A Macro-Micro Perspective on Sustainable: Refurbishment of the Housing Sector

Ovidiu-Horaţiu Teleche

(Teaching assistant Ph.D. candidate Ovidiu-Horaţiu Teleche, "Ion Mincu" University of Architecture and Urbanism, Fildeşului 2, G6 / C18, 031652, Bucharest, Romania, ovidiuteleche@yahoo.com)

1 ABSTRACT

The study is focused on sustainable refurbishment operations applicable within the area of the housing sector:

(1) At a macro scale, the potential benefits are concerning the energy balance at a national level, the use of limited resources and the generated air pollution. The promotion of environmental recovery is proposed as an associated objective of the refurbishment operations.

(2) At a micro level, from the user's perspective, the refurbishment operations are energy-oriented and cost-determined. A detailed study within the area of comfort conditions is proposed.

The paper attempts to connect both ends by valuing potential improvement areas and multivalent refurbishment tools.

The aim is to identify and evaluate locally-effective bioclimatic tools with direct impact on a particularly neglected scope of comfort conditions, while also determining some considerable energy savings.

Green construction systems are being considered for architectural refurbishment, with the use of urban vegetation and ecosystems as main tool at the landscape level.

For assessing the effectiveness of the proposed tools, the development of a pilot project is proposed, starting with the first step of setting the preliminary objectives. Economical and social accessibility of the solutions are key aspects.

The initiated research develops as a part of a permanently open, interdisciplinary and collaborative study.

1 REFURBISHMENT OF THE HOUSING SECTOR

1.1 Context and limitations

Although it allows for extrapolations, this paper is primary concerned with the aspects related to refurbishment operations within the following context (i.e. that of Romania):

- Eastern European developing country;

- temperate to continental climatic conditions.

The proposed approach is primarily concerned with the urban housing sector, without being restricted to a particular housing type.

However, the proposed approach reflects a particular characteristic of the housing sector in Eastern Europe, which is the sizeable proportion of private ownership of dwellings1.

1.2 Outline of the necessity of the refurbishment operations in Eastern Europe

On one hand, in Eastern Europe, the demographic trends are decreasing. By the year 2050[2], population is expected to drop by 20%. This suggests a possible decrease in future demand for new housing. On the other hand, in South-Eastern Europe, about 50% of the housing stock is over 40 years old[3].

Overall, we can conclude that about 30% of the existing housing stock might need upgrading or replacement in order to provide comfortable shelter in the near future, while 20% might be progressively abandoned or demolished.

In Romania, a large number of new developments are still available on the market as a result of the recent construction boom. Currently, the focus turns towards the refurbishment of the existing dwellings.

1.3 Sustainability as a guideline

1.3.1 Conceptual approach

General approaches to sustainable architecture tend to be restrained to the field of environmental ecology. However, the original concept of *sustainable development* theorises an equitable balance of the economic, social and ecological development factors.

As efforts were made adapt the construction industry to the principles of sustainable development, the concept of *sustainable construction* was introduced, defining "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles".[4] This approach addresses the entire life cycle of building: their planning, design, construction, operation, modifications, renovation, retrofit, and ultimate disposal[5].

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1 Jose Palacin, Robert C. Shelburne: The private housing market in Eastern Europe and the CIS. Geneva, 2005.

2 Wolfgang Lutz et al.: Demographic and Human-Capital Trends in Eastern Europe and Sub-Saharan Africa. Washington, 2008.

3 Sasha Tsenkova: Trends and Progress in Housing Reforms in South Eastern Europe, 2005.

4 Charles Kibert: Establishing principles and model for sustainable construction, In: Proceedings of the First International Conference of CIB TG 16. Tampa, 1994.

5 Charles Kibert: Forward: Sustainable Construction at the Start of the 21st Century, In: The Future of Sustainable Construction, 2003.

Therefore, when focused on sustainable refurbishment, we must consider the principles of *sustainable construction*, which are economically and ecologically concerned – while they also aim to enhance the quality of life, to provide and support desirable natural and social environments.

1.3.2 Sustainability and refurbishment operations

Sustainable construction is necessary for sustainable development, but housing refurbishments can't serve international objectives exclusively.

As recent attempts have proven, in both developed and developing countries, it is hardly possible to implement national or international programs that artificially demand inhabiters to refurbish their homes with the main goals of energy efficiency or environmental mitigation.

