areas yielding certain percentage of investigation to the urban zones in order to get the adequate results. This meant that the major urban areas (four largest cities) received 5–10% more starting points for investigation.

## 2. 3. PHASE A OF THE SURVEY

This phase has been conceptualized as a quantification process that was conducted according to the following postulates:

– It has been conducted as an ad hoc survey

– The trained enumerators have collected all data about the buildings on site.

– An explanatory charts have been derived by the Faculty of Architecture in order to explain the nature and structure of the data.

– The territory of Serbia was divided into zones defined by the census principles (6 zones, 25 administrative districts).

The sample itself consisted of approx. 6000 residential buildings throughout Serbia (excluding the territory of Kosovo), and it was based on 2002 census, migration data as well as ISM`s population estimation for 2009. Stratification according to the type of settlement urban/rural has also been preformed for all 25 administrative districts of Serbia. Starting matrix was based on polling place area

(approx. 200 households) that has been chosen according to the probability proportional to size sampling (PPS). From starting point every third building has been recorded. In this phase basic information about buildings have been recorded: address, type of the dwelling unit (as explained in Fig.1), complexity of ground plan, number of floors, number of apartments, total area of the building (estimation), opening ratio, type of the windows, photograph of the building (according to the pre-set principles).

### 2. 4. PHASE B OF THE SURVEY

Second phase was considered as more in depth approach towards the data collection and it included interviews with residents. For this phase every 5$^{th}$ building that has been identified in the phase A has been, in detail, analysed, resulting in sample of approx. 1200 buildings. Data that had to be collected has been structured in six sections according to the type:

A. Building/House data: year of construction (in accordance to the predefined periods), existence and using of the loft and basement space

B. Roof: type of the roof, has it been thermally insulated, thickness of insulation, type of the roofing (by material applied)

C. Outer walls: main building material, average thickness of walls, existence of thermal insulation, thickness of insulation, completion of the facade.

D. Windows: age, condition (estimation), type, existence of the shutters/blinds

E. Heating system: total area of the apartment, heated area, main heating system, number of furnaces/boilers, additional heating, fuel used for heating, are temperatures being kept at desired level during the heating period, has any part of the heating system been replaced in last five years and what would contribute to better heating in your apartment.

F. Demographic profile: number of household members, age profile

## 3. PRELIMINARY FINDINGS

Gained data has illustrated all the diversities of building sector in Serbia and many problems that will have to be resolved in the way towards the improving the energy efficiency. From the point of energy conservation application of thermal insulation represents the most valuable finding. (Fig. 3) Although we can see that use of the insulation has grown to more than 40% in last two decades it is still not sufficient even in accordance to the old regulations, especially if we know that 80% of buildings have only 5cm of insulation.

Significant data also deals with one formerly anticipated, but not at the surprisingly high level, phenomenon – completion of facade. (Fig.4). Although there are

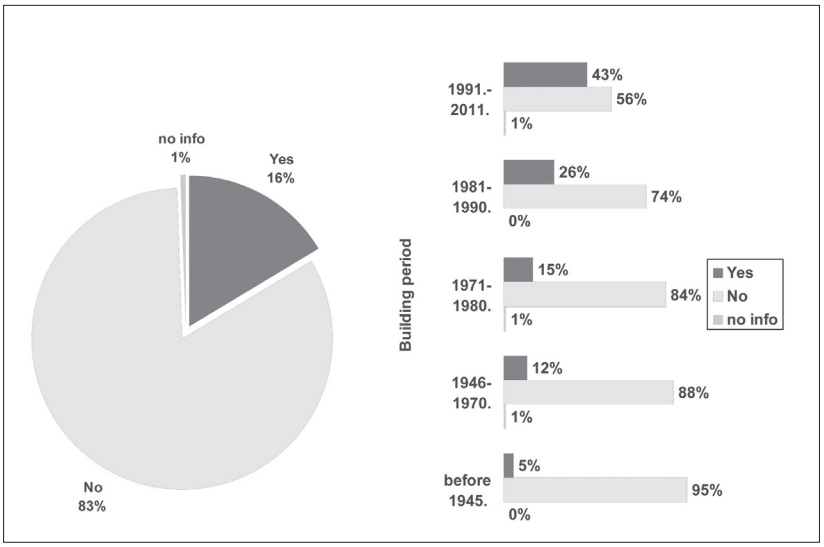


Figure 3: Use of thermal insulation

buildings even older than 40 years, and in full use, they still have no facade, which can be partially explained through taxing regulations that such structures consider to be „work in progress", but also with standard of living, where the quantity (size of the building) exceeds the quality (achieved comfort of living).

