The sustainability of ecologically-friendly construction projects in the Arctic territory of the Russian Federation

M Tsurkan¹, N Serditova and A Vorotnikov²,³

¹ Tver State University, 170100, Tver, Zhelyabova street, 33, Russian Federation
² Russian Presidential Academy of National Economy and Public Administration under the President of the Russian Federation, 119571, Moscow, Vernadsky Prospekt, 82, Building 1, Russian Federation
³ Expert of PORA center, 123100, Moscow, 2nd Zvenigorodskaya st. 12 Building 1, Russian Federation

E-mail: 080783@list.ru

Abstract. The article is aimed at developing the approach to evaluation of construction projects with respect to ecological, economic, and social constituent of “sustainability”. The methods of implementation of the ecologically-friendly construction projects in Russia’s Arctic zone based on the geographic and climatic peculiarities are proposed. The definitions of “sustainability of ecologically-friendly construction projects’ results” and “sustainability of ecologically-friendly construction projects” are provided, and the difference between the terms is explained.

1. Introduction
The strategic goal of the ecologically-friendly construction in Russia’s Arctic zone is a transition to the closed-cycle projects with minimal level of environmental impact, low emissions and dumping, as well as with complete recycling of waste products. For a long time such approach has been considered financially unfeasible, which led to 4 million tons of industrial and construction waste in the coastal area of the Arctic Ocean in 2013 [1, 2].

However, the situation has changed recently. The government campaign to reduce pollution is being carried out, and the key focus of Russia’s Arctic zone development is ensuring its ecological safety, which is impossible without the introduction of “green” management technologies in construction.

The term “ecologically-friendly construction projects” is interpreted variously in scientific literature.

Sometimes the term is correlated with the ecological management of the investment and construction projects. It should not harm humans or the environment, instead, it has to “integrate” into the existing infrastructure of the territory and contribute to its harmonization. The work should be done in the safest way possible for those carrying it out [3].

According to [4], the residential construction presupposes the creation of energy-efficient and comfortable housing built out of ecologically-friendly materials with independent life support systems (energy, heating, water). The greatest possible use of natural resources (rain, wind, solar radiation),
as well as energy and resource saving and utilization of human waste products are to be taken into account.

According to [5], “green” standards should be at the heart of any ecologically-friendly construction project. They are the tools to implement the principles of sustainable development in the construction industry. Moreover, they allow evaluating the level of ecological efficiency and technical equipment of project management processes. The use of “green” project management standards also contributes to the real estate management. It ensures economic efficiency, ecological safety of the projects; decreases the negative impact of the construction industry on the environment; and, as a result, improves the population’s quality of life.

Another aspect of the projects under study is pointed out in [6], arguing that ecologically-friendly construction is aimed at resolving the issues of the quality component of construction projects through the use of modern environmental technologies in urban planning, designing, building, operation, and utilization of the buildings.

Thus, an ecologically-friendly construction project is a complex of interrelated measures in the field of construction and (or) reconstruction of an infrastructure facility under time and resource constraints, while maintaining the “green” standards and the principles of sustainable development, which include ensuring ecological safety of the territory where the project is being carried out.

Five major ecological problems dominate in the Arctic zone of the Russian Federation:

- environmental pollution;
- the loss of biodiversity and decline in bio resources;
- land degradation and violation of land use conditions;
- deterioration of the indigenous people’s (those living in Russia’s Arctic zone) natural habitat and the conditions of their traditional nature management;
- negative impacts of the global climate change.

The principle novelty of the “green” project management is due to the fact that its use is aimed at solving most of these problems. The preservation or the restoration of the environment becomes an indispensable condition for the success of any construction project [7] that is implemented in Russia’s Arctic zone.

