



Sustainable Housing Renewal

M. Sitar and K. Krajnc

¹ University of Maribor, Faculty of Civil Engineering, Smetanova 17, 2000 Maribor, Slovenia

Abstract: Following the already proved models the sustainable planning culture is endangering several methods directed towards the needs of tenants in the existing post-war housing stock. The case-study of our project is the renewal of the multi stored building in the housing estate Metalna, Maribor/Tezno (1949). It is based on the sustainable renovation principle for the quality of sustainable housing in functional, technological and environmental point of view. According to it, the idea of the project was to improve the functionality of the building as well as of individual housing units. One of the main goals was to introduce the variety of space and typology of individual housing units. Beside, there was an intention to rebuild and redesign the green area, especially the problems of parking and playground for children. On the other hand, the project is introducing the low-energy renovation principle including new technologies, structural elements and materials. Two scenarios of technological renewal were suggested. The first one was a classical one using additional thermal insulation of the building envelope and fitting of new structural elements such as windows, doors, balconies, windbreaks etc. (Renewal 1). The second scenario, however, included the sunspace construction used as a new passive solar structural element, modifying the envelope (Renewal 2). The energy efficiency of the suggested scenarios were calculated according to the procedures given in EN 832 standard considering the attached sunspace as integral part of the building in first case and as a passive solar object adjacent to the thermal envelope of the building in the second case. The results show that the last case yields the most energy efficient renewal of the existing residential building.

Keywords: Sustainability, renewal, apartment buildings, energy efficiency

INTRODUCTION

The concept of sustainable development has been a constant in developmental guidelines in all areas of planning and construction since the early 1990s. In architecture, construction, urban design, and urban planning the sustainable culture shapes quality standards. The principles of renovation, reconstruction, restructuring, and renewal of already built structures are written down in many international documents, and are also co-signed by Slovenia, such as Agenda 21, Agenda Habitat etc. Housing construction holds the main position in efforts for integrated renewal and revitalization of housing estates^[1]. Most attention is dedicated to the revitalization of the housing stock built in the post-war period, whose living standards in a functional, urban design, and a constructional-technical sense no longer fit the needs of today's inhabitants.

The restructuring of individual parts of the city sets the foundation for the reactivation of degraded areas and offers numerous possibilities for the

implementation of theoretical results in practice. Projects of sustainable renovation act as important urban design and architectural impulses. In other cases they represent experimental fields for project innovations. However, sustainable renovation became an important research field, especially from the point of view of technology and materials. Different programs encourage different renewal projects with the main goal of improving the quality of apartments, representing also the best practices in sustainable spatial management. Research, which is based on the assessment of the life cycle of the building shows that, at achieving equal parameters in the quality of the building function related to the environment, the renovation is, looking at it holistically, actually more appropriate than new construction^[2].

Renovation of the Housing Stock in Slovenia: When speaking of renovation of multi-apartment buildings in Slovenia, we are mostly thinking of the issues of residential neighborhoods which were built in the post-

Corresponding Author: Metka Sitar, University of Maribor, Faculty of Civil Engineering, Smetanova 17, Postal Code: SI-2000 Maribor, Slovenia, Tel: +386-2-2294 359, Fax: +386-2-2524179

war period on the edges of city centers and in the larger suburbs of small and big cities. These issues have so far not been sufficiently integrally approached. On the basis of the statistical data by Statistical office of Slovenia, 2002, on number of the apartments, their structure, ownership, size, type, purpose, age, materials, etc., we can get an approximately real picture about the situation and the needs for its renewal. The orientation data on the needs and possibilities for renovation of the existing housing stock are extracted from the data on construction activities.

The construction of buildings represents more than 50 percent of the whole construction activity in Slovenia (52.5%). However, about three quarters of the activity is intended for the construction of new buildings and only a smaller share for the renovation.

Table 1: Number of the apartments in the 1971, 1981, 1991, and 2002 censuses

Period	1971	1981	1991	2002
Apartments total	477.273	607.682	683.137	777.772

Source: <http://www.stat.si/letopis/>

In general, we estimate that the condition of the existing multi-apartment housing stock in Slovenia is problematic, and in practice and in some cases even alarming. The most critical buildings needing renovation are the apartment blocks built in 1940s, 50s and 60s. This was the time of the so-called organized housing construction, for which represents an estimate of over 30% of all built apartments, and which according to the 2002 census is c. 230,000 apartments of organized housing construction (Table 2). The data on the age of the apartments shows that more than half or 61% are older than 30 years, which is considered as a limit age for renovation, and it numbers 140,000 apartments.

