

## SUSTAINABLE RENOVATION AND EVALUATION OF BLOCKS OF MULTI-APARTMENT HOUSES

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**Abstract.** A significant amount of energy, materials and finances are consumed when using and demolishing the buildings. Proper planning, design, construction, management and marketing allow to reduce the environmental impact and expenses as well as to improve the quality of buildings and to raise their market value. Renovation of blocks of multi-apartment houses is nowadays one of the most important problems in residential districts which have been built in Lithuania before 1993. Sustainable development of blocks of multi-apartment houses requires to analyze various renovation strategies, prepare scenarios and select the most rational alternative. Based on the definition of sustainability, technical, economical, social and ecological requirements, not only alternatives for buildings, but also for their environment should be analyzed. It is important to improve the quality of the living environment, to reduce pollution and energy consumption, maintain mixed social structure and make a sustainable integration of new buildings into the existing environment. A successful renovation project can be prepared only by conducting a thorough research and properly evaluating buildings and their surrounding environment.

The paper analyses sustainable systems of assessment of the buildings, such as BREEAM and LEED. These tools should be used to assess the multi-apartment buildings and the needs for renovation of them and their surrounding environment. The systems use various information sources, systematics and assessment criteria; therefore, the results may vary greatly, depending on the system selected. The most important modern quality criterion for buildings is the maximum satisfaction of the users' needs and the minimum environmental impact by consuming the minimum amount of energy and other resources. The most important criteria which played a key role in all systems are energy consumption, resource saving, waste management and recycling, inner environment, quality of materials, longevity and the use of the building for another purpose.

**Keywords:** sustainability, multi-apartment houses, renovation, assessment, BREEAM, LEED.

### 1. Introduction

Purpose of the article is to investigate principles of the sustainable development emphasizing the renovation of apartment buildings and relevant sustainable building assessment systems via their comparison. Buildings have a high and permanently growing environmental impact (Castro-Lacouture *et al.* 2009; Chau *et al.* 2010; Wang *et al.* 2005). A significant amount of energy, materials and finances are consumed, as well as the environmental impact exists, when constructing, using and demolishing the buildings. It is spoken more and more about the sustainable development today. Therefore, in order to achieve the efficient energy consumption, environment saving, the systems of assessment of the buildings are also more and more applied, which encourage the society to reasonably perform the planning, design, construction, management and marketing. It helps to reduce the costs and environmental impact, improve the quality of the buildings, as well as to raise their market value. Also the reno-

vation of blocks of multi-apartment houses would help to solve the problems of limited non-renewable energy resources, increasing greenhouse effect and global climate warming. Renovation of buildings is an excellent opportunity not only to reduce the amounts of energy consumed in the building, but also to ensure other principles of sustainable renovation (Mickaitytė *et al.* 2008), the main equivalent components of which are ecological, economic and social. Renovation of residential blocks would help to reduce the energy consumption and CO<sub>2</sub> emission, as well as to improve the quality of life. However, the most efficient result will be obtained only by modernizing the blocks in a complex manner (Zavadskas *et al.* 2008). Therefore, it is very important to assess not only the buildings, but also their surrounding environment, as the problems in designing and constructing the buildings improperly solved in the past raise concerns at present. According to Burnett (2007), the cities and residents of the cities consume energy, raw materials in the highest amounts, and influence the climate change

mostly; however, at the same time, they can play an important role in order to achieve the global sustainability. Renovation of buildings in Lithuania and other countries may help to solve the problems of energy, environmental protection, improve the quality of life (Mitkus and Šostak 2009; Kaklauskas *et al.* 2009; Ginevičius *et al.* 2008); therefore, the modernization should meet the requirements of sustainable development (Šeduikytė and Jurelionis 2009).