The Arctic zone of the Russian Federation includes the Murmansk region, the Nenets, Chukot and Yamalo-Nenets autonomous districts, the municipal formation of the urban district “Vorkuta” (Komi Republic), a number of municipal formations of the Arkhangelsk region (including the municipal formation “Arkhangelsk city”), several districts of the Krasnoyarsk Territory (Taimyr Dolgan-Nenets municipal district, Turukhansky district, Norilsk City district), northern uluses of the Sakha Republic (Yakutia), as well as some lands and islands of the Arctic Ocean. The Svalbard archipelago is formally under the sovereignty of Norway, but the special status of the archipelago, according to which it is recognized as a demilitarized zone, is in effect, and Russia has the right to carry out economic activities on it [8]. Since 2017, the territory of Belomorsky, Loukhsky and Kem districts of Karelia are also included in the list. The authorities of Karelia are intending to achieve the inclusion of Segezha and Kalevalsky regions, as well as the city of Kostomuksha in the Arctic zone of the Russian Federation.

The principal construction under the “Socio-economic development of the Arctic zone of the Russian Federation” state program (up until 2030) is planned in eight “pivot points” : Kola support zone; Arkhangelsk support zone; Nenets support zone; The Vorkuta support zone including the municipal formation of the urban district “Vorkuta” of the Komi Republic; Yamalo-Nenets support zone; Taimyro-Turukhansky support zone in the Krasnoyarsk Territory; North-Yakutsk support zone in the Republic of Sakha (Yakutia); Chukotka support zone.

The creation of another support zone is planned in Karelia’s Arctic zone. It includes building a new port as well as transport and industrial infrastructure facilities. All the units are to be constructed or reconstructed with regard to the concept of sustainable development, which requires clarification and systematization.
2. **Classification of ecologically-friendly construction projects, which can be implemented in the Arctic zone of the Russian Federation**

Various bases can be used for classifying the projects under study. From the general ones, which can be applied to any type of project (i.e., implementation period), to the special ones, which allow to systematize the idea of the ecologically-friendly construction projects.

The authors are proposing the following grounds for the classification: financing model; management methodology; energy factor.

Ecologically-friendly construction projects can be implemented within the following financing models: participatory budgeting; public-private partnership; municipal-private partnership; concessionary agreements; special investment contracts; budget financing; commercial financing.

Based on the “management methodology”, the projects can be divided into: the ones that are implemented on the basis of the standards in the field of project management; the ones that are implemented on the basis of the standards in the field of project management and environmental management; the ones that are implemented on the basis of the standards in the field of project management, environmental management, and sustainable project management.

On the basis of the “Energy factor”, the projects can be systematized the following way: introduction and (or) use of traditional energy efficient and energy-saving technologies; introduction and (or) use of renewable energy sources; heat or energy production.

It is advisable to gradually increase the use of energy-saving technologies in solving the issue of ensuring the safety of communal infrastructure for Murmansk, Norilsk, Vorkuta, Severodvinsk, Novodvinsk, Onega, Monchegorsk, the cities of Yakutia and the Krasnoyarsk Territory, closed administrative-territorial formations.

The first experience of introducing energy smart technologies was gained in Murmansk, Yakutia, and the Krasnoyarsk Territory. The technologies that can be adapted for the Arctic territories have been tested in various aspects (bioenergy, wind and solar energy) [9].

3. **Sustainability of ecologically-friendly construction projects: the concept, approaches to assessment**

The research community has formed a number of sustainability concepts. The following ones can be highlighted: the concept of ecological results priority; the concept of sustainable development digital models; the concept of focusing on the financial components of sustainable development; the concept of technological sustainability; the concept of a combination of environmental, economic and social components of development.

The UN proposed a conception in which the sustainable development goals are reflected most accurately in the context of the three components. With regard to geographical and climatic circumstances, as well as Russia’s economic interests in the Arctic zone, 6 out of 17 UN’s goals can be highlighted. They have pronounced ecological focus. Those 6 goals include Clean water and sanitation, Affordable and clean energy, Sustainable cities and communities, Responsible consumption and production, Climate action, Life below water, Life on land.