Even more is evident from the statistical data on renovation of the apartment surface area, which show that up to the year 1970, only 2.3% of the apartment surface area were renovated, while as much as 70% of all apartment surface area were never renovated^[3]. According to the statistical data we can therefore conclude, that c. 100,000 apartments older than 30 years are in need of a renovation due to their technical and technological shortages, or simply due to their deterioration.

We estimate that the current state, marked by an increasingly diminishing standard of older multi-apartment building, is closely linked with the housing

stock privatisation procedures in the beginning of the 1990s. Important data shows that among the apartments older than 30 years, there are as much as 92% privately owned, which accounts for 90,000 apartments (Table 3). These apartments already represent numerous problems from a maintenance aspect, especially due to the financial constraints of new owners. Despite some existing incomplete documents, the issues of the sustainable renovation of housing and integral renewal of housing areas policy wise, are still completely undefined. We conclude that the potential for an organized innovative approach to integral renovation is realistic mainly for apartments owned by the public sector, which is 8% or c. 8,000 apartments.

Table 2: Percentage of completed works in construction, intended for buildings

Period	2001	2002	2003	2004	2005
Buildings	55,2%	50,9%	47,6%	51,6%	52,5%
Construction of new buildings	40,2%	36,5%	34,1%	38,5%	41,5%
Reconstruction of buildings	7,4%	7,9%	7,6%	7,3%	7,0%
Investment maintenance works	4,8%	3,9%	4,1%	4,5%	3,1%
Regular maintenance works	2,8%	2,6%	1,7%	1,3%	0,9%

Source: <http://www.stat.si/>

MATERIALS AND METHODS

The issues of integral sustainable renovation of housing buildings have been intensively tackled for years in the countries of central Europe, and among others: Austria, Switzerland, Germany, and the Netherlands. Scandinavian countries though, have already developed different strategies of integral renewal in Denmark, Sweden, etc.^[4]. The area of renewal of housing structures is taking a central place in the efforts for integral renovation and revitalization of larger areas, especially in larger housing estates. Among the most typical approaches we can include development models for energy efficient renovation, which through the use of new materials and the testing of new techniques also support different branches of the construction industry. In the aforementioned countries,

Table 3: Number and surface area of the apartments by ownership, 2002 census

Type	Total 2002	Apartment ownership		
		Private ownership (by individuals)	Public ownership	sector Other
Apartments (number)	777.772	718.964	48.516	10.292
Surface area (m ²)	58.031.187	54.923.270	2.517.242	590.675

Source: <http://www.stat.si/letopis/>

the state financial stimulations, education, research, and accordingly adjusted policy of city authorities brought numerous positive results and experiences^[5].

Slovenia defined sustainable development for its strategic orientation in its new laws, strategic and program documents of economic, spatial, social and environmental development relatively early. However, if we take a look at concrete programs in the area of housing construction, we can see that they are, by and large, directed toward new construction, only seldomly and even then partially toward the existing housing stock. In this way, we still do not obtain an integral strategy for the sustainable renovation of the existing housing stock – which would consider especially older apartments, both rented and privately-owned, where the maintenance issues and the need for a higher quality of buildings and their infrastructure are most urgent. The guidelines from the National Housing Program of 2000 were, unfortunately, proven unfeasible soon after the adoption of the program. For some time now, there have been talks of preparing a new national strategic housing document which should, besides objectives and directives, have to also anticipate the instruments, or even better, concrete action programs for its implementation. However, there are some examples of individual renovation projects that were implemented according to the principles of sustainable development, but they are more the result of high awareness and efforts by individuals, than a result of economically efficient strategy of sustainable oriented national policy.

Issues of Energy Efficiency: In the time of global changes of air and climate conditions, awareness of the limited amount of fossil fuel, and general issues of environmental pollution, a thorough shift in energy usage is necessary. In most of the developed countries and countries in development, buildings are using approximately half of the total energy used on a national scale. Sustainable oriented measures in

housing renovation are inseparably connected to the increased care for the energy efficiency of buildings, which by and large contributes to the efficient use of energy. This means that providing a high quality of apartments together with acceptable building and maintenance expenses, is one of the important challenges of architecture, civil engineering, and industry today. European documents on energy properties of buildings are also binding, encouraging measures for efficient energy use in new, as well as in old buildings as one of the main quality standards.

Integral Approach to Sustainable Renovation: An analysis of implemented examples of sustainable renovation combine an urban-architectural design point of view (solution selection, architectural language, desired planning goals) with the environmental (ecologic optimization, innovative technologies, the use of renewable energy sources), and social one (encouragement of a creative community, apartments for special needs groups, etc.). The principles of sustainable renovation can be summarized in the integral approach, based on the following most important measures:

- Improvement of living conditions and provision of user-friendly apartments, increasing flexibility of the whole building concept and its parts, according to the current and future needs of inhabitants,
- Decrease energy use and related building operational expenses,
- Increased use of environmentally-friendly materials and renewable energy sources,
- Economically favorable and innovative planning, building and using measures.

