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The problem of defining standards in the sustainable architecture design

Introduction

In the period of the threat to the environment and energetic crises the sustainable development has become the main strategy in the land management. Architecture and building industry constitute the biggest sections of economy in the economic aspect and in relation to the flow of raw materials. Most of the capital both financial and natural is invested in buildings. The role of architecture and construction in creating the sustainable development is very significant.

Sustainable development was defined in 1987 in the Report 'Our Common Future' worked out by The World Commission on Environment and Development also called the Brundtland Report. The Report contains the list of threats to the future proper development of mankind. A central category of the Report became the notion of the sustainable development as well as the problem of satisfying people's needs at the expense of nature, the needs of the rich at the expense of the poor and the needs of today's generation at the expense of the future generations. It was stated that the principles of sustainable development should be executed by all countries because only then will it be possible to satisfy aspirations of the present and future generations [12].

Sustainable development in relation to architecture was presented for the first time in Gävle in 1998 and published in Agenda 21 in the document called 'Sustainable buildings' [4].

Components of sustainable architecture

Sustainable architecture is the architecture designed in accordance with the principles of sustainable development. In 2006 the European Council adopted a renewed strategy of the EU sustainable development [3]. The strategy lists three dimensions of sustainable development, i.e. environment protection, social integration and economical growth as well as seven key challenges in the sphere of economic, ecological and social policies:

- limitation of climate changes and promotion of pure energy,
- ensuring that transport systems meet the requirements of environment protection,
- promotion of sustainable models of production and consumption,
- better management and counteraction against excessive exploitation of natural resources,
- promotion of high quality public health,
- creating a society which is based on social integration and guaranteeing a high quality of citizens' life,
- active promotion of sustainable development and ensuring compliance of EU actions in this aspect.

The aspect of energy saving in architecture in the modern civilisation conditions plays a key role. Directives of the European Community for the year 2020 presented in the so called 'Green Book of Energetic Effectiveness' [2] assume as follows:

- execution of potential savings in buildings within the range of energy used for heating, air-conditioning, hot water and lighting on the level of 22%;
- doubling of participation of renewable sources of energy from 6% to 12% in the general use of electricity;
- increase of ecological electric energy from 14% to 22% in the general energetic use.

In order to facilitate the process of designing architecture structures which function in accordance with the rules of sustainable development, attempts to codify

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standards are made. Standards set the quality of solutions and they are subordinated to the components which create the model of building functioning in the environment. These components creating particular problem areas comprise the following:

- energy saving and the usage of renewable sources of energy,
- health comfort of users,
- integration of a given structure with the environment and pro-ecological exploitation of the terrain,
- rational usage of water, materials and other raw materials.

Programmes which certify designing and execution of architecture structures deal with standardisation of components.

Designing standards in certificating programmes

Standards of designing and execution of architecture structures are codified in specialist assessing programmes which give certificates to the particular buildings.

The following programmes enjoy a special interest and prestige:

- 'Passive house' programme created in Germany in the Institute of Passive Houses in Dormstandt,
- 'Green building' programme of the European Commission which, using the established standards, goes beyond the narrowly understood circle of energy saving problems,
- 'BREEAM' British programme estimating buildings which has been functioning for several years in the sustainable architecture environment, mainly in Great Britain,
- 'LEED' American programme which currently carries out certification processes in over 33 countries (certificates are granted by US Green Building Council) on different continents.

Analysing the attempts of codifying and determining the standards of designing as well as architecture, we must bear in mind that these programmes are not closed and are subject to constant development and improvement. In our article we focused on the problem of defining standards in the above mentioned programmes.

'Passive house' – the idea of the house was created in Germany in the 1990s. The creators of this idea Doctor Wolfgang Feist and Professor Bo Adamsom [8] made design assumptions according to which passive systems were supposed to cover a big part of the demand for heat. Passive energy sources are as follows:

- heat sources such as, e.g. people, household devices,
- heat recovered from air,
- passive profits from natural sources such as solar energy, earth energy.

In 1991 in Darmstadt the first passive house was built (Fig. 1). In 1996 the Institute of Passive Houses in Darmstadt was established. It is an independent research unit under Doctor Wolfgang Feist's guidance. The creators of the idea focused strictly on the saving energy problem and other factors of sustainable development were left beyond their current sphere of interests. Nevertheless, we should keep in mind the fact that this idea as well as standards undergo evolution. A passive house is considered to be the house which does not use more than 15 kWh of energy per 1 m^2 of usable area in order to provide residents or users with thermal comfort.