## 2. Conceptions of Sustainable Development and Sustainable Renovation of Multi-Apartment Houses

The main provisions of the strategy of the long-term sustainable development on a global scale were formulated in “Agenda 21” of the United Nations, in the Earth Summit, held in Rio de Janeiro, Brazil. The basis of the conception of the sustainable development consists of 3 equivalent components: environmental protection, economic and social development (LR Vyriausybė 2009). Sustainable development is described as the development of the society, providing the possibility to achieve the universal well-being for the present and future generations, by harmonizing the environmental, economic and social objectives of the society and by not exceeding the permissible limits of the environmental impact. Burinskienė and Rudzkienė (2009), Medineckienė *et al.* (2010), Wedding and Crawford-Brown (2007) and many others agree that the goal of the sustainable development is to harmonize the economic growth, social progress, economically use the natural resources and ensure the favourable living conditions now and in the future. Sustainable development is based not on economic, social or institutional dimension, but on their system, understandable as the integrated society (Ciegis *et al.* 2009). Juškevičius (2005) states that the conception of the sustainable development is understandable as the process of creating the healthy environment, social welfare and active community, and the sustainable development in construction is understandable as the construction of the buildings which satisfy the needs of the people and environment. However, it must be emphasized that the negative environmental impact had by the human, both when constructing and renovating the buildings, must be as low as possible. According to Andruškevičius (2005), the renovation of the building is an activity, the purpose of which constitutes the rearrangement of the existing construction works, in order to eliminate its physical, architectural and aesthetic, functional, comfort-related, operational, social, economic and other types of depreciation of engineering equipment, etc. However, this purpose must be achieved by following the conception of the sustainable building. ALwaer and Clements-Croome (2010) understand the sustainable building as a complex of three main interrelated parts: namely, people (owners, residents, users, etc.), products (constructional materials, fabrics, constructions, structure, plants, equipment, automation and control, services) and processes (maintenance, control of equipment). These are the key closely interconnected parts. However, another highly relevant question is the

following: should the sustainable building not stand in the sustainable environment?

Over the last decade, more and more global organizations are investing significant resources to create sustainably built environments, emphasizing sustainable building renovation processes to reduce energy consumption and carbon dioxide emissions (Juan *et al.* 2010). Renovation of the buildings constructed in the last decades and their environment is the task of the increasing importance to the private, public, non-profit owners or investors. The well-being of a human and the whole mankind depends from the equilibrium of difficult social, economic and natural processes; therefore, these parts of development must be examined as a whole. Not only the sustainable construction, sustainable renovation of buildings, but also the sustainable world can be created only in this manner.

The term “sustainable construction” is used to describe the application of sustainable development in construction. The basic definition of sustainable construction was formulated in the conference organized by CIB, held in USA in 1994: its the creation and management of the healthy environment in the construction works and beyond their limits, following the principles of the efficient consumption of resources and environmental friendliness (Ofori 1998; Pollington 1999; Šaparauskas 2001; Antuchevičienė 2005). This conception also covers the sustainability-ensuring constructional materials, safe construction practice and new technologies. The same definition may be applied also to the sustainable renovation of the multi-apartment houses and their environment. According to the climate change, high energy consumption, it is important in the residential sector to understand and encourage the application of new technologies, the efficient consumption of energy and renewable energy sources.

With the renovation of residential houses, it is sought to reduce the energy and building-maintenance bills, in order to improve the safety, comfort, aesthetics, to increase the market value (Martinaitis *et al.* 2007; Užšilaitytė and Martinaitis 2010). However, all this must be executed according to the principles of sustainable development. The priority goal of the Master Plan of Vilnius City is to provide the conditions for continuous, socially and economically motivated growth of the quality of life and reduction of territorial differences. Construction sector has an especially close connection in social, economic and environmental views. Despite the different climate, culture and economy, there are many similarities among the developed and developing countries in terms of the impact of construction industry on environment (Melchert 2007). Energy needs grow in the present world especially rapidly, and it is one of the main reasons why the sustainable renovation of buildings must be sought (Kaminski 2008). Report of Implementation of the National Sustainable Development Strategy for 2005–2007 (Juknys 2008) provides for that 70 % of old multi-apartment houses (about 28.000 multi-apartment houses) will be renovated in Lithuania by 2020, and the thermal energy costs in the housing sector will be reduced to about 30 %.

In order to implement these plans and to obtain the efficient result, it is necessary to fulfill many conditions, including the one – to properly assess the versions of renovation of the buildings and their surrounding environment, by applying the internationally acclaimed sustainable building certification systems.

### 3. Overview of the Systems of Assessment of Sustainable Construction and Built Environment

Many studies have been conducted within the latter decade, different methodologies for the assessment of buildings have been applied, especially to solve the efficiency of consumption of energy and other resources (Sabapathy *et al.* 2010; Iwaro and Mwashia 2010; Galvin 2010; Sartori *et al.* 2009; Filippin and Larsen 2009; Swan

and Ugursal 2009; Zavadskas *et al.* 2008 a, b; Naimavičienė and Mickaitytė 2007; Balaras *et al.* 2007, 2005; Forsberg and Malmberg 2004; Flourentzou *et al.* 2002; Jaggs and Palmer 2000; and many others). The primary role of an environmental building assessment method is to provide a comprehensive assessment of the environmental characteristics of a building (Cole 1999) using a common and verifiable set of criteria and targets for building owners and designers to achieve higher environmental standards (Ding 2008). The internationally acclaimed systems of environmental building assessment methods are oriented towards the energy saving, efficiency of water consumption, reduction of CO<sub>2</sub> emission, improvement of indoor quality of life, management of resources and their purposeful consumption.