How can we ensure an appropriate living environment, which will be the result of optimal planning and building solutions? Every building

represents a complex and dynamic system. The answer lies in the development of integrated modeling and simulations, and their inclusion in the earliest phases of planning and design. Various options are also offered by many more or less sophisticated program tools, with which it is possible to very accurately analyze the properties of construction elements, as well as energy properties of the building.

On the basis of various theoretical knowledge and experience we summarize that the most important characteristics of integral renovation of housing structures, of which some were tested on a practical example of a multi-apartment building renovation:

- Quality architecture, design, which provides functionality and increase of the project solution quality,
- Environmentally-friendly planning, building and use of the apartment,
- Economic management of residential surface area and expenses,
- Wide range of the apartment offer – selection of the apartments of different size, optional solutions of individual housing type,
- Flexibility of the apartments - options to adjust to the changing needs,
- Floor plan solutions – neutrality and construction resistance for variable arrangements,
- Multifunctionality of spaces (resting, hobbies, children, food preparation, etc.),
- Landscaping – according to the needs of inhabitants,
- Integral project solutions, encouraging the forming of neighborhood and community (communication, self-help, etc.),

Option for direct participation in management (ie, owners, tenants).

RESULTS AND DISCUSSION

The research project of sustainable renewal of a multi-apartment building is based on an integral approach to the housing renovation. It consists of designing of a theoretical model of application of some selected issues of sustainable renovation through the example of a multi-apartment block in the housing neighborhood Metalna in the city of Maribor, built at the end of 1940s. The building represents a typical post-war building in the traditional working class neighborhood of Maribor, intended for the needs of workers of a nearby factory. The urban environment, as

well as the larger area, is insufficiently equipped; the concepts for long floor plans of buildings and unified apartment solutions are typical ^[6].

The quality of the construction can be assessed on the basis of existing conditions and plans – construction and equipment is, from the technical and sanitary standpoint, deteriorated and does not fit modern standards. Landscaping is problematic mainly due to the parking and traffic organization – which, because of changing lifestyles and the increased number of cars, are also the most critical issues of older residential neighborhoods in general. The key goals are based on these notions, which we tested on the selected model, in whole or partially in:

- Architectural renovation of the concept and design of the whole building, with a stress on the floor plan solutions of an individual block with the new apartment typology,
- Construction and technological renovation from the point of view of energy efficiency of individual elements and construction parts,
- Surrounding landscape renovation.



Fig. 1: Existing building

Reorganizing the Floor Plan: The project approach is based on the architectural and functional quality of the apartments in assessing the rearrangement of the whole building. The focus lies in the floor plan solutions of the typical long structures, by changing the rigid scheme of equal two room apartments by the open concept, allowing different types of apartments, size-wise, as well as the inner spatial organization. The renovation proposal includes the collection of compatible floor plan solutions by floors, based on the typology of apartments from one room to 5 rooms, also including specific types of apartments for different target groups such as the elderly, young families, one-

person households, etc. Special attention is dedicated to apartments for persons with disabilities. Outdoor living surfaces (i.e., balconies, terraces) are dealt with variously in the two scenarios: in the first one (Fig. 2) by the addition of the outside element – a non-roofed balcony, and in the second one (Fig. 3) with introducing a new glass construction part as a passive energy element.

Project Solutions for Increasing the Energy Efficiency: The project represents the principle of a low-energy renovation of the building, which for a basic intervention anticipates the incorporation of quality insulation materials and elements in all construction segments – windows, doors, walls, ceiling, and roof structures. The utilized methods and solutions are based on tested models, and measures for the energy efficiency increase, taking into account the measures of the Regulations on Thermal Protection of Buildings from 2002, whose basis is the SIST ENV 832 standard. The sustainable renovation of a building is presented in two scenarios, in which an energy efficient renovation examines the connection between possibilities of architectural design, renovation technology, and energy efficiency for the heating of the building.



Fig. 2: Renovation 1

Renovation 1 – represents a model of a standard solution of sustainable renovation, which is based on building additional thermal insulation into the whole building shell, and the replacement of the building elements such as windows, entrance doors, balconies, etc.

Renovation 2 – uses additional innovative options for the energy efficiency increase on the basis of increasing a building mass by closing off the balcony

lidges and adding a new multi-storey glass construction element for obtaining large outdoor terrace areas.



Fig. 3: Renovation 2

Assessment of Heating Expenses: The Renovation 1 model achieved a 72% and the Renovation 2 an even 78% decrease in necessary heat consumption. Correspondingly, there is a decrease in the yearly oil consumption expenses by three quarters, which represents a savings of over 8.600 EUR yearly for heating the entire building. In this way, the comparison assessment of heat loss and heating expenses, merely on the bases of energy savings, already ensures an economically justified investment.

