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Research paper

Modern Approaches to the Design of Sustainable Cities

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Abstract

Constant development of society, connected with the growth of its needs, causes an increase in energy costs in all fields of human activity. Along with a shortage of fuel and energy resources, rising energy prices and increasing environmental requirements to the environment, addressing the problems of harmonious development of mankind in terms of energy saving is becoming more and more acute. The research is devoted to issues of aesthetic aspects of energy-saving and environmental solutions. The aesthetic features of energy-economic and ecological residential development are determined. The basic methods of formation of energy-economic and ecological housing development are revealed.

Keywords*:* aesthetics, energy efficiency, environmental solutions for residential development, sustainable development.

1. Introduction

The problem of development of mankind in a harmonious combination with nature has a long history. From ancient times, philosophers discussed this question. The growth of anthropogenic influence and the development of the scientific and technical complex have intensified the negative impact of man on the nature, the ecological crisis at the end of the twentieth century. has reached a global scale. Energy-economic and environmental solutions, as a new trend in urban planning and architecture, appeared after the global energy crisis of 1974. At the global eco-forum "Rio-92", for the first time, agreements were reached in the form of the so-called "Agenda of the twenty-first century" about the need for countries and cities to move towards sustainable development. In 1992, in Rio de Janeiro, an international conference on environmental protection was held. The most important issue of this forum was the further development an understanding of the connection of international economic and ecological issues within the concept of sustainable development. According to the UN Commission on Sustainable Development, its goal is to meet the needs of the modern society without jeopardizing the ability of future generations to meet their needs. One of the main tasks of sustainable urban development is the energy efficient use in buildings. It is this aspect that the authors of this work focuse on.

2. Literature review

Scientific works of many foreign and domestic scientists were devoted to the research of sustainable development processes. Problems of energy conservation in architecture in Ukraine were studied by: D.I. Antonyuk, O.V. Bumazhenko, M.O. Brodsky, S.G. Buravchenko, O.M. Pechenik, G.V. Kazakov, Yu Lapin, T.O. Kashchenko, A.O. Sardikova, G.N. Khavhong, L.O. Shuldanetal.

Issues of energy saving in construction in Ukraine were researched by: G.P. Vasiliev, V.F. Gershkovich, G.V. Hetun, V.V. Graniev, E. Kolisnyk, V.L. Martynov, A.A. Necheporchuk, O.L. Podgorny, M.A. Sainitsky, O.V. Serhiychuk, L.M. Stronsky, B. Tarnizhevsky, G.G. Farenyuk, R.A. Firth, G.N. Khavhun, L.P. Khokhlova, G.F. Chernykh, N.V. Shilkin and others.
Engineering issues for improving energy efficiency were also esearched by: L.D. Boguslavsky, V.F. Gershkovich, O.T. Dvoretsky, N.P. Selivanov, S.S. Zhukovsky, V.Ya. Labay, Yu.O. Sisemov, B.A. Stupachenko, B.G. Polchuk.
V.S. Buravchenko, O.O. Vasilenko and Soviet scientists N.M. Gusev, A.V. Ershov, N.V. Obolensky, V.G. Makarevich, I.S. Sukhanov were engaged in the studying light means and insolation maintenance of space in architecture.
Investigation of the climate impact on designing buildings and organization of urban areas can be found in the works of: I.N. Skryl, P.I. Skryl, I.P. Kozyatnik, F.A. Ternovsky. In the analysis, we use the concepts of sustainable development in the architecture of foreign authors, including the study of F. Govany and H. Yoshfkawa, C. Jenks, J. Stil, A. R. Anderson, W. Beckman, V.S. Belyaeva, M.M. Brodach, D. Watson, M.A. Voloshin, V.V. Graniev, K. Daniles, J. Zeitun, R. Knowels, A.L. Melua, L.A. Podolyan, R. Sterling [2], Yu.V. Tabunshchikov [4], S. Uelda, N. Fati, V. Hellmann, F. Schubert, Peter and Brenda Vale, Susan Roaf, T.A. Markus, E.N. Morris [1], and Paige [12].

The purpose of the work is to identify the main features of the sustainable development of cities, districts, neighborhoods and individual buildings, on the basis of which the basic qualities and trends of architectural and construction objects are formalized.

