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# “Green” technologies in housing: the experience of Russia

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**Abstract.** In modern economic conditions, the environmental factors, including the housing construction, are becoming increasingly important. There is no universal model of economic development in the world that does not disturb the balance of economic, social and environmental interests. Nevertheless, scientists from many countries are working in this direction, realizing the scale of the serious negative consequences of the existing economic development model functioning. The development of housing on the basis of innovative technologies of «green» construction will allow talking about a new model of sustainable socio-economic development, taking into account the economic, environmental and social factors. The article focuses on innovation in the green building technologies' use. A comparative analysis of the foreign and Russian national rating systems for the buildings' assessing is presented, the advantages of «green» construction, determined by environmental friendliness and energy efficiency, are highlighted, the pros and cons of “green” construction are considered. The examples of innovative “green” technologies in housing construction in Russia are given. Special attention is paid to the development and analysis of the institutional norms governing green construction in Russia at the present stage. The author presents the position of calculating the integral effect (IE) due to the use of innovative technologies and building materials at the stage of evaluation and implementation of an innovative construction project in green housing. In conclusion, the possible ways of activating the processes of “green” housing construction using innovative technologies are given.

## 1. Introduction

The strategic priorities of modern social development are aimed at increasing the role of social and environmental aspects, which is reflected in the theory of sustainable socio-economic development and the concept of a green economy as its organic component. The relevance of the article is determined by the fact that the concept of a green economy concretizes the concept of sustainable socio-economic development, allowing it to be translated into a more applied plane and presented in the form of practical recommendations of economic policy that are aimed at implementing green construction using new environmentally friendly and energy-efficient materials and innovative technologies.

The authors of the article focus on the “green” construction use in housing construction. This position is determined by a number of reasons. So, in Russia a significant part of residential development in cities is represented by residential buildings built during the so-called period of “industrial housing construction of the first mass series”, i.e. in the period from 1950 to 1969, when about 307 thousand residential buildings were built in the country, with an area of 518 million m<sup>2</sup> of



living space. At the moment, the problem of their replacement is being actively discussed both at the federal, and at the regional and local levels. A number of bills aimed at legislative support of this process taking into account the interests of authorities, the public and business are being discussed.

But on the solving way an even bigger problem arises. After 2020, the 50-year period of operation of residential panel and block houses built in the 70s starts, and during this decade (1970-1979) more housing constructions were built in Russia than in the previous 20 years - more than 520 million m<sup>2</sup>. This means that a system of measures aimed at their modernization and updating, which would include examination mechanisms, technological, urban planning, economic, technological and social solutions in the field of housing construction is needed. But today, the issues of creating such a comprehensive system are only occasionally considered among the scientific and professional community.

## 2. Literature review

The last decades of the 20th century have led to the formation of an economy aimed at respecting nature. The green economy trend is a global trend. The concept of a green economy was first introduced into scientific circulation in 1989 in a report prepared by a group of leading economists for the government of the United Kingdom of Great Britain and Northern Ireland [1]. The development of this term is associated with the United Nations Environment Program and published in the Report in 2009, the content of which is associated with the promotion of the concept of a green economy. The report (2009) describes the characteristics of the green economy, including the characteristics of energy-efficient buildings. It is noted that this sector is associated not only with the modernization and use of thermal insulation and other modern technologies, but also with adaptive and flexible design, which makes it easier to integrate the new technologies when they begin to justify the costs (for example, preliminary wiring for a roof photovoltaic system) [2]. The United Nations Environmental Protection Organization (UNEP) interprets the green economy as an economic activity, “which enhances the human well-being and ensures social justice while significantly reducing environmental risks and impoverishment of nature” [2].

In 2011, UNEP published a report for government officials “Towards a Green Economy: The Path to Sustainable Development and Poverty Eradication”, which describes the concept of a “green” economy as an economy that enhances people’s well-being and ensures social justice, and with this reduces environmental risks. And in this interpretation, the emphasis is on environmentally friendly technologies [3].

In the world, the investments in the green economy are growing, and the shares of companies that take into account the environmental risks show more sustainable growth and stability. According to FTSE Russell, the UK’s annual analysis report for 2018, the green economy has grown to \$ 4 trillion, or 6% of the global economy, and has become equal to the mining sector. By 2030, FTSE Russell predicts that, while maintaining the current course towards sustainable development, the green economy should grow to 10% of the gross world product [2].

The problems and development of the green economy are devoted to a large number of scientific papers, both by scientists and practitioners in this field. Such authors as Rodionova, Lipina (2015) consider the green economy as the only right direction to achieve the sustainable development goals [4].

Vertakova and Plotnikov (2019) note that sustainable development is a priority in the modern world and one of its effective tools is the development of a green economy. The scientists suggest priorities and directions for the green economy development to regulate the regional development in order to achieve the main goal - sustainable development in Russia [5].

Khan, Kupeshev and Ann (2019) draw attention to the fact that “the green economy model only complements, but does not cancel, the sustainable development model. The latter retains its significance, but acquires a longer-term goal-setting” [6].