**Table 1.** Sustainable building rating systems

Name of the System	Year of Creation, Country
BREEAM (Building Research Establishment Environmental Assessment Method)	1990, UK
LEED (The Leadership in Energy and Environment Design)	1998, USA
HK-BEAM (Hong Kong building environmental assessment method)	1996, Hong Kong
GBTool (Green building challenge)	1995, International
CASBEE (Comprehensive assessment system for building environmental efficiency)	2004, Japan
BEPAC (Building environmental performance assessment criteria)	1993, Canada
DGNB (German Sustainable Building Council)	2007, Germany
LiderA	2000/2005, Portugal
Green Star	2003, Australia
HQE (High Quality Environmental standard)	1992, France
Minergie	1994/1997, Switzerland
TQB	2002, Austria
CEPAS (The Comprehensive Environmental Performance Assessment Scheme for Buildings)	2001, Hong Kong
BCA Green Mark	2005, Singapore
TERI GRIHA	2007, India
Protocollo ITACA (Innovation and Transparency of the Contracts and Environmental Compatibility)	2005, Italy

Many building assessment methods have been created in the world since 1990, the ones most frequently met are mentioned in Table 1. These and many others are based on the principles of environmental protection and sustainable development; therefore, Haapio and Viitaniemi (2008) raise the question: how to select and obtain a result that would be most appropriate and most reliable to assess a particular building? And who is responsible for the results, if they contain big errors? The user may really select the results of that method, which are more favourable to him in a particular case? It provides the possibility to manipulate. Table 1 presents the assessment systems created in order to reduce the negative environmental impact, by designing, constructing, renovating and/or operating the buildings; however, their usage is limited by differences of climate, legislation, culture, etc. of different countries. Therefore, in order to obtain the efficient result, the assessment system must be adapted according to the conditions of the country. With the help of the assessment methods, such as BREEAM, LEED, CASBEE, GBTool, Ali and Nsairat (2009) offer the

SABA assessment tool, having taken into account the environmental, social and economic aspects of their country Jordan. Therefore, the majority of the methods are mostly broadly applied in the countries where they have been created. However, the BREEAM and LEED assessment methods are far advanced, applied in a number of countries of the world, many later appeared systems are based on them. These sustainable building assessment leaders have different versions to assess various types of buildings; therefore, the possibilities of their application are broader. E.g. the method intended to assess particularly the multi-apartment houses will yield a more precise result, than the general methods whereby any type of the building can be assessed.

BREEAM (Building Research Establishment Environmental Assessment Method) assessment method has been created in the UK in 1990. It is one of the mostly broadly applied methods in assessing the environmental impact, related to the buildings. More than 200.000 buildings in the world have the BREEAM certificates and

more than a million of them have been registered for certification (BREEAM 2009). This method allows to assess the usefulness of the building in an ecological respect in the following fields: Management; Health and Wellbeing; Energy; Transport; Water; Material and Waste; Landuse and Ecology; Pollution.

LEED (The Leadership in Energy and Environment Design) created in USA in 1998 is also the broadly applied, internationally acclaimed, green building assessment system. For LEED, also as for BREEAM, it is sought to determine and assess the level of environmental friendliness of the building, to look at the sustainability of the building as at the whole in respects important to the health and environment of the human. This assessment method can also be applied in any phase of the life cycle of the building. LEED encourages the sustainable view into the building in the following main fields (LEED 2010): Sustainable Sites; Water Efficiency; Energy and Atmosphere; Materials & Resources; Indoor Environmental Quality; Innovation in Operations; Regional Priority.

The assessment fields of these methods are similar; their assessment system is also similar: each of the assessment fields is granted a certain number of credits (points) which are attributed according to the way how the building being assessed conforms to the criteria of that field. After summing up the number of credits (points) collected in all fields, the total result is obtained, which, in comparison with the assessment scale, the building is assessed (certified):

- According to BREEAM: Pass; Good; Very Good; Excellent.
- According to LEED: Certified; Silver; Gold; Platinum.

However, the BREEAM and LEED assessment methods do not cover one of the most important fields – financial assessment. Liu and Lu (2009) state that the green building must also be based on the economic analysis. Environmental issues and financial considerations should go hand in hand as parts of the evaluation framework (Ding 2008; Kajikawa and Inoue 2010). The pay-off is an important factor in preparing the project; therefore, the non-availability of the financial assessment reduces the usefulness and efficiency.