If we add to this an average area being heated by the tenants (Fig. 5) it is evident that a building fund represents a field for major improvement leading not only towards the reduction of energy consumption but, at the same time, raising

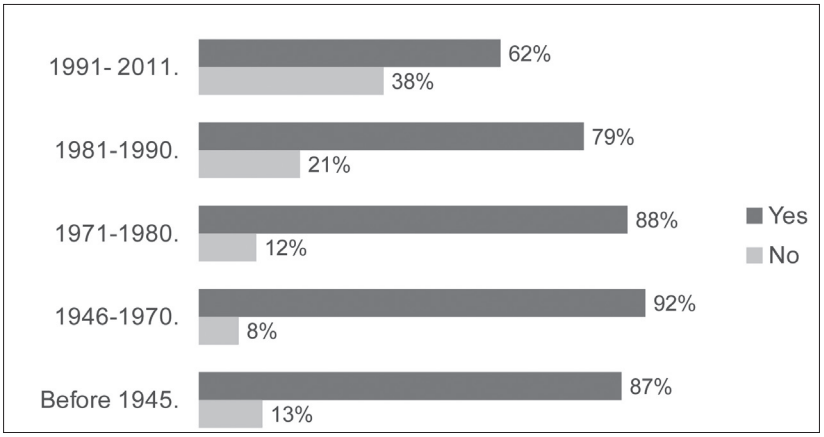


Figure 4: Level of facade completion

the comfort of living without increasing the overall energy consumption.

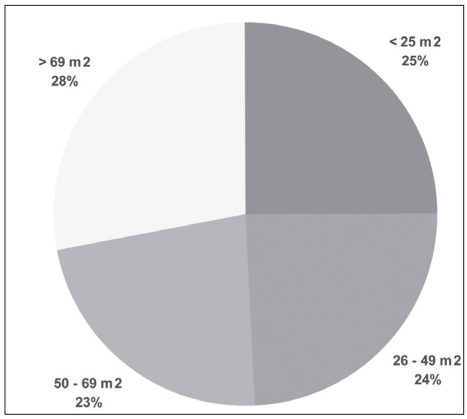

Figure 5: Size of the heated area

## 4. PRELIMINARY TYPOLOGY

Definition of typology has been achieved in a matrix scheme (Fig.6) for the whole territory of Serbia, as the illustrative chart regardless statistical benchmarking. It has been presented as a collection of „model buildings", acting as the visual representations of statistical averages of all analysed buildings for the certain position in chart. As such it only illustrates the variety of buildings and is exceeding the TABULA matrix consisting of only four building classes (free standing, terraced, collective and apartment blocks).

Further work is concentrated on definition of averages in the field of size, form, construction techniques, used materials, applied systems and technology and of course, energy consumption. All representative buildings will be modelled in appropriate software (being in accordance to Serbian regulations regarding Energy Performance Certificate issuance) thus providing data on the estimated consumption. Cross referencing with real representations in the form of energy bills collection is to be done and models readjusted if found necessary.

Improvement measures are also to be calculated on two levels:

– First level will improve the building envelope in a way it will meet the regulations for the new constructions, which largely exceeds the prescribed level for major renovations and reconstruction. According to the current sub-law regulations improvement of existing buildings only has to raise the level of energy consumption by one class (from EPC). These measures will cover the standard building practice techniques and standard design solutions, enabling easy application.

– Second level of improvement will try to raise the overall performance of model buildings up to the „low energy standard" again using the common methods with reasonable investment resources. This level will try to impose a novel solutions and technical systems as a demonstrational procedure.

Two levels of improvement of model buildings will define the potential for energy savings, materials and equipment quantities, payback period (according to projection of energy costs increase) and will serve as a starting point for decision making as for the governmental bodies, private entities and construction companies. Statistically relevant estimations on all three levels (existing, improvement