3. Methods of Forming Sustainable Cities

Sustainable development is not a new ideology, based on the need for the balance between the environment, society and the economy. In recent years, examples of successful implementation of the concept of sustainable development have emerged in such areas as urban development, architecture, energy, agriculture, production and consumption.
To date, the world has developed the basic principles of sustainable development of territories (cities and other settlements):
- in new settlements and urban neighborhoods, a humane number of loors of residential buildings is created (no more than 5 floors); planning solutions take into account the creation of rational transport infrastructure, easy accessibility of administrative, business and shopping centers, institutions;
- construction is carried out on the principle of cells, that is, "green" yards and playgrounds are created. Business quarters with high-rise buildings are separated from "green" residential districts.
- Transport is selected according to the environmental criterion (trolleybuses, trams, funiclars, overground and underground electric trains, electric and other environmentally friendly vehicles); cycling (personal and public) is encouraged and supported;
- appropriate parking is organized near residential blocks and administrative and business centers taking into account the demo graphic and economic development of the region;
- great attention is paid to the improvement of territories – reservoirs are created, parks, alleys, embankments, etc.;
- the functional purpose of each quarter is considered (zoning);
- when creating the engineering infrastructure, the possibility of using local renewable energy resources in each quarter is taken into account;
- the architectural image of buildings is consistent with the characteristics of the local landscape, taking into account national traditions.

There are tendencies for consolidation, environmental friendliness, multifunctionality, flexibility, variability, versatility, adaptability, diversity, environmental orientation, conceptuality, artistic expression, typification, unification, progressivity, technological, engineering and technical equipment. Considering the architectural object on different hierarchical levels, modern approaches to the development of architectural and construction objects in the contiguous cities were classified in the following way:

On the level of city-building solutions, enlargement (linear and transparent blocking, multi-segmentation, compactness, branching-waist structure, stylobate structure), environmental friendliness (preservation of functional zones, increased use of open spaces), struggle with the effect of the superheated island , use of natural resources, green plantations, natural and artificial reservoirs), efficient use of the territory (calculation and increase of density of construction, logistic function of functional zoning, preference for quarterly construction, high-density low-rise "carpet" building), polyfunctional buildings (tight-functional zones, open space zoning,freely transformed, interaction with the urban environment, open common areas).

On the level of architectural and planning solutions, the main approaches to the formation and development of architectural and construction objects in sustainable cities are flexibility (rapid response to the growing needs of people, response to changes in conditions and requirements of the operation of objects, the ability for dynamic adaptation, avoiding depreciation), the variability of structures (overcoming repetition and monotonous quarterly construction, the ability to use relief, obtaining the largest number of options with a minimum number of elements), versatility (combination of the main function with auxiliary, fast adaptation to any function), adaptability (the concept of "growing house" with buildings, which allows you to finish building new parts of the house, using the elements of the existing, the concept of "free planning and guides", the concept of "open construction", the concept of "loft"), a variety of architectural and planning solutions (the implementation of the principle of "ordered flat" with the design of apartments based on the individual project of the customer at the stage of general building of the house, satisfuing needs of different social groups of the population by combining different types of apartments in one house), orientation, specialization (the choice of the main criteria is made according to energy efficiency and environmental friendliness, subordination to climatic conditions, non-violations of the architectural and natural environment), conceptual development (application of algorithms of housing design from the sketch to the implementation of the priority of the idea of energy efficiency, on the level of architectural and planning decisions), artistic expressiveness (harmonization of form, scalability, tectonics, parametryzm, the application of national traditions, inheritance, composition and stylistic devices).

On the level of engineering-design solutions and typological peculiarities, which are influenced by the choice of constructive systems, the main approaches of the formation and development of architectural-construction objects in the constituent cities are the openness of constructive systems (interaction of the processes of designing and building of typical constructions, spatial solutions of buildings based on the same solutions), uniformity and unification (high construction rates, low energy and labor complexity of construction, installation of built-in premises on the first floor and attic, interchangeable elements), progressive design and manufacturability of the building and materials (engineering and technical equipment og monitoring and control of the microclimate, effective ventilation with heat recovery, regulation of heating and lighting, renewable energy).