The refurbishment of homes has to be generated and customised by their users, individuals or communities.

On one hand, the challenge is to identify refurbishment "tools" that are socially and economically accessible and serve the direct interests of the inhabitants, such as increasing comfort conditions, improving aesthetics and reducing use-related costs – while also sustaining environmental recovery.

On the other hand, the challenge is to educate the inhabitants into using these "tools" in pursue of their own interests, but thus also generate a large-scale mitigation of the resource-efficiency and environmental problems.

2 MACRO SCALE

2.1 Political objectives concerning the refurbishment of the housing sector

The political objectives concerning the housing sector are generally determined by energy targets, resource-efficiency and international agreements on reducing greenhouse gas emissions (Fig. 1). Indeed, the impact of the housing sector in these areas is considerable: buildings are responsible, in Europe, for approximately 40% of the total energy consumption and for 36% of the greenhouse gas emissions.

Unfortunately, environmental protection is attempted almost exclusively through actions aiming directly at cost-related or measurable results. These are practical objectives that don't generally include a cultural dimension.

However, socio-economic research[6] points out that energy-efficiency as an exclusive, self standing policy can lead to paradoxical results, generating opposite effects. Reducing the energy requirements of a commercial product or service induces a form of social enthusiasm and increased irresponsibility related to the use of the specific product or service. This increases demand and leads to a paradoxical rise in the total energetic consumptions generated by the use of that product, on a large scale.

This is, perhaps, the reason behind the larger energy consumptions in the residential sectors in industrialised as compared to developing countries, despite obviously higher construction standards. Occupant behaviour affects building performance, making predictions of energy use and carbon emissions difficult[7].

Therefore, a cultural approach of the refurbishment operations is necessary, even when "purely mathematically" concerned with political objectives like energy-efficiency.

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6 John M. Polimeni, Kozo Mayumi, Mario Giampietro, Blake Alcott: Jevons' Paradox and the Myth of Resource Efficiency Improvements. London, 2008.

7 Marianne Heaslip: Low carbon housing for non-experts: usability in whole house retrofit, Retrofit 2012 Conference. Manchester, 2012.

2.2 Macro scale potential of the refurbishment operations

Architecture and urbanism imply a considerable ecological impact, through construction, use-related processes, and through the lifestyle and habits they determine for individual inhabitants and for communities[8].

The potential benefits of the refurbishment operations exceed the commonly assumed political objectives. Aiming at values difficult to measure financially is, perhaps, much more productive then expected.

Environmental recovery and the improving of the general public health and productivity[9] are associative goals – achievable by sustainable refurbishment of the housing sector. By responsibly conducting desirable refurbishment or renewal operations, local communities can capitalise on the architectural, historical and cultural values of the residential buildings and areas[10].

Scientific research[11] in the field of urban ecology promotes a prioritisation of the areas to be refurbished, oriented towards the management and restoration of the remnant ecosystems, in order to maximise conservation outcomes and minimise costs.

These potential benefits can be addressed through public education and a sociocultural approach of the problems concerning the residential buildings and their surroundings.

Previously completed pilot programs[12] have clearly concluded that sustainable urban renewal requires active citizen participation. A synergistic approach is, perhaps, the best option to achieve sustainable urban renewal: improving public education through fostering social cohesion.

Sustainable development implies a conscious and responsible positioning towards others; a selfless attitude. Can one truly be committed towards future generations without maintaining relationships with the present social environment[13]?

Perhaps the eco-cultural and the eco-social logics of sustainable architecture describe the best suited refurbishment solutions for the Romanian housing sector, as they rely on the use of local low-tech, commonplace and vernacular technologies and they promote the reconciliation of individual and community in socially cohesive manner[14] that allows for coherent decisions and actions, especially required in the context of fragmented ownership of the housing assemblies.

Apparently, we are missing some political instruments required for an equitable approach to more sustainable housing. But the change is in our hands.

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8 Ovidiu-Horaţiu Teleche: Sustainable architecture: advanced technology vs. traditional methods. In: Provocări în spaţiul construit. Bucharest, 2012.

9 Ales Krainer: Passivhaus contra bioclimatic design. In: Bauphysik, Vol. 30, Heft 6. Berlin, 2008.

10 Ana-Maria Dabija: *Rehabilitation of mass dwellings in Romania. A critical approach*, WESC (Word Energy System Conference). Târgovişte, 2010.