Abdelfattah (2019) demonstrates a new approach to the concept of sustainable development and a green economy, believing that the concept “gives us a new way of thinking and managing the human impact on the world that can lead to long-term positive results for the greater benefit of human

societies”, noting that, namely, sustainable development led to the “green” construction development [7].

Fedrigo-Fazio and Ten Brink (2012) believe that green economy is developing as a positive model of future economic growth that can be achieved through the use of the Earth’s natural resources with minimal environmental damage and without the effects on the climate changes [8].

All the scientists, researchers and practitioners agree that the concept of a “green” economy is aimed at developing a harmonious relationship between the economy, the social sphere and the environment, which is a very important aspect of the further development of the economy and society.

### **3. Analysis of innovative technologies in green construction**

“Green” building is impossible without the use of innovative technologies and materials. Yudenko, Nikolikhina and etc. (2019) believe that the basis for the ongoing economic growth of organizations engaged in the construction of buildings and structures is to increase their competitiveness in increasing the share of the occupied construction market through the introduction of new structural solutions, the use of innovative building materials, design technologies and construction of construction projects [9].

Vasileva and Bachurinskaya emphasize that housing construction has great potential for the introduction of innovative technologies, a special place among which is digitalization, which allows creating digital models of residential buildings that meet all modern requirements of green building at the design stage [10].

The green economy is developing on the basis of “green” technologies. In accordance with the classification of the Organization for Economic Co-operation and Development (OECD), the “green” technologies mean [11]:

- general environmental management (waste management, combating water, air pollution; land restoration, etc.);
- production of energy from renewable sources (solar energy, wind energy, biofuels, etc.);
- climate change mitigation;
- reduction of harmful emissions into the atmosphere;
- fuel efficiency;
- improving energy efficiency in buildings and lighting fixtures.

In the applied sense, a green building involves the use of innovative technologies and measures that will ensure the receipt of a certificate according to some international or national standard, or gain recognition through the publication of “transparent” calculations of its efficiency. The standards are designed to create a sustainable and comfortable human environment. At the same time, the following advantages of “green” construction, determined by environmental friendliness and energy efficiency are distinguished;

- reduction in operating costs and improving the quality of real estate;
- minimizing the impact on the environment and human health;
- use of innovative technologies;
- use of technologies and methods leading to sustainable development of territories.

The emphasis on energy saving is given in a significant number of articles by the foreign authors, so Zhineng Tong (2020) in his work argues that in order to “implement sustainable development, it is necessary to use energy conservation and environmental protection technologies to the maximum extent possible in the design, construction and use of the building, reduce energy consumption and implement the construction of green buildings” [12].

Shikha Jha et. al. (2018) in the study [13] shared the experience of Asian countries, which in the early stages of development took steps to achieve a balanced growth model that includes “green” technologies, and now have better quality of growth than countries focused primarily on the economy. Achieving this balance is especially important for low- and middle-income countries, since the transition to an inclusive path of green growth at later stages of development often entails high costs.

The “best growth” of the economy is the growth, which increases incomes, reduces poverty, improves health, cities become more livable, it contributes to sustainability, faster innovation and a better climate by reducing carbon dioxide emissions.

Scientists Acemoglu, Aghion P. et. al. (2012) substantiate the effect of green technologies, believing that green technologies include products that help create alternative energy, such as solar panels and thermal heating disks. Solar panels, which can be installed in homes, apartments and commercial buildings, use sustainable solar heat to charge solar panels, which can be used for electricity instead of traditional, sustainable sources such as gas. The thermal heating discs used in swimming pools absorb the sun's rays and radiate them across the surface of the pool, providing an alternative means of heating that avoids the use of fossil fuels [14].

Simon Kollerup, Minister for Industry, Business and Financial Affairs of Denmark (2019), notes the urgent need as well as the great business potential of cities to become greener and more livable. Moving to smarter cities can help both to cope with climate change and at the same time make urban areas a better place to live. [15, p.4].

Ivanova, Levchenko (2017) give economic bonuses from the implementation of “green” construction, which are as follows: obtaining tax benefits for real estate properties that have “green” certificates; increasing the competitiveness of the facility in the market; reduction of greenhouse gas emissions, i.e. reduction of the negative impact of the facility on the environment; creation of new green jobs; improving public health and, as a result, reducing losses from health insurance payments [16].

There are also negative aspects of “green construction” in Russia, which boil down to the following: a rise in the cost of construction and design of facilities (on average, a rise in price is from 8-15%), a long payback period for projects, difficulties in valuing the benefits of “green” construction, is quite low ecological culture and consumer attitude to nature, lack of public awareness of projects using green technologies.

Nevertheless, the institutional standards that regulate the green building are being developed in Russia, and the country is not aloof from the global certification process for green building. The objects are being built in the country that receive LEED, BREEAM certificates, as well as national certification systems. So, in Russia, the certification is carried out in accordance with the STO NOSTROY standard “Green Construction. Residential and public buildings. Consideration of regional features in the rating system for assessing the sustainability of the environment”. The standard provides for the procedure for taking into account the features of the regions of the Russian Federation that differ in climate, resource capabilities (water and energy), alternative energy potential and economic potential. Table 1 shows a comparative analysis of building rating systems.