The mentioned approaches allowed to reveal the structure of the design process of sustainable cities, which consists of the conceptual development of a town-planning solution, with its functional features, engineering-constructive aspects, and artistic-compositional categories, the levels of realization of the object and the implementation of the material structure, the stages of realization and types of building of sustainable cities are revealed.

The main trends in the design of sustainable cities are economy, energy conservation, and the rational use of material and energy resources. The main methods are the method of control, automation regulation, design, increase of air-tightness of buildings, application of engineering tools, application of alternative energy sources, application of an integrated approach. The main ways are to reduce energy consumption, use of energy from non-renewable sources of energy, economic evaluation. The structuring of the main constituent parts of sustainable cities has allowed us to present a comprehensive approach to the design of sustainable cities and to show interdisciplinary interaction in order to apply innovations from different areas.

The main methods of designing sustainable cities are divided into 4 levels: city-planning, architectural-planning, constructive and engineering.

Town-planning level. Analysis of foreign and domestic experience in the design of contiguous neighborhoods and districts has shown that traditional linear and forward mesh building structures are used for the purpose of economic high-density use of territories with the possibility of choosing better orientation for premises, protection of premises from solar radiation and wind. Mesh structures are formed on the basis of rectangular, hexagonal, and other modular grids. Also, the planning of the neighborhoods has a standard building that provides a choice of optimal orientation in terms of insolation and protection against noise and dust, and perimeter construction that allows to use perimeter-like buildings, such as wind screens for the protection of buildings inside the block from the prevailing and dangerous winter winds, and for ventilation use of passes and arches in houses by the prevailing summer winds. For avoiding vortex rollers behind homes located

along the perimeter of the block, on the windward side there is a low-rise building with a "critical zone" overlay or a stylobate part as a reflective surface. Perimeter building blocks dominate the houses of linear form, they have both latitudinal and meridional orientation, as well as compact terraced houses with a decrease in height in the middle of the quarter to improve insolation of buildings. The study of the project experience has made it possible to identify the main urban planning requirements that need to be met when designing them. This is the analysis of climatic factors, the most important of which are the amount of solar radiation, the strength and speed of the wind, the landscape and terrain, as well as an analysis of the existing urban development situation (higher level in the hierarchical structure of residential education), aeration, insolation. Based on the analysis of domestic and foreign experience in the design and construction of stable neighborhoods, the main urban planning techniques for the formation of a sustainable environment have been identified. This is the formation of quarters of perimeter, routine, compact and compact terraced buildings with increasing elevation from north to south or a decrease in height in the middle of the quarter, avoiding shading houses by each other, installing windscreen screens, including "green zones" in the structure of the block to improve microlimate, avoiding vortex rollers from the windward side of buildings, arranging arches and fences to ensure aeration of the territory, noise protection. A separate point is the influence of aerodynamic factors on building in the city structure, the arrangement of ventilation and wind protection.

Architectural and planning methods. Analysis of foreign and domestic experience in the design of sustainable buildings, has allowed to identify the main requirements that need to be met in the formation of sustainable development. These are requirements for architectural, planning, design and engineering-technical solutions. The main requirements for architectural and planning decisions of the house are the choice of its orientation to provide sufficient amount of solar radiation (insolation), protection of the building from overheating (sunscreen), provision of premises of the house with a sufficient level of natural light, functional and temperature zoning of the house, compactness of the form of the house, performing aeration of the home and providing conditions for its natural ventilation, home wind protection. The main architectural and planning techniques are to increase the ratio of compactness (by constructing an atrium inside the house or joining several atrium houses, building a structure with a wide body or expanding the corpus of existing building, building glass balconies, loggias, bay windows on the southern facade, the construction or extension of the attic or the heated attic, the construction of a house-insertion in a linear manner, allowing the neighboring walls to be placed adjacent to one another), methods associated with the increase of insolation houses (the use of light wells, the increase of the area of fenestration on the southern facade, the decrease in the depth of the room, the choice of a color design of the facade and the interior, taking into account that white color reflects 80% of the light directed to it, black - 9%), sun protection (separation of the building from the lining blocks and projecting from the plane of the facade or changing the orientation, the horizontal division of the canopies and balconies), the methods of temperature zoning of the building (the determination of the thermal core, buffer zones, the application of the climatic buffer zone for use of the complex facades, rounded, aerodynamic, or facade inclined at an acute angle to the prevailing wind), methods related to the improvement of the aeration of the house (such as raising the house on the supports, climatic facade) .