The passive house must meet specific standards:

- a total coefficient of thermal permeability for the passive building cannot be higher than 0,15 W/m^2 K;
- a coefficient of 'U' heat permeability for walls, the roof and floor on the ground cannot be higher than 0,13 W/m^2 K;
- a coefficient of 'U' heat permeability for windows not higher than 0,8 W/m^2 K;
- a coefficient of solar energy 'g' permeability for window panes not higher than 50%;
- exchange of air not more than 0,6 of the house cubature

Fig. 1. Passive house in Darmstadt, arch. Bott, Ridder, Westermeyer (by L. Kamionka)

Il. 1. Dom Pasywny w Darmstadt, arch. Bott, Ridder, Westermeyer (oprac. L. Kamionka)

Fig. 2. First passive house in Poland with Certificate, 2007, southern façade. Smolec near Wrocław, arch. B.P. Lipińscy (photo: L. Kamionka)

Il. 2. Pierwszy dom pasywny w Polsce z Certyfikatem, 2007, elewacja południowa. Smolec k. Wrocławia, arch. B.P. Lipińscy (fot. L. Kamionka)

Fig. 3. First passive house in Poland with certificate, 2007, northern façade. Smolec near Wrocław, arch. B.P. Lipińscy (photo: L. Kamionka)

Il. 3. Pierwszy dom pasywny w Polsce z certyfikatem, 2007, elewacja północna. Smolec k. Wrocławia, arch. B.P. Lipińscy (fot. L. Kamionka)

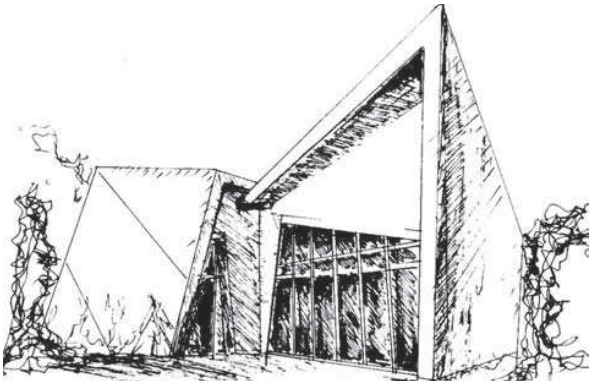


Fig. 4. Economical energy house in Dattein 2009, arch. D. Libeskind, source: Rheinzink (by L. Kamionka)

Il. 4. Dom energooszczędny w Dattein 2009, arch. D. Libeskind, źródło: Rheinzink (oprac. L. Kamionka)

per hour, e.g. for the house with 500 m^3 (193 $m^2 \times 2{,}6$ m) cubature the maximum ventilation efficiency is 300 m^3/h.

Execution of the defined standards cause a decrease in the use of energy in relation to the effective laws and technical conditions [6].

The first design of the passive house in Poland was performed in Smolec near Wroclaw in 2009 (Figs 2, 3). Architects use the idea of an energy-saving house in their designs and realizations more and more often. In cooperation with Daniel Libeskind in Dattein, a prototype of the ecological house was built which was to be mass produced (Fig. 4).

The European Commission undertakes many initiatives within the scope of sustainable development and the particular role of the architectural activity. In 2008 this Commission published 'The Council conclusions concerning architecture: participation of culture in sustainable development' [5]. The Commission undertook the initiative of the programme based on a voluntary participation, which aimed at increasing energetic effectiveness of buildings.

The **'Green building' [11]** programme was activated in January 2005. This is a voluntary programme thanks to which the owners or users of buildings are helped with increasing energy saving and introducing renewable sources of energy into the construction substance.

The office block UNIQA in Vienna was built in accordance with the Green Building standards (Fig. 5). Each company, firm, organization or a natural person who is going to contribute to the tasks of the programme can participate in the Programme. The 'Green Building' – is:

- flexible and open – in order to be applied in different kinds of buildings along with their surroundings and to comprise modernization of the already existing buildings;
- precise enough to guarantee that companies which join the programme shall fulfill their obligations and shall achieve a significant part of potential energetic savings;
- possible to be adapted to different national as well as regional and local conditions;
- competent and effective in popularizing the Directive on Energetic Efficiency of Buildings and stimulating its implementation.

