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DOI: 10.32702/2306-6814.2022.11—12.140

## APPLICATION OF TOOLS FOR SUSTAINABLE DEVELOPMENT OF AGGLOMERATIONS IN THE USA AND CANADA

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### ЗАСТОСУВАННЯ ІНСТРУМЕНТІВ ЗАБЕЗПЕЧЕННЯ СТАЛОГО РОЗВИТКУ АГЛОМЕРАЦІЙ У США ТА КАНАДІ

***The article analyzes the use of tools to ensure the sustainable development of agglomerations in countries such as the United States and Canada.***

***It has been found that the reproduction of socio-ecological and economic resources in the countries under study is carried out by using certain tools to ensure the sustainable development of agglomerations, including the use of alternative energy sources, green roofs, buildings with a neutral energy balance or buildings with a net zero balance of consumed energy, the development of programs to reduce the consumption of fossil fuels, as well as financial instruments such as: taxes on environmentally harmful products in consumption; benefits on tax on property belonging to the main funds of environmental purposes; trust environmental funds; accelerated depreciation of environmental funds; sale of pollution licenses through environmental banks; environmental insurance of companies.***

***The use of these tools will help create additional jobs, reproduce water resources, improve the thermal characteristics of houses, and save resources for future generations.***

***It was revealed that the practice of ensuring the sustainable development of agglomerations in the countries under study is focused on the rational use of natural resources with a subsequent reduction in their consumption, reproduction, ensuring socio-ecological and economic security, etc.***

***Attention is focused on the need to build sustainable housing in the agglomerations of Ukraine, which will contribute to the formation of progressive resource-saving, high-tech, environmental and social models of the functioning of economic relations subjects, and will also reduce the level of monetary costs for residents to consume resources. An important role in this process is assigned to establishing cooperation between local self-government bodies, construction organizations, educational and scientific institutions in the development of projects for the construction of buildings with a neutral energy balance in agglomerations, among which the MINERGIE standard occupies an important place, as well as the creation of highly automated agro-industrial complexes in cities in specially designed high-rise buildings ("vertical farms").***

***У статті здійснено аналіз застосування інструментів забезпечення сталого розвитку агломерацій у таких країнах як США та Канада.***

***З'ясовано, що відтворення соціо-еколого-економічних ресурсів у досліджуваних країнах здійснюється шляхом застосування певних інструментів забезпечення сталого розвитку агломерацій, серед яких: використання альтернативних джерел енергії, "зелених дахів", будинків із нейтральним енергобалансом чи будівель із чистим нульовим балансом спожитої енергії, розроблення програм зі скорочення споживання викопних видів палива, а також таких фінансових інструментів, як: податки на екологічно шкідливу у споживанні продукцію; пільги щодо податку на майно, яке належить до основних фондів природоохоронного призначення; трастові природоохоронні фонди; пришвидшена амортизація природоохоронних фондів; продаж ліцензій на забруднення через екологічні банки; екологічне страхування корпорацій.***

**Використання означених інструментів сприятиме також створенню додаткових робочих місць, відтворенню водних ресурсів, покращенню теплових характеристик будинків, заощадженню ресурсів для прийдешніх поколінь.**

**Установлено, що практика забезпечення сталого розвитку агломерацій у досліджуваних країнах зорієнтована на раціональне використання природних ресурсів із подальшим скороченням їхнього споживання, відтворення, гарантування соціо-еколого-економічної безпеки тощо.**

**Акцентовано увагу на необхідності зведення сталого житла в агломераціях України, що сприятиме формуванню прогресивних ресурсозберігаючих, високотехнологічних, екологічних і соціальних моделей функціонування суб'єктів економічних відносин, а також зумовлюватиме зниження рівня грошових витрат жителями на споживання ресурсів. Важлива роль у цьому процесі відведена налагодженню співпраці між органами місцевого самоврядування, будівельними організаціями, освітніми та науковими установами у ході розробки проєктів будівництва будівель із нейтральним енергобалансом в агломераціях, серед яких вагоме місце займає стандарт МІНЕРДЖІ, а також створення у містах високоавтоматизованих агропромислових комплексів, розміщених у спеціально спроектованих висотних будівлях ("вертикальні ферми").**