Planning solution of premises is recommended to be applied in the ratio of length and width of the room within 1,4-1,6, which ensures a stable temperature regime. In a rectangular room, the natural light and airing deteriorate, although the temperature conditions improve, the natural light in the square room improves, but the ability to withstand external thermal influences decreases by half compared to the deep room.

Constructive methods. The main requirement for the constructive solution is the thermal protection of the enclosing structures by increasing the resistance of the heat transfer, increasing the volume tightness and creating a thermal battery inside the building. Enclosing structures consist of transparent (windows, doors) and opaque (walls, ceiling, roof) structures. Hence the main methods of energy efficiency improvement. Methods for the installation of energy efficient walls include structures of ventilated facades (ventilated systems of insulation with a layer of air between the heater and the supporting structure of the wall), the construction of non-ventilated walls (using mineral wool and polystyrene boards as insulation), the construction of a multilayer heat-insulating system "MITs" (thermoshape), the construction of a light-transparent facade with collectors ("Solar walls.") Methods for the installation of energy-efficient windows and glazed doors include the use of multi-chamber windows It is a 2-x, 3-chamber-type glass, glass-coated glass, glass, glass with melting suntan, heat-reflective films, reflex glass, filling the inner space of the glass pane with a vacuum or an inert gas (argon) , the use of a transparent thermal insulation, acrylic foam, capillary glass, cellular polycarbonate, airgel, silicagel on silicic acid.The arrangements of the roof are divided according to the type of space attic space. A roof may be with a cold attic, with a warm attic, combined with the exploited rooms (mansard) The techniques of overlapping are based on insulating both interiors and attic and sub-ceiling overlays, which also adds noise protection to the building. Creating a thermal battery is possible due to application of the internal structure of the building, made of materials that have a low resistance to heat transfer, such as full brick.

Engineering or engineering-technical methods. Requirements for engineering solutions are based on providing and maintaining normative indicators of the microclimate of premises due to the equipment of the house with modern engineering equipment with the ability to control and manage the process of its work. The engineering and technical measures of sustainable buildings include devices for heating and hot water supply, ventilation and conditioning, energy consumption, devices for converting alternative sources of energy.

Among the devices for heating and hot water supply boilers have high-efficiency using primary energy carriers and renewable energy sources, heating control and control systems, heat recovery heaters of sewage effluents. Among the devices for ventilation and conditioning are recuperators and regenerators of heat, installation of ventilation systems in accordance with the prevailing wind, usage of the system of utilization of heat (cogeneration). Lighting devices are energy-saving devices, such as halogen lamps, LED, fluorescent and home appliances of the energy efficiency class A, A +, A ++ and above. Renewable energy extraction and conversion devices are divided into types depending on the type of energy used. The most common are solar energy conversion devices (solar collectors, photovoltaic converters), wind energy (wind turbine generators), ground energy (heat pumps), biomass energy. New energy sources are searched, among them: water vapor, which evaporates from rivers, lakes, seas; bacterial spores that change size depending on humidity; the process of photosynthesis; servers of Internet companies that produce excess heat. Engineering devices in this paper are considered as complementary to the basic architecture-building solution or as the initial central idea of creating a certain volume, subordinated to a certain type of alternative energy, the way of obtaining and transforming it.

At this stage of modern architecture, state support for the development of sustainable cities is an important issue. So, the Swedish government set the task for the delegation for sustainable urban development to manage and provide financial support for projects aimed at developing a sustainable city.