The procedures of the 'Green Building' programme specify technical modules assessed in the process of certification, i.e.:

- energetic industry management,
- three-generation (mechanics, heating, refrigeration engineering),
- exploitation of solar energy,
- electric devices,
- distributional transformers and UPS,
- furnishings: equipment and devices,
- heating systems,
- ventilation,
- air-conditioning and passive cooling,
- kind of external material of the building,
- lighting comfort.

The procedures of technical modules define the standards which a building is supposed to meet.

In 2009 the office block Atrium City situated in the centre of Warsaw obtained the certificate 'Green Building' from the European Commission as the first in Poland (Figs 6, 7, 8).

The 'BREEAM' [13] programme was worked out in Great Britain in 1990. The programme is cyclically updated (the last amendment took place in 2008).

Fig. 5. UNIQA Towers in Vienna, Green Building.2008, arch. Neuman & Partner (by L. Kamionka)

Il. 5. UNIQA Towers w Wiedniu, certyfikat Green Building.2008, arch. Neuman & Partner (oprac. L. Kamionka)

Fig. 6. Atrium City-Warsaw, view from John Paul II Boulevard, first certificate in Poland "Green building" – 2009, "LEED" – 2010, arch. Kazimierski & Ryba (photo: L. Kamionka)

Il. 6. Atrium City-Warszawa, widok od strony al. Jana Pawła II, pierwszy certyfikat w Polsce „Green building" – 2009, „LEED" – 2010, arch. Kazimierski & Ryba (fot. L. Kamionka)

The standards comprise a two-stage procedure of assessment including the following stages:

- designing,
- realisation and they make it possible to assess various buildings.

There are three levels of influence on the environment which are used in the assessment:

- global,
- local,
- internal.

A Conference Centre, which constitutes a model of programme assumptions, was built in accordance with the defined standards in Durham in England (Fig. 9). 'BREEAM' is also tested in the structures of architecture which is designed and realised in accordance with principles of sustainable development outside Great Britain, e.g. Hermitage Plaza in Courbevoie (Fig. 10).

The programme procedures determine the categories and standards of designing a building:

- energy,
- health comfort,
- water,
- usage of the terrain,
- design management,
- materials,
- contamination, wastes,
- transport.

Total of the points from the assessment in the design stage and in the execution stage give a definite result and as a consequence a category of the granted certificate:

- satisfactory– at least 60% of the maximum number of points,
- good – at least 70% of the maximum number of points,
- very good – at least 80% of the maximum number of points,
- excellent – at least 90% of the maximum number of points.

Fig. 7. Atrium City, view from western part (photo: L. Kamionka)

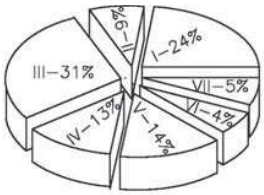
Il. 7. Atrium City, widok od strony zachodniej (fot. L. Kamionka)

Fig. 8. Atrium City, interior atrium (photo: L. Kamionka)

Il. 8. Atrium City, wnętrze (fot. L. Kamionka)

Fig. 9. Rivergreen Centre of Durham, Breeam 2007, arch. Jane Darbyshire & David Kendal Ltd. (by L. Kamionka)

Il. 9. Centrum Konferencyjne Rivergreen w Durham, certyfikat BREEAM 2007, arch. Jane Darbyshire & David Kendal Ltd. (oprac. L. Kamionka)



Assessed categories
I. Energy and atmosphere
II. Pro-ecology and comfort of the interior
III. Water management efficiency
IV. Environment
V. Materials and raw materials
VI. Regional priorities
VII. Innovativeness and the quality of designing solutions

Fig. 11. Percentage value of the participation of individual categories in the importance of the certificating evaluation (by L. Kamionka)

Il. 11. Wartość procentowa udziału poszczególnych kategorii w wadze oceny certyfikującej (oprac. L. Kamionka)

The certificate of the **'LEED'** programme functions mainly on the territory of the United States; however, it is worth noticing that there is a growing interest in it in Europe, the Middle East and Africa.