**Table 1.** Comparative analysis of global and national rating systems зданий.

Sections	LEED	BREEAM	DGNB	Green standards (Russia)
Energy saving	+++	+++	+++	+++
Environmental protection	+++	+++	+++	+++
Landscaping and greening of the surrounding area	+++	+++	+++	+++
Economic criteria for ecology and energy efficiency	+	+	+++	++
Reliability and safety (heat resistance, fire safety,	+	+	+++	+

strength and stability)

Recycling	+++	+++	+++	+++
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#### 4. The main results

In the article, the authors emphasized the housing construction. The question arises - why, for example, is the construction of energy-efficient buildings in Germany compared to Russia economically viable?

*First*, the green technologies are, first of all, resource-saving and non-waste technologies. At the moment, the country's lack of resources is not relevant and spending money on modern environmental equipment is not a priority.

*Second*, energy saving and improving energy efficiency are not directly related to the economic growth of the country.

*Third*, the mentality of Russian citizens is not rooted in the understanding that it is necessary to protect the environment, and then a small number of volunteers who are trying to "help" nature, are not able to solve the problem.

*Fourth*, green technologies in housing are limited with high costs.

In Russia, the examples of green technologies relate more to offices, business centers, and less commonly to industrial buildings. And usually these are headquarters, offices, industrial production of foreign companies certified according to BREEAM, LEED systems. If the attention to housing is paid, then the examples of "green" objects are certainly present, but for the most part they do not have international certificates. As an example, an "active home" in the Moscow region. There is no certificate of international "green standard". Among the "green" technologies used at the facility the following can be noted:

- orientation of the building to the cardinal points. The asymmetric slope facing the south plays an important role in the energy balance of the house and allows you to accumulate the energy of the sun thanks to reasonably located dormer-windows and solar collectors VELUX;
- automatic solar curtains. All the windows are equipped with sun-protection elements (awnings), which automatically open, increasing lighting and heating due to solar energy, or close, preventing overheating on hot days;
- automated control system for engineering systems. The weather station monitors the direction and speed of the wind, in addition, each room is equipped with sensors that detect temperature, humidity and CO<sub>2</sub>;
- alternative energy. Hot water is partially provided by solar collectors, and a heat pump is built into the heating system.

The authors propose the priorities of "green" construction, aimed at improving the quality of life of the population, namely innovative technologies and materials. The issues of effective activity of enterprises in the field of housing should not be forgotten. The use of innovative building materials in housing is associated with the manifestation of different types of effects. This actualizes the solution of the problem of identifying and classifying the potential effects and substantiating methods for their calculation, reflecting the results of the use of innovative building materials in construction. Yudenko, Chepachenko, Nikolikhina, Polovnikova [9] offer an integral effect (IE) due to the use of innovative technologies and building materials at the stage of assessment and implementation of an innovative construction project, calculated according to the expression:

$$IE = \sum_{n=1}^N \sum_{t=1}^T (IIt - ICt) * DCt \quad (1)$$

where  $IIt$  – is the generated integrated income of the construction project using innovative technologies and building materials in the t-th billing period;

$ICt$  – denotes the generated integral investments (costs) for the implementation of the construction project in the t-th billing period;

$DCt$  – means the discount coefficient;

$N$  – is the total number of potential local effects taken into account;

$t$  – denotes the starting year of the billing period;

$T$  – defines the final year of the billing period.

The recommended methodological approach improves the quality of the innovative technologies and building materials application the level impact analysis and assessment in the construction of the residential buildings and structures on the economic performance of the construction organizations.

## 5. Summary

Green building is a global trend, a priority for development on a global scale, but is widely used mainly in developed countries. This is due to the high cost of building residential buildings according to the standards of “green” construction, limited natural resources, a high level of environmental self-awareness of the society, which is typical for countries with developed economies and high living standards. At the same time, “green” construction is an imperative of modern development for any country and any society, it is an essential component of sustainable development, maintaining favorable living conditions for future generations of people.

The study showed that “green” construction has not yet become widespread in Russia, since there are still no powerful incentives for this: there is no shortage of natural resources with a shortage of available investment resources, green, but expensive housing is not in demand by the market. At the same time, according to the authors, there are ways to intensify the processes of “green” construction in Russia. In this direction, the authors propose the following measures:

- widespread introduction of innovative technologies and materials at all stages of housing construction: from the design of residential buildings to their settlement, and then the operation on the principles of energy and resource conservation;
- analysis and assessment of the impact of the level of application of innovative technologies and building materials in the construction of residential buildings on the economic performance of construction organizations;
- stimulation of construction organizations to comply with the standards of “green” construction in the form of tax incentives, subsidies, state programs to support green construction;
- education of the population in the “green” construction’s benefits field, the introduction of disciplines reflecting the standards of “green” construction in educational programs for the training of personnel for housing construction.

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