REGULATIONS FOR EFFICIENCY ASSESSMENT OF INVESTMENT PROJECTS IN THE ENERGY SECTOR: BRIEF OVERVIEW AND COMPARATIVE ANALYSIS

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ABSTRACT
The policy of decarbonization and eco-modernization of the energy industry adopted by many countries implies a serious selection of investment projects primarily on the environmental pillar: projects aimed at reducing the negative impact on the environment or projects whose environmental damage from the implementation might be minimal, become priority. Therefore, the environmental impact assessment of investment projects became mandatory in the efficiency assessment process. Nowadays, there is no generally acclaimed methodology in the world for assessing the environmental and economic efficiency of investment projects: each country may have and apply its own requirements and methods or use recommendations developed and prepared by the international organizations. To ensure high efficiency of environmental and economic assessment, numerous normative tools, including recommendations and/or requirements for their implementation, are recommended that may vary significantly in different countries. The present study aims on comparative analysis of normative documents adopted in Russia, the USA and the EU to assess the environmental and economic efficiency of investment projects. In addition, the results of the analysis will help to identify the key differences in regulations and the main problems and difficulties of conducting an environmental and economic assessment of investment projects. Finally, this may enable further assessment of the possibilities of creating a unified global approach.
Keywords: efficiency assessment, investment project, regulations, energy efficiency, economic efficiency, environmental impact assessment, circular economy.

1 INTRODUCTION

The participant countries of the 26th UN Conference on Climate Change once again confirmed the importance of enhancing actions on mitigation of the anthropogenic impact on the environment [1]. At present, most governments are implementing the principles of the circular economy, including the use of renewable resources, recycling of secondary raw materials, development and use of renewable energy sources (RES) [3]–[5]. Therefore, in the context of the transition to a circular economy, any economic activity should demonstrate the prevention of negative environmental impact, rational use of resources and strive to minimize the generation of waste and other types of pollution.

The energy sector, as the world's largest environmental polluter [5], is expected to undergo significant changes in the upcoming years: eco-modernization of traditional energy facilities, dynamic development and introduction of renewable energy facilities, phase-out of coal use as fuel, etc. [6]–[8]. Large-scale transformations in the process of transition to a low-carbon economy are already stimulating the development and implementation of relevant investment projects in the energy sector: according to the International Energy Agency (IEA), the costs of research and development (R&D) in the energy sector worldwide increased from $26.9 billion in 2014 to $30.3 billion in 2019 at comparable prices for 2019 [9].

The inflows of investments and the current environmental agenda require a thorough selection of projects, taking into account both the economic and environmental pillars [10],


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[11]. There is no unified recognized regulatory framework for efficiency assessment of investment projects in the energy sector at present.

Thereby, environmental impact assessment (EIA) procedure is mandatory within investment projects' selection and assessment. EIA allows making a decision on the implementation of a project not only by its economic parameters but also by a number of environmental characteristics [12]–[15].

It is important to note that EIA is just the one of the assessment stages that includes the analysis of the potential project's impact on the environment, the consideration of the long-term consequences and costs of environmental protection measures and the analysis of other environmental costs and energy efficiency of the project [11], [16]. A significant contribution to the development and improvement of approaches to EIA is made by the International Association for Impact Assessment (IAIA) that unites specialists in the field of assessing the social and environmental impact of programs or projects on the environment [17].

The purpose of this study is to review and compare key regulatory documents and standards for the environmental and economic assessment of investment projects in the United States, the European Union (EU) and Russia. It is expected that the results obtained will reveal the main features of regulatory documents, their content, approaches to evaluation and identify disadvantages and advantages.

2 MATERIALS AND METHODS

To analyse regulatory documents in the field of environmental and economic assessment of investment projects, the authors divided the considered documents into three groups:

1. Recommendations and/or guidance for general efficiency assessment of investment projects.
2. Recommendations and/or guidance for conducting Environmental Impact Assessment (EIA) of investment projects.
3. Recommendations and/or guidance for the energy efficiency assessment of investment projects (EEA).

The authors selected most significant documents in each of the above-mentioned groups used in the USA, the EU and Russia. To conduct a comparative analysis of regulatory documents on EIA and EEA, the authors also analysed the methodological recommendations of international organizations that are used in most countries in addition to the national regulatory documents. The list of documents is given in Table 1.

The list of criteria for comparative analysis of selected regulatory documents is presented in Table 2.