11 Cristina E. Ramalho, Richard J. Hobbs: Time for a change: dynamic urban ecology. In: Trends in Ecology and Evolution, Vol. 27, No. 3. Oxford, 2012.

12 Martin Wood, Bill Randolph, Bruce Judd: Resident participation, social cohesion and sustainability in neighbourhood renewal: developing best practice models, AHURI Positioning Paper No. 26, 2002.

13 Ovidiu-Horaţiu Teleche: op.cit.

14 Simon Guy, Graham Farmer: Reinterpreting Sustainable Architecture: The Place of Technology. In: Journal of Architectural Education, Vol. 54, Issue 3, pp. 140- 148. Washington, 2001.

3 MICRO LEVEL

3.1 User goals and motivations

When starting a house refurbishment process, users have a set of complex and inter-related goals[15], which are likely to include thermal comfort, as well as saving money, aesthetics or avoiding waste. The relative weight of these goals may vary across time and contexts, but should not be neglected[16].

At an individual level, education determines all preferences and goals that do not concern saving money or assuring physical comfort. Addressing sustainability requires an educated approach.

A challenge specific to the Eastern-European housing context is the fragmented ownership of the housing assemblies with owner-occupied dwellings. In this case, individual goals compete at a community level, and community goals need to be consciously assessed. In multi-unit houses, the owners have to organise an association which will represent the common interest of the community.

While instinctive goals like cost-saving, energy-efficiency, or physical comfort are consensual, pursuing elevated goals like sustainability becomes more problematic within a community. Education and social cohesion are required.

3.2 Micro scale potential of the refurbishment operations

Regardless of the user's conscious motivations and their explicit set of goals, often restrained to physical comfort conditions and architectural features of their homes, post occupancy evaluations demonstrate the prevailing importance of psychological comfort in determining user satisfaction.

Thermal comfort is the user goal which has received the most research attention[17]. It has been concluded that thermal comfort is dependent on the perceived degree of user control, climate, as well as psychological and cultural influences. This fits with the fact that comfort is determined by psychological factors rather than explicit physical factors[18].

Not surprisingly, scientific research describes a positive link between nature and health indicators, including psychological and physical well-being [19]. While needed to provide shelter and physical comfort, buildings are as much comfortable and healthy as they are inherently integrated into the natural environment[20]. This concerns both the surroundings of the building and the interior space, as well as the mediation between the two, preferably allowing a direct contact.

Moreover, environmental integration contributes to the aesthetic character[21], a commonplace goal of the refurbishment operations. In the same time, the use of natural materials for the interior space is

15 Adrian Leaman: Usability in Buildings: the Cinderella subject. In: Building Research & Information, Vol. 28, Issue 4, pp. 296-300. London, 2000.

16 Marianne Heaslip: op.cit.

17 Idem.

18 Fergus Nicol, Susan Roaf: Post-occupancy evaluation and field studies of thermal comfort. In: Building Research & Information, Vol. 33, Issue 4, pp. 338-346. London, 2005.

19 Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning, Nature and the Environment: Nature and Health. The influence of nature on social, psychological and physical well-being. The Hague, 2004.

20 Ales Krainer: op.cit.

21 Alexandra A. Maciel, Brian Ford, Roberto Lambertsa: Main influences on the design philosophy and knowledge basis to bioclimatic integration into architectural design - The example of best practices. In: Building and Environment, Vol. 42, pp. 3762 - 3773. Amsterdam, 2007.

beneficial to comfort conditions[22] and less demanding for the environment, while the use of local or recycled materials is both economic and ecological.

Refurbishment operations offer the opportunity to mitigate the environmental effects of the housing sector, while strengthening the contact with the natural environment and increasing the presence of natural elements. This approach doesn't primarily address energy efficiency and carbon reduction targets – but, as it concurs to their addressing, it serves the inhabitant's interest in comfort, health and well-being. The potential lies within the economy of means particularly required for achieving psychological comfort and health benefits, that also allow for more sustainable homes.

4 MEETING BOTH ENDS: BIOCLIMATIC TOOLS

In order to mediate macro-scale objectives with inhabitant goals related to the refurbishment operations, an equitable approach and dedicated instruments are required.

Addressing potential improvement areas in education is crucial; this can be organised more efficiently at a macro scale. General public education should be more dedicated to fostering social cohesion, improving public health, promoting sustainability and cultivating respect for cultural and patrimonial values.