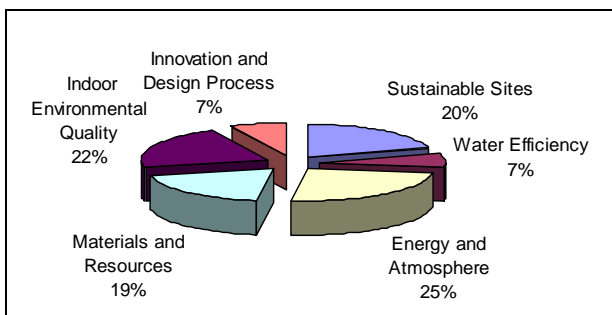


Fig 1. Significances of the LEED assessment fields

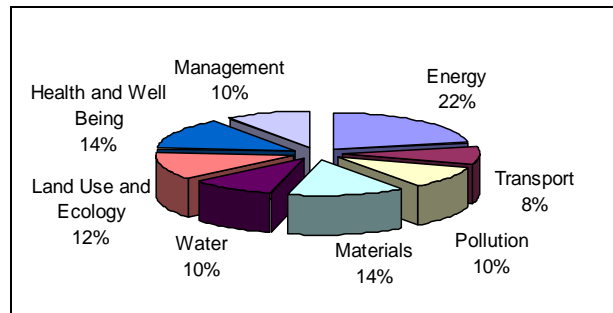


Fig 2. Significances of the BREEAM assessment fields

It is clear that a robust and credible building environmental assessment scheme will play a key role in assessing building energy performance (Roderick *et al.* 2009). LEED and BREEAM attach the highest significance to the energy consumption (Fig 1, Fig 2). After making a comparison of energy consumption by using 3 assessment methods – BREEAM, LEED and HK-BEAM - , Lee and Burnet (2008) concluded that it is very hard to collect the credits according to the BREEAM assessment. But Papadopoulos and Giama (2009) notice that the efficiency of the BREEAM energy consumption is divided into two fields: Energy and Pollution. These two fields are closely interrelated. The usage of natural resources and the factors influencing the climate change depend from the efficient energy consumption.

The usage of ecologic materials is important in assessing the buildings. After conducting the study, Lacouture *et al.* (2009) state that, if there are no possibilities to acquire the materials with desirable features, or if they are expensive, it is almost impossible to receive a high LEED assessment. The environmental impact assessment systems attach not the last significance to this field. Materials and resources used for the sustainable building must have as low as possible negative environmental impact.

Although the BREEAM and LEED assessment methods are broadly applied, Malmqvist *et al.* (2010), Cole (2005), Ding (2008), Humbert *et al.* (2007), Wallhagen *et al.* (2008) criticize these methods about their point systems, as the significances are often determined on unclear bases, having influence on the final results in order to receive as many as possible points. The plain and clear assessment system is a high advantage; however, much time and experience is needed to create a reliable and user-friendly assessment system. Sustainable development has led to the complicated methods, systems covering much information which must be collected, analyzed, processed; therefore, the assessment systems are continuously improved and updated. The assessment systems are more and more broadly applied, more separate buildings are certified. In order to make the renovation as efficient as possible, the multi-apartment houses should be renovated not one after one, but in a complex manner, i.e. the whole block together with the environment. At the small variety of multi-apartment houses, the assessment of the entire renovation of the block of multi-apartment houses

could be conducted; and, on the basis of it, the priorities of renovation of the blocks could be set out.

#### 4. Conclusions

Certified and highly evaluated multi-apartment houses must satisfy the users' needs and be environmentally friendly. It is one of the main requirements of the sustainable building. However, the sustainable residential house should stand in the sustainable environment. Therefore, the complex assessment and renovation of multi-apartment houses would help to implement it. The problem of modernization of the buildings in Lithuania, like in many other countries, is especially relevant. In order to determine the efficiency of renovation of the buildings, a thorough and comprehensive assessment must be conducted. On the basis of the principles of sustainability, the multi-apartment houses should be renovated not separately, but together with their surrounding environment, i.e. block after block; and thus, the obtained result would be more efficient. For this purpose, due to the numerically insignificant variety of multi-apartment houses, it is necessary to assess the renovation of blocks of multi-apartment houses; and, on the basis of that, to set out the priorities of renovation of blocks.

The major part of the sustainable building assessment systems is based on the structure of the leaders, such as BREEAM and LEED. The environment-saving building assessment methods are oriented towards the energy saving, efficiency of water consumption, reduction of pollution and climate change, improvement of indoor quality of life, management of resources and their purposeful consumption. Although BREEAM and LEED are mostly broadly applied methods, they do not cover one of the most important fields – financial assessment. This assessment should be parallel to the other assessment fields.

The sustainable building assessment systems are useful to the designers, architects, contractors and building owners. All participants of the renovation process undertake to reduce the environmental impact had by the building. Therefore, the application of assessment methods has a high influence on the natural resource consumption, climate change, CO<sub>2</sub> reduction, improvement of the quality of life. However, in order to obtain an efficient result, the criteria of the assessment method and the assessment system must be adapted according to the conditions of the country.

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