3 RESULTS AND DISCUSSION

3.1 Overview and comparative analysis of regulations for general efficiency assessment of investment projects

Among the fundamental international documents reflecting the methodology for efficiency assessment of investment projects are the "Evaluation Manual" developed by the United Nations Industrial Development Organization (UNIDO) and "Guide to Cost–Benefit Analysis of Investment Projects" developed by the European Commission (EC).

Methodological recommendations on investment project efficiency assessment, which are applied in Russia, are based on a document issued by UNIDO. Consequently, they have

Table 1: The list of considered regulatory documents and recommendations.

Name of the document	Organization/Country
Regulations for general efficiency assessment of investment projects	
Evaluation Manual	UNIDO
Guide to Cost–Benefit Analysis of Investment Projects	European Commission
Methodological Recommendations on Investment Project Efficiency Assessment	Russia
Regulations for environmental impact assessment	
Environmental Impact Assessment of Projects	European Union
National Environmental Policy Act (NEPA)	USA
On Approval of Requirements for Environmental Impact Assessment Materials	Russia
The World Bank OP 4.01 “Environmental Assessment”	The World Bank
Family of ISO 14000 “Environmental Management”	ISO
Regulations for energy efficiency assessment	
Guidebook for Energy Efficiency Evaluation, Measurement, and Verification: A Resource for State, Local, and Tribal Air and Energy Officials	USA
Commission Recommendations on Energy Efficiency First: from Principles to Practice. Guidelines and Examples for its Implementation in Decision-Making in the Energy Sector and Beyond	European Union
Methodological Recommendations for Evaluating the Effectiveness of the Implementation of Energy Saving and Energy Efficiency Measures in Industry	Russia
Family of ISO 50000 “Energy Management Systems”	ISO

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Table 2: The list of criteria for comparative analysis of selected regulatory documents.

The group of documents	Criteria for comparative analysis
Regulations for general efficiency assessment of investment projects	1. Approaches to the assessment; 2. Assessment principles; 3. Step-by-step framework of the evaluation procedure; 4. Assessment recommendations by sector; 5. The presence of the EIA part; 6. Proposed methodology/ies for the EIA; 7. Indicators for the EIA; 8. Case-study.
Regulations for environmental impact assessment	1. Applicability to the investment project evaluation; 2. Principles of the EIA/EEA; 3. Step-by-step framework of the EIA/EEA; 4. Indicators for the EIA/EEA; 5. The recommendations for EIA/EEA by sector; 6. Alternatives evaluation; 7. Recommendations for report preparation; 8. Case-study.
Regulations for energy efficiency assessment	

approximately the same structure, principles and approach to evaluation (cost-efficiency approach) [18], [19]. The significant differences between two considered documents are the presence of the case study and the system of indicators necessary for the assessment in the Russian version. Both differences could be described as the advantages of the document.

The recommendations developed by the EC [20] are based on the cost–benefit approach, contain a more detailed description of the assessment procedure for several sectors of the economy including energy, a case study for each sector and a separate methodology for calculating greenhouse gas emissions. In addition, the document contains a whole section of recommendations for EIA. In 2021, the EC prepared updated recommendations for efficiency assessment of investment projects [21] that are complementary to the considered document.

In all documents, much attention is given to the assessment of the economic and/or social effectiveness of the project. The assessment of its environmental performance is a separate assessment stage (EIA) that is managed by other regulations. The considered documents contain references to the need for its implementation, references to methods or generalized recommendations. For instance, the methodology for estimating greenhouse gas emissions is presented in the "Guide to Cost–Benefit Analysis of Investment Projects" in an abbreviated version, some recommendations for EIA are contained in the "Evaluation Manual" [18], [20].

The comparative analysis of the regulatory documents is presented in Table 3.

Thus, despite the similarity of individual elements of the considered regulations, there is a significant discrepancy in methodological approaches to assessing the impact of the project on the environment. To conduct an EIA, it is necessary to use additional tools and recommendations, or resort to the services of third-party

3.2 Overview and comparative analysis of regulations for general efficiency assessment of investment projects

3.2.1 National Environmental Policy Act (USA)

In 1970, the National Environmental Policy Act (NEPA) was signed in the USA that marked the beginning of activities in the field of EIA around the world. It marked the transition from

Table 3: Comparative analysis of regulations for general efficiency assessment of investment projects.