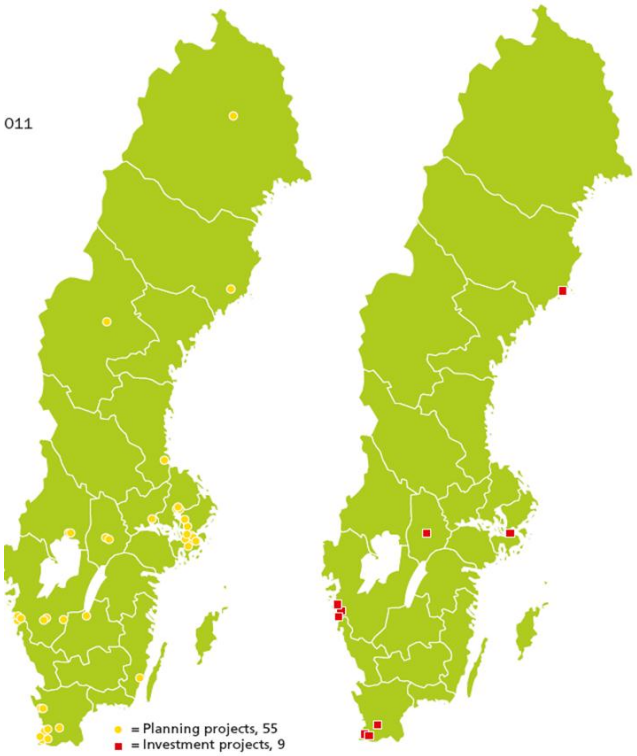


Fig. 1: Scheme of location of coordinated and invested projects of project proposals of Sweden

This support is the promotion of sustainable urban development, projects that not only help reduce greenhouse gases emissions but are also the best examples of urban development measures that use integrated urban planning and green technologies. Projects should reflect the potential inherent in the development of sustainable cities, be demonstration models and promote the spread and export of green technologies and expertise. Projects should also promote an attractive solution that is beneficial to people who need to live and be active within an environment built or regenerated to stimulate innovative and unusual solutions.

Such support was 340 million Swedish kronor in 2009-2010 and was mainly intended for investment projects for newly built or regenerated urban areas or residential areas (Fig. 1). A smaller part of the grant could be allocated to planning projects that prompted the feasibility study, inter-sectoral planning and information initiatives. The delegation provided support of 9 investment projects and 55 project proposals. Today, Sweden is at the heart of sustainable urban planning and international stimulation of new demonstration models and reinforces this position by shedding light on several aspects of sustainable development. One such example is cooperation in planning and implementation with the municipality, the business sector. Projects also show how technical systems are interconnected. The main results can be achieved through a coherent approach to energy, waste and wastewater management.

Sustainable city district of Ålidhem.

Fig. 2: Winter Garden. The recreation area is heated all year round by heating the air from the spent spent energy.

The city of Umeå has its own wind turbine, solar cells. In 2008, an entire residential block was burned down at Ålidhem. The idea was to create the largest low-energy project in the northern part of Sweden. At the same time, other areas are beginning to be motivated, as well as a safer housing environment. The initiative includes more than 500 apartments, 140 of which will be new low-energy ones.

Centralized heating for domestic needs. The climate in Ålidhem and Umeå is cold, but the area has a large centralized heat supply system, 99% of which is powered by unmined fuels. The project reduced overall energy consumption and centralized heating was used to heat water in dishwashers, washing machines and other household machines. The buildings will be equipped with new ventilation systems with recuperators and energy-efficient LED bulbs.

New ways to attract people. The project will help residents to be more environmentally friendly. Individual smartphones will be installed to measure energy in apartments. The encouragement of Ålidhem residents is an important part of future change. Residents had little interest in a consistent approach, however, new ways to increase participation in the testing process were proposed. For example, AB Bostaden in Umeå has, for example, organised a walk tour with residents of municipal housing to study aspects of sustainable development and the safety of the local environment. Students from the Umeå University and the Skuggteatern group of local theater in Ålidhem were also involved. To attract new ideas, a large poster was created on the building of the future youth recreation center, with the words "Hello Ålidhem, what do you want to do with this building?" The mechanics were called to evaluate the existing proposals and to suggest their own ideas. Prior to physical investments in Aliad through dialogue with local residents and other participants During the Ålidhem campaign, residents were able to put forward their own proposals for the development of their environment, the method proved to be very successful, with more than 200 respondents expressing their thoughts in this regard. Most got what they wanted and Ålidhem now has its own culture center.