Solving educational problems allows to achieve both categories of goals, political and individual. It is also necessary to reconsider human potential and to stimulate private initiatives.

It should be noted that the commonplace refurbishment operations are overlooking an essential area of potential benefits, which particularly concern achieving psychological comfort and health benefits, but also concern the aesthetic character of the homes and their surroundings.

When analysing the interior comfort conditions and their induced energy requirements (Table 1), the area of psychological comfort points out a surprisingly large potential in achieving healthier and more comfortable living while in the same time reducing energy requirements. These simple measures include designing for natural lighting, allowing visual and physical connection to the exterior, the possibility to control the heating and cooling systems, the landscape design and the biological diversity of the surroundings, the presence of indoor plants.

The integration of urban vegetation and ecosystems improves the microclimate around buildings buildings and benefits a wide range of services such as heating, cooling, environmental amenities, rain water uptake, waste processing, and even food production. However, the use of vegetation becomes a challenge particularly in dense urban fabrics. Where necessary, the possibility of introducing green roofs or vertical landscaping solutions can be considered.

Such solutions are specific to the concept of bioclimatic design. While some have already been tested for performance[23], their application is so far reduced, partly due to their high costs. Possible developments of such systems – using low-tech, commonplace and "do-it yourself" technologies – may offer solutions for bioclimatic architectural refurbishments in Eastern-Europe.

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22 Sue Roaf, Manuel Fuentes, Stephanie Thomas: Ecohouse: A design guide, p. 86. Oxford, 2001.

23 M. Ottelé: The Green Building Envelope. Vertical Greening, Ph.D. Thesis, p. 37. TU Delft, 2011.

Interior comfort conditions																			
Building life-cycle					Physical comfort [1]						Psychological comfort [2]								
• Design and construction	• Operation and repairs	• Current-use	• Demolition	**Energy requirements**	• Temperature (conduction, convection [3], radiation [4])	• Humidity	• Ventilation and air velocity	• Air quality	• Noise levels (exterior, interior)	• Electromagnetic radiation (exterior, interior)	• Natural lighting	• Visual connection to exterior	• Physical connection to exterior [5]	• Adjustable heating and cooling	• Landscape design and biological diversity	• The presence of indoor plants or natural elements			
				• Design															
				• Construction [6]															
				• Maintenance and improvements											[12]				
				• Water															
				• Sewage											[13]				
				• Garbage collection															
				• Heating					[9]		[10]		[11]		[14]				
				• Sanitary hot water															
				• Cooling / mechanical ventilation		[8]										[15]			
				• Lighting and electricity															
				• Indirect energy requirements [7]											[16]				
				• Demolition and disposal															

Table Legend:

Achieving comfort condition leads to:

- Reduced energy consumptions
- Potentially reduced energy consumptions (see *Table Notes*)
- Possibly increased energy consumptions
- Increased energy consumptions

Table 1: **Interior comfort conditions vs. energy requirements**
See *Table Notes* for references

Table Notes:

[1] Physical comfort is described by directly measurable internal and environmental conditions.

[2] Psychological comfort concerns factors that determine a general subjective well-being. Comfort is considered a psychological phenomenon rather than being a physiologically determined (Nicol and Roaf).

[3] The air temperature gradient is acceptable up to 3-7°C (Zhang et al).

[4] The radiant temperature from windows or walls. Increased difference between indoor air temperature and radiant temperatures causes discomfort (Huizenga et al).

[5] The presence of intermediary spaces between the indoors and outdoors; the presence of operable windows; as stated by (Brager).

[6] The embodied energy of building materials and systems and the energy used in the construction process.

[7] Food, transport, and recreation generate the most important indirect energy requirements, as part of the household metabolism. The efficiency of the urban infrastructure also determines the amount of indirect energy requirements generated by the housing sector (Moll et al).

[8] Controlling humidity can allow for a reduction of the energy required by the mechanical cooling (Ouazia et al).

[9] Assuring better insulation capabilities for airborne noise can also lead to a better thermal insulation of the exterior walls as it requires air-tightness.

[10] Unfortunately, by common belief, window is still being considered the weakest point of the envelope. Nevertheless, it is the window that brings daylight to the interior and can also enable solar heat gains (Krainer).

[11] During spring and autumn, when day-time exterior temperature can exceed the radiant temperature of the interior walls.

[12] Protecting the building envelope from solar radiation.

[13] The presence of trees and vegetation can reduce the load on the sewage system.