*Key words: agglomeration, experience of the USA and Canada, tools for ensuring the sustainable development of agglomerations, vertical farm, environmental insurance, socio-ecological and economic security in agglomerations, MINERGIE standard.*

*Ключові слова: агломерація, досвід країн США та Канади, інструменти забезпечення сталого розвитку агломерацій, вертикальна ферма, екологічне страхування, соціо-еколого-економічна безпека в агломераціях, стандарт МІНЕРДЖІ.*

## PROBLEM STATEMENT IN GENERAL FORM AND ITS CONNECTION WITH IMPORTANT SCIENTIFIC OR PRACTICAL TASKS

At the present stage, the problems of ensuring the sustainable development of agglomerations were recognized as relevant in most countries of the world. This is due to the need to find ways to solve the problems of rational use and reproduction of socio-ecological and economic resources and achieve the state of the corresponding level of security of urbanized territories.

Given the experience of such countries as the United States and Canada, it is obvious that the basis for ensuring the sustainable development of agglomerations is the formation of progressive resource-saving, high-tech, environmental and social models of the functioning of economic relations. This allows the economic system to respond accordingly to the requirements of social development, to ensure the achievement of the proper level of indicators of socio-economic efficiency in agglomerations. Understanding the problems of ensuring the sustainable development of agglomerations of the countries of the world will make it possible to distinguish a range of methods and tools used to solve them and will contribute to their use in Ukraine.

## ANALYSIS OF RECENT STUDIES AND PUBLICATIONS IN WHICH THE SOLUTION TO THIS PROBLEM HAS BEGUN

Scientific research of such scientists are important for understanding the specifics of the use of tools for ensuring the sustainable development of agglomerations in foreign countries: M. Averkina, M. Bahinskyi, Z. Herasymchuk, N. Dunnett, N. Hrynychuk, M. Derkach, N. Kingsbury, G. Lappo, O. Lebedynska, A. Lelechenko, H. Maloian, N. Pavlikha and others.

## FORMULATION OF THE PURPOSE AND OBJECTIVES OF THE ARTICLE

The purpose of this article is to summarize the experience of using tools to ensure the sustainable development of agglomerations in the USA and Canada in order to implement it in Ukraine.

## PRESENTATION OF THE BASIC RESEARCH MATERIAL WITH FULL JUSTIFICATION OF THE SCIENTIFIC RESULTS OBTAINED

The reproduction of socio-ecological and economic resources in the USA and Canada is carried out by using such tools to ensure the sustainable development of agglomerations as the use of alternative energy sources, "green roofs", the development of programs to reduce the consumption of fossil fuels. Key areas of sustainable development of urbanized areas include: reducing electricity consumption, creating additional jobs, reproducing water resources, improving the thermal characteristics of buildings, ensuring social and environmental safety of saving resources for future generations.

In the perspective of studying foreign experience on the issue, we propose to explore achievements in this area:

— USA (as country that widely test the latest tools, such as: "green roofs", houses with a neutral energy balance);

— Canada (as one of the first countries to initiate development based on sustainability, also implementing projects such as "green" roofs, the construction of buildings with a net zero balance of energy consumed);

— implementation of MINERGIE projects for optimal use of energy resources.

Thus, in the United States, natural ventilation schemes have been widely used, which are effective in the process

of reducing the volume of artificially conditioned air with large electricity consumption. In addition, buildings with a zero local balance of consumed energy are erected, in which the amount of energy provided to the building with alternative sources is equal to the amount of energy consumed by the building.

The United States introduced buildings with a net zero balance of consumed energy, in which the amount of energy provided by alternative sources of the building itself overlaps both the consumed energy and the energy spent on its transportation to the building.

Similar to US cities in Canadian cities, such buildings are also being built. This country has created the Neutral Energy Balance House Coalition, which promotes not only the construction of such houses, but also the adoption of the "almost neutral energy balance house" (nNZE) standards; a "neutral energy balance house" (NZE) producing the same amount of energy it consumes during the year; a "finished building with neutral energy balance" (NZER), in which renewable energy sources are not yet installed, as a result of which it cannot achieve neutral balance; NZEV — Net-Zero energy home definition and performance metrics project, which confirmed energy generation at the level of annual consumption [15].