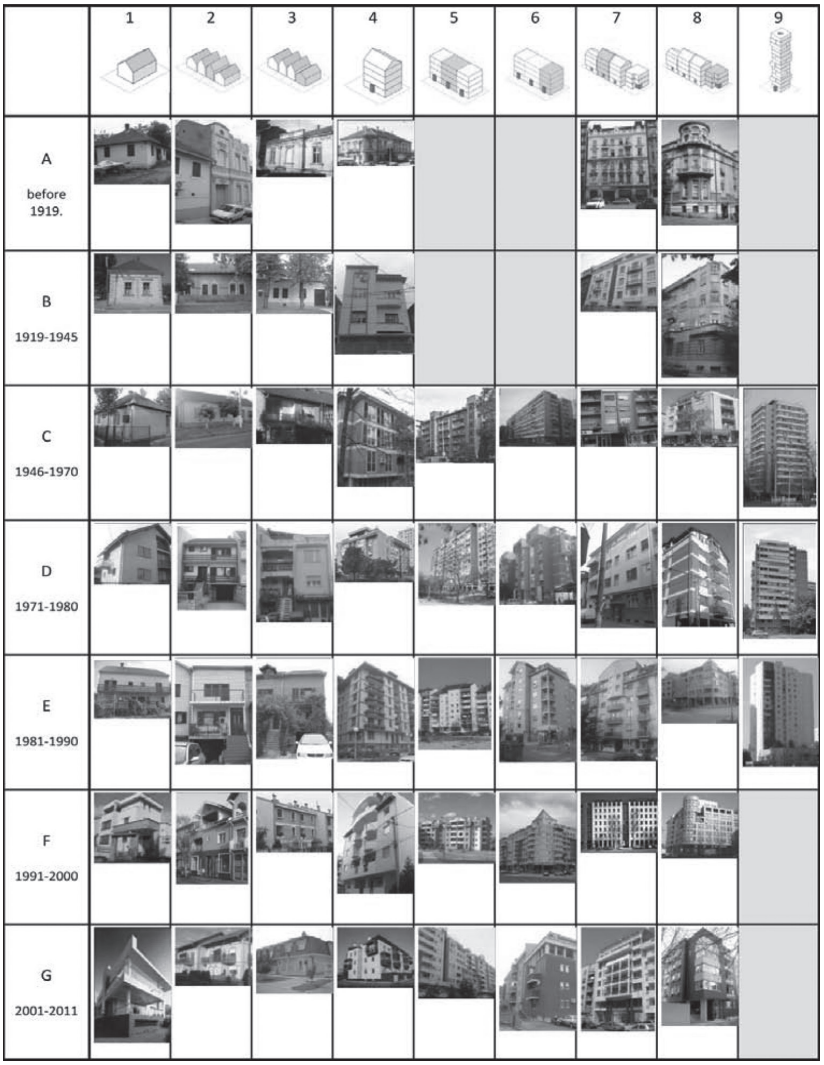


Figure 6: Preliminary Serbian residential building typology

1&2) and projections will be made providing total energy savings and market potential.

## 5. CONCLUSION

Energy performance of building sector in Serbia has not been fully explored and lot of misunderstanding exist even among the professionals. Relevant regula-

tions from this field are being divided between several ministries making the decision process very slow and complex.

By making the national residential building typology together with improvement levels and calculations we will be able to adequately formulate strategies needed for managing the building fund in energy conscious way. Experiences derived from this research will address wide range of participating parties from private owners, market orientated companies, financial institutions and governmental bodies.

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## NACIONALNA TIPOLOGIJA STAMBENIH ZGRADA KAO OSNOV STRATEGIJE REHABILITACIJE

**Sažetak:** Aktuelni Zakon o planiranju i izgradnji Republike Srbije reguliše pitanja energetske efikasnosti u zgradama, i zajedno sa setom podzakonskih akata tretira i postojeće i novoprojektovane objekte. Imajući u vidu da u Srbiji postoji oko 3.200.000 stambenih jedinica, ukazala se potreba za formiranjem nacionalne tipologije koja bi bila osnov za formulisanje odgovarajuće strategije u ovom sektoru.

Nakon priključenja evropskom projektu TABULA (Typology Approach for Building Stock Energy Assessment), pristupilo se formiranju nacionalne tipologije prema metodologiji ovog projekta, uz uvažavanje lokalnih specifičnosti. U cilju dobijanja relevantnih ulaznih podataka, sprovedena je obimna anketa i istraživanje na terenu. Nacionalnom tipologijom identifikovani su karakteristični objekti za koje su ispitani različiti modaliteti unapređenja od minimalnog zadovoljenja postojećih standarda, do postizanja viših energetskih razreda.

Rad objašnjava metodologiju, procedure i lokalne specifičnosti ovog procesa uz prikaz karakterističnih problema i potencijala datog pristupa.

**Ključne reči:** *stambene zgrade, tipologija, energetska efikasnost, regulativa*