A place to test new solutions. The area should be shown as a demonstration model in combination with Umeå as a European cultural city in 2014. The decision of the Ålidhem played an important role in the future development of the city. Cooperating with several institutes in Umeå the Institute of Design, the Institute of Technology, the Academy of Fine Arts and the School of Architecture, will be test grounds for a new sustainable urban development. The following improvements for Ålidhem are planned: 50% reduction in energy consumption due to the latest insulation solutions and densification methods, energy consumption will be halved. To preserve the original bricks of exteriors, the insulation is installed inside the buildings.

Local energy production. On the roofs of the homes of Ålidhem, built-in solar panels on sloping roofs are installed. This preserves the traditional architecture of the area. The purpose is to recreate the original characteristic appearance of the roof from the surface of the earth. The energy will flow into an area of two wind turbines that will be installed next to it.

Public space. The winter garden was designed, the air in which it is heated, using the waste energy from district heating. This is a common area where residents will be able to spend time. As the garden is heated all year round, it will provide new leisure opportunities.

Advantages of the project

- A glazed winter garden and a pleasant indoor temperature will be maintained using the remaining centralized heat supply from local buildings. This will create a new meeting place for the locals and new opportunities for the rest all year round.
- The transformation of a busy highway into a low traffic street

• The highway is separated. Heavy traffic will be moved to other roads. This will increase noise protection and provide a prospect for new residential and commercial activities, for walks, cycling, and above all for social activity.

Brief description of the project. Transformation of the residential area with a large number of houses; an example for building and energy initiatives in a cold climate.

Another striking example is the sustainable project of the city of Jarva, part of Stockholm's initiative to rebuild the city's neighborhoods with residential buildings. The suburb of Jarva in the northwest of Stockholm will be a zone of minimal environmental impact. Using innovative technologies and with the participation of local residents, the project will create positive social, ecological and economic development in the city of Jarva. Many homes built in the 1960s and 1970s require large-scale repairs. Energy consumption should be halved to meet current carbon emission requirements. The goal of the sustainable Jarva project - the city should be a national and international example of how to reconstruct residential buildings. Energy consumption in Jarva will be no more than 88 kW•h/(m^2•year), which can be compared to the national standard of 110 kW•h/(m^2•year) for new homes. There are three most commonly used types of buildings to be restored: 11-12 storey tower blocks in Akalla and Guzba, 5-6 floor balcony apartments in Gusby and triple-railing blocks in Rembebi. Two different methods have been applied: traditional on-site reconstruction and reconstruction of the underground. Both methods are compared and evaluated in terms of their impact on the environment, economy and historical value. The first stage was completed in 2011. Construction of two more buildings continues. The whole housing stock is municipal, including 5200 apartments in Jarva. By 2020, the most effective methods of reconstruction will be selected and applied. More than 200 million Europeans live indwelling-houses of the 1960s and 1970s. Similar re-construction methods can be repeated in many houses of the Euro-Rap. Solar panels and solar collectors are installed on the facades and roofs of homes in Akalla and Rinkeby. It is planned to build a 2 MW wind turbine in Jarva, which will facilitate local power generation and meet the demand for electricity in the area.

Transport. Stockholm politicians, civil servants and locals appreciated the current network of bike tracks in the area. The analysis will form the basis of the new Jarva plan. One of the initiatives is to improve communication between the northern and southern parts of the city and enhance the existing route through the green Jadwafelt area and build new roads with efficient LED lighting. There is a number of initiatives that encourage more people to start riding a bicycle, including a "bicycle borrowing" scheme. Cycling weeks are held, there is an adult school and road safety courses for children. Also, a motorway in Jarva will be created, which will encourage further sustainable development.

Information and participation. Application of technical solutions for the implementation of a sustainable lifestyle is not enough. In order to meet the goals, informational support and initiatives also help: Residents submit comments through the Jarva Dialogue initiative and take part in repair solutions. Local residents and environmental ambassadors living in the area are trained to disseminate information and advise on a more sustainable way of life for every person in the household. Local clubs, schools and healthcare facilities have proposed environmental training. The use of hot water in the area is twice as high as the normal rate. Partly due to the fact that the average household is twice as big as in other areas. It is expected that technical measures and information initiatives significantly reduce hot water consumption.