In addition, the Canada Mortgage and Housing Corporation is the sponsor of the sustainable housing competition "Equilibrium," to which fifteen demonstration projects of houses with a neutral energy balance and an almost neutral energy balance have been submitted annually since 2008. The first building constructed as part of the competition was the house with an almost neutral energy balance "Eco Terra House" in Eastman, Quebec [10].

The construction of sustainable housing in the agglomerations of Ukraine is promising in this area, given that this will help reduce the volume of electricity and thermal energy consumption, and therefore leads to a decrease in the level of monetary costs for residents to consume resources. Since there are no practices for the construction of such buildings in Ukraine, this process requires cooperation between local self-government bodies, construction organizations, educational and scientific institutions in the development of projects for the construction of buildings with a neutral energy balance in agglomerations.

Ensuring sustainable development of agglomerations in the context of rational consumption of environmental resources can be implemented through the construction of buildings according to the MINERGIE standard (minimum energy consumption). This standard justifies the advantages of building well-insulated and hermetic buildings to achieve high energy consumption standards.

In line with the rational use of environmental resources in the agglomerations of Ukraine, it is proposed to develop clear criteria and standards for determining the environmental feasibility of constructing buildings to reduce the level of consumption of energy resources, which will also contribute to the rational use of economic resources by reducing the expenditure part of local energy budgets. To this end, it is also proposed to attract a personnel resource capable of developing appropriate

criteria and standards for local self-government bodies, which will positively affect the rational use of social resources in the agglomeration.

Thus, in Vancouver (Canada), local governments open up wide opportunities for citizens to participate in decision-making on urban design, social programs, etc. In particular, the practice of providing citizens with funds for the development and implementation of local projects to solve problems in their areas of residence has been worked out, which means that employment has increased [2].

Another example that is relevant for most countries of the world community in the context of ensuring the sustainable development of agglomerations is the reproduction of resources in sufficient quantities. This can be achieved by distributing effective resource reproduction tools, in particular the use of "green" roofs. One of the largest "green" roofs in the United States is located in the River Rouge factory of Ford Motors, Dearborn, Michigan, where 42,000 m<sup>2</sup> of the roofs of the plant are covered with vegetation. Planted under the underground parking of Millennium Park in Chicago, the park occupies 99,000 m<sup>2</sup> [9].

The biggest "green" roof in New York City is built in midtown Manhattan, atop the Morgan Mail Processing and Distribution Center of the United States Postal Service. Covered by local vegetation, the roof has an estimated life of 50 years and allows the postal service not only to save approximately \$30,000 per year for heating and cooling, but also to significantly reduce the amount of wastewater and dirt entering the city's water supply system.

We believe that the use of "green" roofs in the agglomerations of Ukraine is a rather urgent task, since green roofs help reduce heat loss and the cost of heating buildings in the cold, which brings such buildings closer to the standards of a passive house.

Also, the arrangement of such roofs is aimed at: reducing the cost of cooling buildings by 15—19% due to natural evaporation of moisture; reducing the amount of water entering open areas in the form of precipitation as a result of snow melting; a decrease in the average temperature in the city during the summer; creating a habitat for urban fauna that enriches its biodiversity; significant reduction of air pollution and its enrichment with oxygen, which accordingly increases the comfort of life in cities and reduces the number of diseases, especially asthmatic [5]; rainwater treatment, including heavy metals; noise absorption.

Taking into account the above, we note the expediency in ensuring the reproduction of resources in the agglomerations of Ukraine to use roofs of the "green" type, which can be equipped on already erected buildings, and laid as part of the architectural solution of designed buildings. The use of such roofs is a decision that is quite relevant for industrial enterprises of the city, since it is about the possibility of absorbing negative emissions of harmful substances that accompany the functioning of industrial facilities. These roofs are also effective in reducing the consumption of energy resources, namely gas and electricity, which will positively affect the level of sustainable development of agglomerations.