From the Table 4 it is evident, that we designed two sub-option solutions: We added the multi-storey glass construction element as a passive solar object, which we took into account as a part of the heated part of the building in the Renovation 2a option, and as part of the non-heated part of the building in the Renovation 2b option. These sub-options are extreme ends of the glass part of the building shell response to the time-dependent outdoor conditions. In this way they can, on the basis of the architectural design and construction-physics approaches, represent a starting point for a more detailed analysis already in the early stage of renovation. A more precise calculation of model solutions is possible with the use of simulation methods of energy and substance transfer through the outside shell, and by taking in account the position of the building and the local weather conditions ^[7]. The energy efficiency of the proposed scenarios is tested on

Table 4: Comparison assessment of heat losses and heating expenses

Type of calculation	Existing building	Renovation 1	Renovation 2	
			Renovation 2a	Renovation 2b
Yearly needed heat (kWh/m ² a)	147,60	40,50	27,20	31,20
Expenditure of heating oil (l/m ²)	20,00	5,45	3,60	4,15
Value in SIT/m ²	2.360,00	643,10	424,80	489,70
Net heated area (m ²)	1.207,90	1.207,90	1.827,90	1.270,60
Yearly expenditure of heating oil (EUR)	100,66	27,43	27,42	2,20
Yearly expenses for heating oil purchase (EUR)	11.877,68	3.236,69	3.235,38	2.592,56
Savings (EUR)	-	8.640,99	8.642,30	9.285,13

Source: Krajnc, K., Trajnostna prenova vecstanovanjske zgradbe (Sustainable Renewal of the apartment building), 2005. Thesis, unpublished. Faculty of Civil Engineering, University of Maribor

the basis of the calculation of the necessary heat and related heating expenses. Although the necessary heat for the existing building far exceeds the yearly needs of a "normal house" (app 148 kWh/m²), the results show that the building can be, already with the measures from the first scenario (Renovation 1), categorized among "low-energy houses" (app 40 kWh/m²). As expected, even more efficient is the second scenario (Renovation 2) which, with the extra passive solar multi-storey glass element, brings the building to an energy savings of a so-called "passive house" (app 30 kWh/m²).

CONCLUSION

The presented model of sustainable renovation of a multi-apartment building represents an opportunity for the use in practice – on the basis of a pilot case, which would, with the support of the national and local policy, link the research activity of the university with the economy in all its segments, and with that also most likely gain the support of general public. To assert the principles and goals of sustainable culture in planning, construction, and renovation, the framework of policy measures is needed, which would include all fields and activities for improving the renovation conditions, including the legislative and financial field. Moreover, the future users of housing – owners as well as tenants, should be already attracted for cooperation in the earliest stage of planning and decision-making.

To summarize, we can establish, that the integral process of housing estates renewal demands certain interdisciplinary work approach. Contemporary approaches in accordance with the sustainable culture call for permanent cooperation and coordination of all participants – architects, civil engineers, and representatives of other professions – at the preparation, implementation, as well as monitoring and evaluation of the renovation projects.

REFERENCES

1. Miguel Ruano, 1999. EcoUrbanismo. Entornos humanos sostenibles: 60 proyectos. EcoUrbanism. Sustainable Human Settlements: 60 Case Studies. Editorial Gustavo Gili, SA, Barcelona, pp: 11-14
2. Erlandsson, M., and P. Levin, 2004. Environmental assessment of rebuilding and possible performance improvements effects on a national scale. Building and Environment, 39 (12): 1453-1465.
3. Kilar V., 2004. Trendi razvoja in projektiranja sodobnih konstrukcij stavb. In: Ob vstopu Slovenije v Evropsko unijo. Simpozij Druzba, prostor, graditev, 19. 5. 2004, Ljubljana (ed. B. Skraba) pp. 151-157. Inzenirska zbornica Slovenije, Ljubljana
4. SUREURO–Sustainable Refurbishment Europe. Information available at: <http://www.sureuro.com>
5. Bueren van, E., 2001. Sustainable Building Policies: Exploring the Implementation Gap. In: Towards Sustainable Building (ed. N. Maiellaro) pp. 29-42. Kluwer Academic Publishers, Dordrecht
6. Jelka Pirkovic-Kocbek, 1982. Izgradnja sodobnega Maribora: mariborska arhitektura in urbanizem med leti 1918 in 1976. Znanstveni institut Filozofske fakultete v Ljubljani, Partizanska knjiga, Ljubljana, pp: 52-53
7. J A Clarke, 2001. Energy Simulation in Building Design. 2nd Edition. Butterworth-Heinemann, Oxford, pp: 202-275.