The programme 'LEED' [10] as a programme which comprehensively deals with the issue of sustainable development has been enjoying a greater interest and prestige among investors, developers and designers. At present, in more than 33 countries a qualification procedure for obtaining the certificate is in progress. The certificate is granted following a successful assessment of a building by the US Green Building Council in seven categories in which a definite number of points can be obtained as follows:

- Energy and Atmosphere – max number of points – 35,
- Pro-ecology and interior comfort – max number of points – 15,
- Effectiveness of water management – max number of points – 10,
- Integration of a building with the surrounding – max number of points – 26,
- Raw materials and Materials – max number of points – 14,
- Regional priorities – max number of points – 4,
- Innovativeness and the quality of designing solutions – max number of points – 6,

The system of categories sets the standards of functioning of an architectural structure.

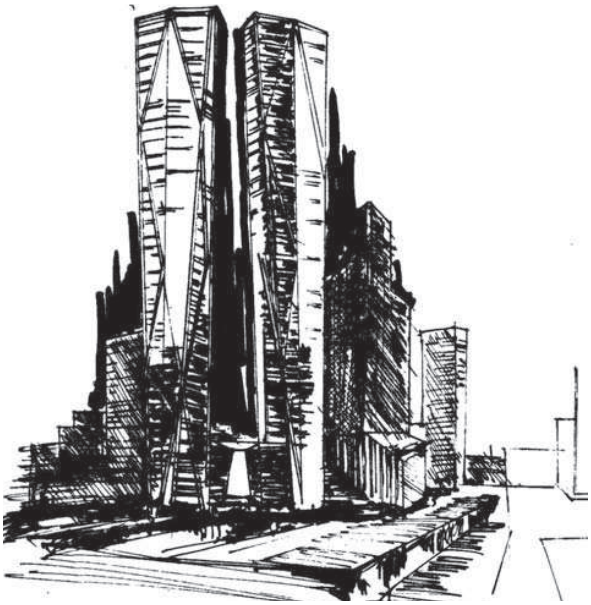


Fig. 10. Hermitage Plaza of Courbevoie, BREEAM – period of project design. Construction 2010–2015, arch. Normana Fostera (by L. Kamionka)

Il. 10. Hermitage Plaza w Courbevoie, certyfikat BREEAM na etapie projektowym. Realizacja 2010–2015, arch. Normana Fostera (oprac. L. Kamionka)

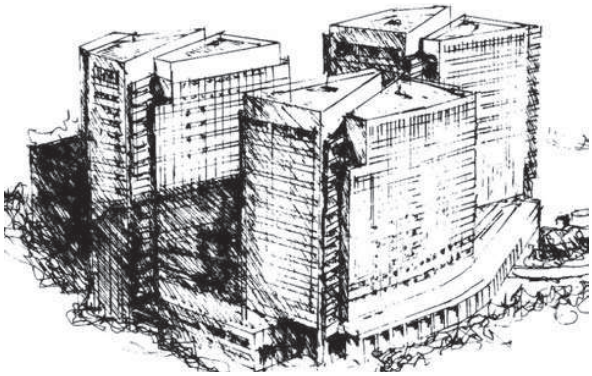


Fig. 12. Adobe Towers of San Jose USA, LEED – 1996, 1998, 2003, arch. Hellmuth Obata & Kassabaum Inc. (by L. Kamionka)

Il. 12. Adobe Towers w San Jose USA, certyfikat LEED etapy 1996, 1998, 2003, arch. Hellmuth Obata & Kassabaum Inc. (oprac. L. Kamionka)

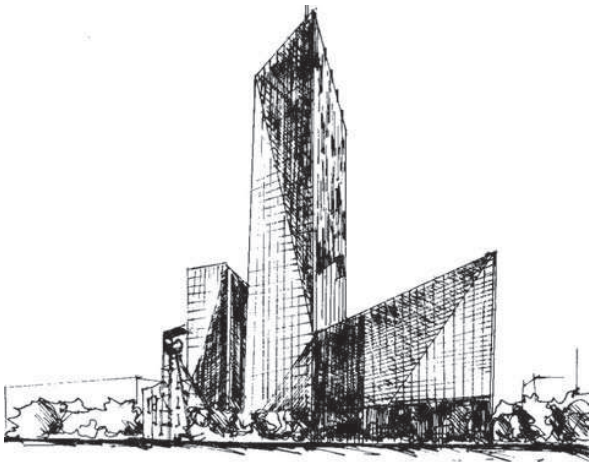


Fig. 13. Jindrich Plaza of Ostrawie, CMC architects David Richard Chisholm, Vit Maslo (by L. Kamionka)