To reproduce socio-ecological and economic resources in US cities, public authorities actively practice operating with such financial instruments as: taxes on environmentally harmful products in consumption; benefits on tax on property belonging to the main funds of environmental purposes; trust environmental funds, the budget of which is formed from taxes on the manufacture of environmentally hazardous products and used to preserve and reproduce socio-ecological and economic resources; accelerated depreciation of environmental funds (two years); sale of pollution licenses through environmental banks; environmental insurance of companies.

Therefore, the obvious possibility of solving the problem of ensuring the reproduction of socio-ecological and economic resources in the agglomerations of Ukraine by referring to these financial instruments is determined. To do this, local self-government bodies should be given the task to develop special programs for the use of financial instruments that will contribute to the accumulation of funds in terms of the reproduction of socio-ecological and economic resources.

Since the preservation of socio-ecological and economic security is the fundamental postulate of the theory of sustainable development of agglomerations, it seems logical to conduct a detailed analysis of the tools for achieving it. Thus, the creation of highly automated agro-industrial complexes in cities located in specially designed high-rise buildings ('vertical farms') is determined by one of the priority tools for achieving socio-ecological and economic security.

Professor Dickson Despommier, in his work "The Vertical Farm: Feeding the World in the 21st Century", calculated that "a 30-story building with a single floor base of 5 acres (approximately 0.05 km<sup>2</sup>) is planted with dwarf wheat, will correspond to a traditional farm with an area of 2,400 acres (almost 9.7 km<sup>2</sup>) in its productivity. In the aspect of the social effect, the "vertical farm" allows to provide city residents with high-quality, fresh, environmentally friendly food at any time of the year. In an aspect of the ecological effect, such a farm reduces the use of drinking water for irrigation and watering within 70% by applying mainly process water, which is treated directly on the farm, and helps to solve the problem of rational use of rainwater. If ordinary fields miss a significant part of rainwater, allowing it to seep down, flow into lowlands, then in "vertical farms" a special reservoir may be provided for collecting water, which will be used rationally: it will not go to lowlands and soil depths, but flow to the lower tiers" [6].

The practice of "vertical farms" contributes to the conservation of land resources; due to isolation from the natural environment, the possibility of avoiding such negative consequences for the soil as deforestation and desertification caused by traditional agriculture; reducing the use of pesticides and herbicides; expansion without the destruction of forests occupying traditional agriculture. In addition, the advantages of a "vertical farm" include reducing greenhouse gas emissions into the atmosphere due to the use of biomass waste for biogas production; reduced consumption of diesel fuel for mechanized treatment of cultivated land.

The economic effect of "vertical farms" involves limiting the cost of delivery of agricultural products from the place of cultivation to the places of storage and sale; higher productivity compared to traditional agriculture (the possibility of increasing yields from 4 to 6 times), achieving independence from seasonal weather fluctuations, which allows growing crops throughout the year; attracting alternative energy sources (windmills, solar panels and wastewater biogas), etc.

Considering the sufficient number of available agricultural land, a small number of megacities with a population of more than 1 million people, we recognize the rather distant prospect of ensuring the sustainable development of the agglomerations of Ukraine with the introduction of "vertical farms."

At the same time, in the context of the achievement of socio-ecological and economic security in the cities of the USA and Canada, environmental insurance for damage caused by existing or future environmental pollution is widespread, which is an addition to the comprehensive general liability insurance policy [3]. This tool covers the costs of treatment activities within a certain level, compensation for civil liability and, as an exception, compensation for environmental risks and negative consequences.

The logic of considerations regarding the introduction of the environmental insurance process to achieve socio-ecological and economic security in the agglomerations of Ukraine is seen in the fact that most enterprises with the dominance of an extensive type of business are potentially dangerous, and their activities negatively affect the state of socio-ecological and economic security; environmental insurance will contribute to financing the necessary environmental measures in agglomerations.

## CONCLUSIONS FROM THE STUDY AND PROSPECTS FOR FURTHER RESEARCH IN THIS DIRECTION

Thus, the practice of ensuring sustainable development in agglomerations of countries such as the United States and Canada convinces that the common pillar of the measures under study is their focus on the rational use of natural resources, followed by a reduction in their consumption, reproduction, guarantee socio-ecological and economic security as a mechanism for avoiding and neutralizing threats to humans and the environment.

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*Стаття надійшла до редакції 14.06.2022 р.*