Naturally, these are not the only environmental goals. All the UN’s sustainable development goals are, to a certain degree, environmental [10]. This is why the realization of the ecologically-friendly construction projects in Russia’s Arctic zone, at the very least, has to be aimed at avoiding negative effects within each of the 11 goals that were not mentioned.

At the same time, in the context of project management, the term “sustainability” is often used to evaluate the potential results of the project. It has the meaning of “prolonged positive results”, which depend not only on the climatic peculiarities, but also on the availability of funding for maintaining the facility in proper technical condition.

Within the framework of this approach, it is expedient to use the “sustainability of project results” category.
In particular, a certain combination of techniques and methods can be proposed in order to predict the ecologically-friendly construction projects (the ones that are implemented under the Local Initiatives Support Program in the Murmansk region) sustainability:

- the selection of an object for financing an ecologically-friendly construction project in the direction corresponding to art. 14 (local issues) of the Federal Law No. 131;
- the inclusion of the documents confirming the possibility of ensuring the prolongation of the projects’ positive results without using the regional budget; the documents are provided by the municipal administration to the Ministry of Internal Policy and Mass Communications of the Murmansk Region, responsible for implementing the projects of the Local Initiatives Support Program in the territory of the Russian Federation;
- expert assessment of the project by the commission established by the Ministry of Internal Policy and Mass Communications of the Murmansk Region. The assessment has to be based upon criteria and sub criteria reflecting the presence of the funding sources, efficient operation and maintenance mechanisms.

For estimating the sustainability of the ecologically-friendly construction project results an index \( R_{pr} \) can be used

\[
R_{pr} = \sum_{i=1}^{n} b y_i \times p y_i, \tag{1}
\]

where \( b y_i \) – the assessment score of the \( i \) criterion, which reflects the funding availability and the efficient operation and maintenance of the infrastructure;

\( p y_i \) – weight of the \( i \)-th criterion;

\( n \) – total number of criteria.

The project can be considered sustainable if the index is maximal (max), relatively sustainable if the index is positive \( R_{pr} > 0 \), and unsustainable when the index \( R_{pr} = 0 \).

The thermal insulation characteristics should be indicated at the project’s planning stage. They depend on a number of components, the examples of which are drawn in Table 1.

**Table 1.** The comparative analysis of heat insulators that can be used in Russia’s Arctic zone

| Material         | Density, kg/m\(^3\) | Durability at least, years | Thermal conductivity, W/m °C | Vapor permeability coefficient, mg/(m h Pa) |
|------------------|----------------------|-----------------------------|------------------------------|---------------------------------------------|
| Mineral wool     | 50                   | 50                          | 0,04                         | 0,3                                         |
| Extruded foam polystyrene | 30               | 50                          | 0,032                        | 0,03                                        |
| Foamed-glass     | 100                  | 100                         | 0,04                         | ---                                         |
| Foamed-concrete  | 200                  | ---                         | 0,05                         | ---                                         |

*Source: compiled by authors using [10]*

Extruded foam polystyrene has the best insulating properties among the materials provided in the table. Moreover, it does not deform under the mechanical load pressure, which is not the case for mineral wool. The production technology is not as energy consuming as that of foamed-glass. The weight of extruded foam polystyrene products is more that 10 times less than that of cellular concrete. However, the flammability class of the material is pretty high (it burns, melts), which is why it is essential to choose the products with increased fire resistance (i.e., with fire retarders) and self-extinguishing materials, the ones that do not sustain combustion. Thereafter, it is not recommended to combine products made of extruded foam polystyrene and wooden or other flammable materials [11].

For implementing the ecologically-friendly construction projects, it is also important that the managers and experts involved have training in environmental protection and environmental safety.
in order to ensure sustainability. In addition, respective experts should carry out their work within the projects with respect to professional standards related to the waste management. There are around 10 standards accepted at the moment.

It is equally important to use the best technologies available while building in Russia’s Arctic zone. Such technologies allow to minimize the ecological impact while ensuring economic (investment) availability [11].