Criteria	Evaluation Manual (UNIDO)	Guide to Cost–Benefit Analysis of Investment Projects (EU)	Methodological Recommendations on Investment Project Efficiency Assessment (Russia)
1. Approach to the assessment	Cost–effective approach	Cost–benefit approach	Cost-effective approach
2. Assessment principles	+	+	+
3. Step-by-step framework	+	+	+
4. Assessment by sector	–	+	–
5. The EIA part	+	+	–
6. Proposed methodology/ies for EIA	–	–	–
7. Indicators for the EIA	–	–	–
8. Case study	–	+	+

a reactive approach in environmental management to a preventive one, when possible anthropogenic consequences are assessed before making a final decision on the implementation of any activities.

The document obliges to conduct an environmental assessment of any state project and provide reports on the expected project's impact on the environment (environmental impact statement (EIS)) [22]. Due to the legislative peculiarities of the United States, the specifics of financing large projects and their implementation, almost all private projects are somehow connected with the state activities that makes the EIA procedure mandatory for them [27]. Typical EIS structure: introduction part: a statement of the purpose and need of the proposed action; description of the affected environment; range of alternatives to the proposed action; analysis of the environmental impacts of each of the possible alternatives.

The second part of the EIS involves an assessment of the impact of the project on the environment and includes an analysis of the impact of the planned activity on the quality of atmosphere, water resources, biological diversity of the territory where the activity is planned to be implemented.

NEPA does not contain information on recommended approaches to assessing the environmental effectiveness of the project, since the EIA with the subsequent preparation of the EIS is often carried out by specialized organizations or an invited group of specialists who possess the necessary methodological tools. However, the section "Analysis of the environmental impacts of each of the possible alternatives" provides a recommendation for using cost/schedule risk analysis.

On the basis of NEPA, regulatory documents were subsequently developed and adopted, fixing the need for EIA in the EU, Russia and other countries.

3.2.2 Environmental Impact Assessment of Projects (EU)

Two key directives are applied on the territory of the EU that enshrine the need for EIA of investment projects: the Strategic Environmental Assessment Directive (SEA) (Directive 2001/42/EC) [28] and the Environmental Impact Assessment Directive (EIA) (Directive 2011/92/EC) [29]. Requirements and regulations of Strategic Environmental Assessment Directive are used at the stage of selection and initial evaluation of investment projects on

environmental and social aspects. Environmental Impact Assessment Directive contains requirements for the evaluation of already selected investment projects.

The key regulatory document in the field of EIA in the EU is the Environmental Impact Assessment of Projects manual, prepared and approved by the European Commission. The manual contains step-by-step instructions on preparing an Environmental Impact Assessment Report on an ongoing project or an already functioning enterprise and mandatory assessment elements such as climate change impact (mitigation and adaptation), risks of major accidents and disasters, biodiversity, use of natural resources. The document does not contain a specific procedure for conducting EIA, but some recommended methods are given [23].

The most frequently mentioned approaches are life cycle impact assessment (LCIA), multicriteria analysis and the use of special indicators to assess the impact of the project on the environment. The evaluation and preparation of the report can be carried out by a third-party organization that has a certain accreditation, or the project contractor independently, the choice of the evaluation methodology remains at the discretion of the project customer's specialists.

3.2.3 The Order of the Ministry of Natural Resources and Ecology of Russian Federation N 999 of December 1, 2020 "On approval of requirements for environmental impact assessment materials" (Russia)

At the legislative level, the need for an EIA procedure in Russia is enshrined in Article 32 of Federal Law N 7-FZ of 10.01.2002 (ed. of 12/30/2021) "On Environmental Protection" [30]. Requirements for the EIA procedure and materials since 2020 are contained in the Order of the Ministry of Natural Resources of the Russian Federation N 999 of December 1, 2020 "On approval of requirements for environmental impact assessment materials". The regulation includes the principles of EIA, requirements for materials and documentation on the results of the EIA, the need to consider alternative options for the implementation of the planned activity.

A feature of the Russian legislative act is the clause on mandatory public participation in the EIA procedure. The document does not contain a methodology for calculating the indicators required for the EIA.

3.2.4 The World Bank OP 4.01 "Environmental Assessment"

In 1989, the World Bank published recommendations for the EIA procedure. A distinctive feature of the recommendations is the division of all projects into three main categories

- Category A: Require a full EIA;
- Category B: Require only the environmental analysis;
- Category C: Not require an EIA.

Projects falling into categories A and B are required to assess the impact of the project on the quality of atmosphere, water resources, biodiversity and the territory where the project is planned to be implemented. At the same time, the recommendations do not contain a specific assessment methodology: it can be selected by the project organizers independently from officially approved methods on the territory of the state where the project is being implemented, or by invited specialists and organizations.