Il. 13. Jindrich Plaza w Ostrawie, CMC architects David Richard Chisholm, Vit Maslo (oprac. L. Kamionka)

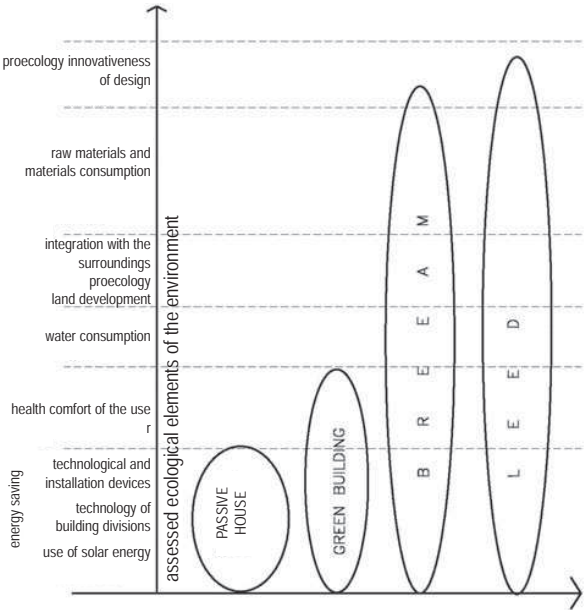


Fig. 14. Problem areas of sustainable development in codified certificating programmes (by L. Kamionka)

Il. 14. Obszary problemowe zrównoważonego rozwoju w skodyfikowanych programach certyfikujących (oprac. L. Kamionka)

The number of granted points depends on results which a building achieves in the above mentioned categories, while the total number of points decides about the level of certification.

Fig. 15. The Cycle of the existence of architecture object in the environment (life cycle) (by L. Kamionka)

Il. 15. Cykl funkcjonowania obiektu architektury w środowisku (life cycle) (oprac. L. Kamionka)

The categories which play a key role in the process of certification are as follows:

- 'energy and atmosphere' which constitutes circa 31% of the total point value,
- 'integration of a building with the environment' which constitutes circa 24% of the total point value.

A percentage value of particular categories which matters in the certificating assessment is shown in Figure 11.

The number of the scored points determines the level of the granted certificate:

- 'LEED' Certificate basic level 40 – 49 points;
- 'LEED' Certificate silver level 50 – 59 points;
- 'LEED' Certificate golden level 60 – 79 points;
- 'LEED' Certificate platinum level over 80 points;

The complex of edifices of the Adobe Towers in San Jose in the USA as one of the first received a platinum certificate (Fig. 12). The complex of Jindrich Plaza buildings in Ostrava also received the 'LEED' Certificate (Fig.13). In 2010 the aforementioned office block Atrium City in Warsaw met the standards of the programme and received a silver certificate 'LEED' (Figs 6, 7, 8).

Preliminary assessment of standards specified in the analysed programmes

On the basis of the review we carried out, we must conclude that the scope of standards of the 'Passive House' programme is the most narrowed down and it does not include the entirety of the sustainable development issues, nevertheless it rigorously deals with the issues of energy saving of a building, which are significant for creating sustainable development. The programme 'Green building' goes beyond the problems of energy saving but its standards in this aspect as well as the scope of architectural structure assessment at the current stage of the programme procedures do not give a fully satisfying image. The programmes 'BREEAM' and 'LEED' deal with a much more extensive range of the sustainable development problems and they are enjoying more and more popularity and interest. It is worth emphasising that the sustainable architecture standards are a significant factor of an economising city [7]. In Figure 14 we presented the comparison of the analysed certificating programmes in the aspect of the sustainable development issues.

In the process of designing architecture which complies with the principles of sustainable development, we must take into account the full cycle of functioning of the spatial complex which comprises a given fragment of the environment. This cycle is presented in Figure 15.

In Poland there are more and more design, developer and construction companies which are applying for the certificate. Several designs and implementations are in the process of assessment and certification, which is a most desired tendency

The role of architecture in designing for sustainable development

Standards of sustainable architecture pose new tasks and open new perspectives for an architect as a designer and coordinator of a designing process. Close cooperation with designers of installations and energy issues of a building on each stage of designing is of key importance to achieve the assumed goals.