Coming back to ecologically-friendly construction project sustainability, a methodology based on the UN concept and distinguishing projects according to the following characteristics can be proposed. Ecologically-friendly construction project can be considered sustainable if its parameters meet the criteria grouped into three units: socio-economic; eco-economic; socio-ecological.

Such division has been used to calculate the sustainable development ranking of the Russian Arctic regions, according to which the following hierarchy was developed in 2018 (Figure 1).

![Figure 1. Sustainable development ranking of the Russian Arctic regions in 2018](image_url)

*Source: compiled by authors using [12]*

There are two components in the basis of this ranking: the calculation of the region’s sustainable development quantitative index (objective data); the calculation of the region’s sustainable development expert index.

It is essential to assess the presence or absence of the following components in the proposed methodology for assessing the sustainability of ecologically-friendly construction projects ($R_{ep}$, similar to the index derived from eq. (1)), which are implemented in Russia’s Arctic zone:

1. Socio-economic unit: the aim of the project and the regional strategic planning documents’ compliance ($A_1$); sustainability of the results of the project ($B_1$) defined by the equation (1); observance of the scanty indigenous people’s rights ($C_1$); the number of beneficiaries ($D_1$); public participation ($E_1$); the number of jobs created as a result ($F_1$).

2. Eco-economic unit: environmental protection costs ($A_2$); land restoration costs ($B_2$); the use of the best technology available during construction ($C_2$); excess emissions costs ($D_2$); hazardous waste produced during implementation phase ($E_2$); waste management ($F_2$); introduction and (or) use of energy-efficient and energy saving technologies, including renewable energy ($G_2$).

3. Socio-ecological unit: increase of indigenous people’s (those living in Siberia and the Far East) life expectancy ($A_3$); population’s adaptation to climate change as a result of the project, economic systems’ adaptation ($B_3$).

Values and significance for the proposed criteria are presented in Table 2.

Thus, the sustainability of ecologically-friendly construction project is the compliance with economic, social, and ecological factors during its implementation. Moreover, it is the prolonged positive result after the project’s completion, which depends not only on climatic characteristics, but also on funding to maintain the building in the best technical condition.
Table 2. Elements for assessing the sustainability of ecologically-friendly construction projects in Russia’s Arctic zone

| No. | Criteria | Criterion value | Number of points | Weight |
|-----|----------|-----------------|------------------|--------|
| 1. | Socio-economic unit: | | | |
| 1.1 | A₁ | Consistent | 100 | 0.3 |
| | | Inconsistent | 0 | |
| 1.2 | B₁ | Sustainable | 100 | 0.025 |
| | | Relatively sustainable | 50 | 0.075 |
| | | Not sustainable | 0 | |
| 1.3 | C₁ | Consistent | 100 | 0.025 |
| | | Inconsistent | 0 | |
| 1.4 | D₁ | ≥ 1000 | 100 | 0.075 |
| | | > 500, < 1000 | 70 | |
| | | >100, ≤ 500 | 40 | |
| | | ≤ 100 | 10 | |
| 1.5 | E₁ | Implemented | 100 | 0.05 |
| | | Not implemented | 0 | |
| 1.6 | F₁ | ≥ 1000 | 100 | 0.05 |
| | | > 500, < 1000 | 70 | |
| | | >100, ≤ 500 | 40 | |
| | | ≤ 100 > 0 | 10 | |
| | | 0 | 0 | |
| 2. | Eco-economic unit: | | | 0.35 |
| 2.1 | A₂ | ≥ 30% | 100 | 0.05 |
| | | >10%, < 30% | 70 | |
| | | ≤ 10%, > 1% | 40 | |
| | | ≤1%, > 0 | 10 | |
| | | 0% | 0 | |
| 2.2 | B₂ | ≥ 30% | 100 | 0.05 |
| | | >10%, < 30% | 70 | |
| | | ≤ 10%, > 1% | 40 | |
| | | ≤1%, > 0 | 10 | |
| | | 0 | 0 | |
| 2.3 | C₂ | Used | 100 | 0.05 |
| | | Not used | 0 | |
| 2.4 | D₂ | Not implemented | 100 | 0.05 |
| | | Implemented | 0 | |
| 2.5 | E₂ | Not formed | 100 | 0.05 |
| | | Formed | 0 | |
| 2.6 | F₂ | Implemented | 100 | 0.05 |
| | | Not implemented | 0 | |
| 2.7 | G₂ | Used | 100 | 0.05 |
| | | Not used | 0 | |
| 3. | Socio-ecological unit: | | | 0.35 |
| 3.1 | A₃ | Possible | 100 | 0.2 |
| | | Impossible | 0 | |
| 3.2 | B₃ | Presupposed | 100 | 0.15 |
| | | Not presupposed | 0 | |
| Total | | | 1 | |