Cultural Initiatives. The Stockholm City Museum is implementing activities within the framework of the project aimed at increasing the knowledge of people about Jarva and increasing the pride of the inhabitants living there. One event that the Museum has carried out is the presentation of an apartment in Tennessee, in the same form as it was immediately after its construction in the 1960s. This apartment is now open to the public. The cultural and historical information is provided - a way in time, with information boards, which cover both past and present aspects of the area. Similar information boards were also installed on the adjacent cultural reserve "Yarvafelkt". A manual was prepared for schools and preschools to encourage visits to green areas.

Another example is the sustainable urban development in the Coastal District of Malmö, Västra hamnen. Malmö continues town-planning initiatives in the Västra hamnen district. The largest district of energy-saving homes in Sweden is being built as a part of the Fullriggaren project. Long-term solutions for sustainable development can be realized due to close cooperation with builders. Västra hamnen became the innovation of the Sustainable Development of the city of Malmö. Expansion of the territory began when the city hosted a European residential exhibition in the summer of 2001. The transformation of the industrial area of the promenade into a living urban area was carried out and put into operation with the public display (Fig. 2). It was the first urban area in Sweden with a neutral climate, where the energy system fully utilizes energy from renewable sources such as solar, wind and water, produced locally. Following this highly professional demonstration, the project, designed by Flaghauzen to make stability top priority, began to evolve. The ideas of sustainable development continue to evolve in the third project at Västra hamnen. Part of the Fullriggaren project is the construction of a multistorey city park. Nearly 75% of the 630 apartments will be leased out. Construction began in the summer of 2010 and completed at the end of 2012. For further sustainable urban development, further steps had to be taken. The city of Malmö and the twelve buildings of the construction companies of Fullriggaren were preparing for the start-up construction project in two years and worked together to create a common information base and general references. The focus was on issues such as energy efficiency, waterproofing, ventilation, green urban areas, open drainage system, highways and ownership forms.

The low-energy buildings and passive houses Fullriggaren will be the largest area in Sweden with energy-efficient buildings. One third will be classified as a passive house standard, the rest as a low-energy building, which is 40 percent better than the national energy requirements of Sweden. Office premises will be classified as buildings according to the Green Standard, which is 25% better than the norm. It also reduces need for energy to control lighting and smart measurements of electricity, heat and hot water.

Renewable energy from waste, sun and wind. It is also the largest area in Sweden where organic waste is collected with grinding machines and pipe networks for production, stocking and collection of biogas are located. Organic waste is expected to produce about 270 MW of biogas per year, equivalent to 70,500 liters of petrol. Renewable energy will be produced through solar panels and a city wind turbine, and will enter the heat supply network through a solar bank located on a multi-storey car park. The automotive pool for everyone will be the first in Sweden, where all residents will have access to it.

4. Experiment and Results

Foreign experience has shown that it is necessary to solve problems of the formation of sustainable architecture in a comprehensive manner. Designing energy-efficient buildings located in the historical building of the city, it is necessary to develop a system of recommendations that would take into account energy-efficient, aesthetic, environmental, sanitary-technical, constructive requirements.

In connection with the set goals, a research of construction was carried out, which showed that the distinctive situation in the historical regions of Ukrainian cities, in particular, Poltava, is full or partial reconstruction. The results of the analysis of the study on approaches to reconstruction of the building are summarized in Table 1, where:

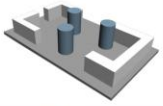
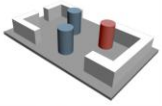
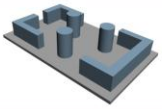
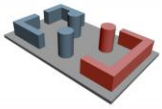
m - the current situation;

n - new building. The new building can be completely new, fully or partially reconstructed or partially newly reconstructed (table 2).

Table 1. Options for reconstruction of buildings with increase of its energy efficiency.

No. of methodology	Existing building	New building	The purpose of the application of this variant of the methodology
1	m	0	Assessment of the situation
2	m-1	1	Increasing the energy efficiency of the whole building based on the optimization of one building
3	m-n	n	Increasing the energy efficiency of the whole building based on the optimization of several buildings
4	0	n	Increasing the energy efficiency of the through optimization of the entire building

Table 2. Types of new buildings.