In the book entitled 'Architecture & Quality of Life' [12] by Architects' Council of Europe an urgent need was emphasised of comparing the main goals of action comprising, on the one hand, economic development and competitiveness and, on the other hand, a balance – all things analysed as regards the quality of life. A leading role is supposed to be performed by the architect in this process.

While designing buildings the principles of architectural shaping, which aim at the best combination of a building function with a harmonic integration with the environment as well as at increasing energetic efficiency and ecological comfort, ought to be employed.

The triad of sustainable development: Ecology – Society – Economy is associated with the Vitruvian triad: Durability – Beauty – Usability [8].

Modern ecological designing consists in conscious taking into consideration the rules of building physics, the principles of energy and material saving, the usage of natural energetic resources of the surroundings, rational water economy as well as preference of pro-ecological relations with the urban surroundings.

A building design should constitute a resultant value of a multi-criteria analysis in which each of the solutions is confirmed by a simulation which allows estimating the effects of the accepted concept.

The architect's role is to give such values to the created buildings so that they could form a harmony in the content and form of the building (technical and functional issues). Aesthetics of sustainable architecture should determine the harmony between the form, technology and widely understood surroundings. An architect as a creator and coordinator in a complicated process of designing must harmonise different specialists in, e.g. constructions, installations, energetic balance, building management, ecology and economy.

The architect in an inter-disciplinary process of designing should always take sides with Man as a user of the created space.

Conclusions

The problem of specifying the standards in designing sustainable architecture – was analysed on the examples of the chosen certificating programmes. The standards which were defined in them comprised numerous categories:
cenergetic efficiency

- comfort of the user, micro-climate,
- efficiency of water economy,
- integration of a building with the surroundings, pro-ecological usage of the terrain,
- management of materials and raw materials,
- pro-ecological innovativeness of a design and regional preferences.

The energy saving factor in sustainable architecture in modern civilisation conditions plays a key role. Sustainable architecture which is designed and executed in accordance with the codified standards of sustainable development brings about significant profits as follows:

- for the natural environment, it contributes to the limitation of natural resources consumption as well as the decrease of the environment degradation,
- for health and safety, it contributes to the improvement of comfort, health and safety of users,
- social ones, it contributes to the improvement of the quality of life and relieving local infrastructure,
- economic ones, it contributes to the increase of the worked out benefits and profits.

Architecture in the light of the codified standards should be considered in a full cycle of functioning (life cycle). The stage of designing is important as well as the stages of design implementation, exploitation of a building and finally its utilisation.

The investor, developer, designer can freely make choices as regards participation in a particular programme.

The architect as a coordinator of the multi-domain process of designing should be a guarantee of such values that they could result in a harmony of the content and form of the building with adherence to the sustainable development principles.

Programmes, which assess and certify structures of architecture, should be considered as unfinished processes in a dynamic concept. The problem of defining standards in designing sustained architecture is still open, which is proved by periodic changes in the programmes with an aim to create optimal models of buildings conducive to sustainable development. These changes take place particularly in the scope of:

- adaptation to local conditions,
- increase of the area of certificating connections of architecture with the environment.

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Problem określenia standardów w projektowaniu architektury zrównoważonej

Architektura funkcjonująca w zgodzie z zasadami zrównoważonego rozwoju powinna odpowiadać określonym standardom. Próbę ich zdefiniowania podejmują programy certyfikacyjne. W artykule przedstawiono wybrane programy: „Dom pasywny", „Green building", „Breeam", „Leed", które obejmują problematykę zrównoważonego rozwoju w różnym zakresie i w różnym stopniu. Certyfikat „dom pasywny" skupia się głównie na energooszczędności, „Green building" obejmuje problematykę energii i komfortu użytkowego. Programy „Breeam" i „Leed" dają kompleksowy obraz zrównoważonej architektury. Kodyfikują takie kategorie oceny, jak: energooszczędność, komfort zdrowotny użytkownika, efektywność gospodarki wodą, proekologiczność użytkowania terenu, efektywność użycia materiałów i surowców, proekologiczna innowacyjność architektury. Programy certyfikacyjne nie są zamknięte, podlegają ciągłemu rozwojowi i doskonaleniu.

Key words: standards of architecture, environment friendly programs, sustainable architecture

Słowa kluczowe: standardy architektury, programy proekologiczne, architektura zrównoważona