[14] The use of deciduous vegetation for summer solar shading instead of other mechanical devices naturally and gradually allows for solar heat gains in the colder seasons. Moreover, the presence of vegetation improves the air quality which in turns can reduce the necessary fresh air flow, thus reducing energy consumptions during the heating seasons.

[15] The presence of indoor plants can regulate air humidity and air temperature and thus reduce the load on the mechanical cooling system (Roaf et al).

[16] Landscape design of the domestic surroundings can reduce the indirect energy consumptions for recreational commuting. Landscape design for food production can also reduce indirect energy consumptions.

5 SETTING THE PRELIMINARY OBJECTIVES OF A PILOT PROJECT

In Romania, a pilot project on sustainable refurbishment of a multi-unit housing block has not been conducted so far. Preliminary objectives should include:

(1) Firstly, fostering the social cohesion of the community. The project should start by setting and implementing social objectives. This also facilitates the cooperation of the occupiers.

(2) Preferably, the pilot-project should be economically feasible itself.

(3) The project should be user-oriented. Building evaluation is necessary for monitoring performance to discover and then try to solve problems[24]. The goals should include the improvement of social and environmental comfort conditions, while also determining some considerable energy savings.

(4) Repeatable solutions should be developed and implemented within the project.

(5) The project should monitor and improve the performance of the implemented solutions, for future pilots or large-scale implementations.

The proposed research requires an open, interdisciplinary and collaborative development.

2 CONCLUSION

Regarding the sustainable refurbishment of the housing stock, macro-scale objectives are partly competing with inhabitants' goals. A bioclimatic approach to housing refurbishments requires generally accessible solutions and has direct benefits for the inhabitants, that are also reflected on a large-scale.

However, the addressing of environmental and energy efficiency goals must consider the inherent social and cultural aspects for achievable results. For this reason, the concept of sustainability appears to offer not just a promising, but a necessary solution for the refurbishment of the housing sector, especially in developing countries.

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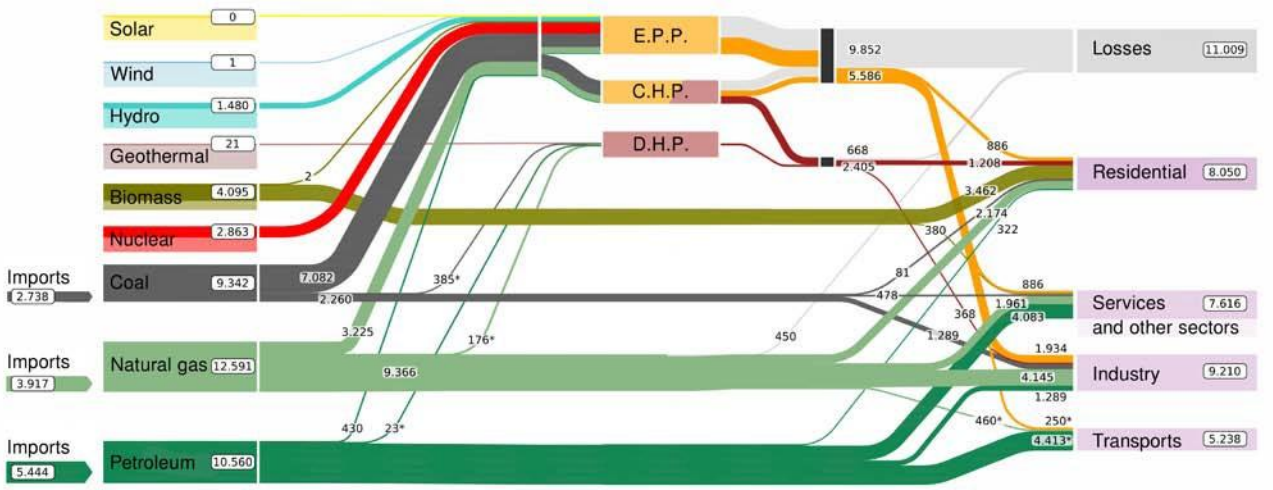

Fig. 1: **Romania Energy Flow – 2008** (units = ktoe)
E.P.P. = Electrical Power Plant, C.H.P. = Combined Heat & Power, D.H.P. = District Heating Plant
Data sources: National Institute of Statistics, Romania & Eurostat 2010
Diagram created with *e!*sankey 3.0 (www.e-sankey.com)