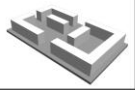
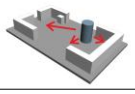
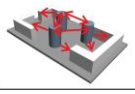
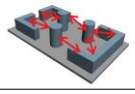
No. of metho-dology	New building	Fully or partially reconstructed building	Partially new partly reconstructed building
1			
2			
3			
4			

Thus, four variants of methods of increasing energy efficiency of residential development can be distinguished:

- estimation of energy efficiency of existing building;
- construction of one new building or its full or partial reconstruction in the conditions of existing building;
- construction of several new buildings, full or partial reconstruction of several houses or part of new, part of the reconstructed houses in the conditions of the existing forgotten;
- construction of new buildings in the whole quarter, full or partial reconstruction of existing buildings or building of part of the territory of the block by new buildings and reconstruction of another part of the quarter buildings.

New or reconstructed energy efficient residential buildings increase the efficiency level of the entire quarter (tab 3).

Table 3. Influence of new residential buildings with high energy efficiency on surrounding buildings.

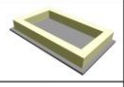
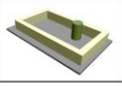
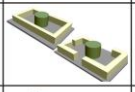
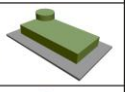
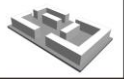
Calculation of energy efficiency of existing buildings	Influence of one energy efficient building to the environment	Influences of several energy efficient buildings to the environment and one to outher	Mutual influence of new energy efficient buildings to each outher
			

In the first version, the method for determining energy efficiency of existing building by the degree of generalization can be carried out in two ways:

- with generalized construction indicators used at the early stage of designing;

- with accurate calculations of energy efficiency indicators for each home (Table 4).

Table 4. Degrees of calculation generalization of existing, new or reconstructed residential development with increase of its energy efficiency.

No. of methodology	1	2	3	4
Methodology for determining the energy efficiency of an existing one buildings with generalized construction indicators				
Methodology for determining the energy efficiency of an existing one building with accurate calculations of indicators energy efficiency for each building				

In the second variant, the method of determining energy efficiency of existing building on the degree of generalization can also be carried out in two ways.

In the third variant, the method for determining the energy efficiency of both existing construction and the new or reconstructed by generalization level can be carried out in two ways:

- with generalized indicators of existing buildings and with the general indicators of new or reconstructed buildings;
- with generalized indicators of existing construction and with accurate calculations of energy efficiency indicators for each new or reconstructed building;
- with accurate calculations of energy efficiency indicators for each existing building and with generalized indicators of new or reconstructed buildings;
- with accurate calculations of energy efficiency indicators for each existing building and with accurate calculations of energy efficiency indicators for each new or reconstructed house.

In the fourth variant, the method of determining energy efficiency of a new or reconstructed building by the degree of incorporation can also be carried out in two ways.

The proposed methodology for determining energy efficiency of houses involves compiling the results of calculations to quantitative indicators as the criterion of optimality of a home-building on the indicator of its energy efficiency is quantitative and can be measured in the units given, in the amount of fuel per square meter or in kW•h/(m^2•year).

This technique allows you to increase energy efficiency of buildings, taking into account a large number of indicators. By performing calculations according to this technique, the architect will have the opportunity to check his creative discovery for the issue of energy efficiency or to use recommendations on methods for increasing energy efficiency under specific conditions and constraints [3].

5. Conclusion and Further Research

Architects of the present day are ready to implement the basic ideas of the concept of sustainable urban development. Renewable energy sources are widely used today, cities are selected so that they can supply these energy sources, which is why the ecological cities are usually small. Also methods that reduce the need for air conditioning are widely used to reduce energy costs. Such methods include tree planting, the use of natural ventilation systems, increasing water run-offs and green areas. An important aspect is the improvement of the public transport system and the increase of pedestrian zones, the installation of cycle tracks. Of course, the best solution is to bring transport outside the city or to use eco-cars (zero-emission vehicles). Relevant is the reduction of urban growth, the search for new ways that will reduce time spent on transport, thus solving the problem of transport accessibility. Maximum landscaping of the territory of the city: gardening on the roofs and vertical gardening of buildings, construction of ecological buildings (for example, active houses).

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