Source: compiled by authors using
4. Conclusion
The development of the Arctic zone territories of the Russian Federation requires the use of sustainable tools, which are ecologically-friendly construction projects. They meet the principles of the UN’s concept and ensure a prolonged positive result of the project. Climate change scenarios for the region has to be taken into account with respect to the climatic restrictions.

The methodology proposed in this research can be used to assess the sustainability. This methodology can become the basis for developing a standard for ecologically-friendly construction projects implementation in Russia’s Arctic zone.

Further development of this topic requires a pilot testing of the method, i.e. based on floating nuclear power plant under construction project assessment. The results of the research are of practical significance for public authorities, project management experts, scientists working in the field of sustainable development, as well as environmental experts.

References
[1] Nekrasova M A, Palagin V S, Skorobogatov D A and Tsvetkov A V 2012 GPM in the year of ecology Oil & Gas Field Engineering Special issue 4 36–41
[2] Sokolov Yu I 2013 The Arctic: the problem of accumulated environmental damage Arctic: ecology and economy 2 (10) 18–27
[3] Shevchenko V Ya 2018 Management of investment and construction projects, taking into account the influence of environmental factors
[4] Shevchenko N S, Velichko E G and Chovrebov E S 2017 Formation and implementation of the methodological principles of ecological housing construction (on the example of the eco-efficient business-energy complex) Vestnik MGSU 12 № 4 (103) 415–28
[5] Chelyadinova E Yu and Nekrasova M A 2014 Analysis of the best practices of "green" project management in green building. In the collection: Actual problems of ecology and environmental management Collection of scientific papers 476–79
[6] Ryzhanushkina A Yu and Gabrin K E 2018 Ecological-oriented subcode to the management of innovative development of the regional construction complex Bulletin of the South Ural State University Series: Economics and Management 12 (1) 133–41
[7] Nekrasova M A 2014 Green project management of green building in the Arctic Proc. The Urgent Ecological and Environmental Management Problems 468–71
[8] Orlov D 2018 Development of the Arctic zone of Russia and the main challenges for its development (APEC analytical report)
[9] Tsurkan M V, Liubarskaia M A, Vorotnikov A M and Maiorov S V 2017 Implementation of energy efficient smart technologies at the urban territories of the Arctic zone of Russia IOP Conf. Series: Earth and Environmental Science 72 (2017) 012029 doi:10.1088/1755-1315/72/1/012029
[10] Sarvut T O and Dmitriev N S 2017 Features of the design of objects for various purposes in the conditions of the Arctic region of the Russian Federation International Research Journal Issue 04 (58) 2 100–2
[11] Bobylev S N, Kudryavceva O V and Grechuxina I A 2019 Sustainable development and environmental and economic priorities for Russia. Foresight "Russia": a new industrial society. Future Document Collection I.V. Saint-Petersburg International Economic Congress (SPEC-2018) 3 451–60
[12] Polar Index of Regions Stable Development Rating of Russian Arctic Regions 2018 (Electronic Materials) https://www.econ.msu.ru/sys/raw.php?o=49786&p=attachment

Published under license in Journal IOP Conference Series Earth and Environmental Science