As in NEPA, the World Bank's EIA results report should include an assessment of alternative projects and solutions. At the same time, the methodology for calculating the ecological and economic efficiency of alternative projects and the project under consideration is not given. The document notes the need to compare economic results and socio-environmental consequences on the principle of "with the project" and "without the project".

The World Bank OP 4.01 “Environmental Assessment” is used in many countries around the world. In addition, the World Bank itself conducts EIA of socially significant projects. Based on this document, recommendations to the EIA European Bank for Reconstruction and Development (EBRD) were developed in 1992.

3.2.5 Family of ISO 14000 “Environmental management” issued by International Organization for Standardization

ISO standards are strategic tools in the form of recommendations and guidelines that help public and private companies to improve the efficiency of their activities and meet modern requirements in various fields.

The group of ISO 14000 includes 29 standards affecting various aspects of environmental management at enterprises [26]. As part of the efficiency assessment of investment projects, the following standards are applied:

- ISO/DIS 14005:2019 “Environmental management systems – Guidelines for a flexible approach to phased implementation”;
- ISO 14044:2006 “Environmental management – Life cycle assessment (LCA) – Requirements and guidelines”;
- ISO 14031:1999 “Environmental management. Environmental performance evaluation. Guidelines”;
- ISO 14097:2021 “Greenhouse gas management and related activities” [26].

The application of the standards listed above makes it possible to conduct a deep EIA of an investment project, including at each stage of its life cycle. The potential impact of the project on the environment is often assessed only at the operational stage, while a negative impact can be exerted at the initial and elimination stages. The main advantage of the ISO 14000 family is the high level of consistency of all standards among themselves: for instance, the LCA procedure can be supplemented with indicators from ISO 14031 and ISO 14097:2021 that will significantly improve the quality of the assessment [26]. ISO standards can be applied to enterprises and projects implemented in various sectors of the economy regardless of their regional affiliation.

Table 4 presents a comparative analysis of the five reviewed documents in the field of EIA.

Guideline on Environmental Impact Assessment of Projects (EU) and The World Bank OP 4.01 “Environmental Assessment” showed the largest compliance with the selected criteria – six of eight.

NEPA is the first normative instrument stating the need for EIA, became the basis for the development of Guidance on Environmental Impact Assessment of Projects in the EU, OP 4.01 “Environmental Assessment” The World Bank and the Federal Law “On Environmental Protection” in Russia. In that regard, all documents have the same structure and a common set of EIA requirements.

The Family of ISO standards 14000 is the only group of international regulatory documents that enshrines approaches to assessing the environmental effectiveness of investment projects and provides a list of indicators. At the same time, ISO standards do not contain information about the need to compare alternative projects with each other and recommendations for compiling a report. This is due to the fact that the standards are advisory and can be applied worldwide.

The reviewed regulatory documents do not contain a single approved methodology for assessing the environmental effectiveness of projects. Most of the recommendations are

Table 4: Comparative analysis of regulations for EIA.

Criteria	National Environmental Policy Act (NEPA), (USA)	Guideline on EIA of Projects (EU)	On approval of Requirements for EIA Materials (Russia)	Family of ISO Standards 14000 "Environmental Management" (International)	The World Bank OP 4.01 "Environmental Assessment" (International)
1. Applicable to the investment project evaluation	+	+	+	+	+
2. Principles of EIA	+	+	+	+	+
3. Step-by-step methodology of EIA	+	+	+	+	+
4. Indicators to the environmental assessment	–	–	–	+	–
5. EIA by sector	–	–	–	–	–
6. Alternatives evaluation	+	+	+	–	+
7. Recommendations for report preparation	+	+	+	–	+
8. Case study	–	+	–	–	+

Table 5: Comparative analysis of regulations for EEA.

Criteria	Guidebook for Energy Efficiency Evaluation, Measurement, and Verification: A Resource for State, Local, and Tribal Air and Energy Officials (USA)	Commission Recommendations on Energy Efficiency First: From Principles to Practice (EU)	Methodological Recommendations for Evaluating the Effectiveness of the Implementation of Energy Saving and Energy Efficiency Measures in Industry	Family of ISO 50000 "Energy Management Systems"
1. Applicability to the investment project evaluation	+	+	+	+
2. Principles of EEA	+	+	+	+
3. Step-by-step methodology of EEA	+	+	+	+
4. Indicators to the of EEA	+	+	+	+
5. EEA by sector	–	–	–	–
6. Alternatives evaluation	+	+	–	–
7. Recommendations for report preparation	+	+	–	+
8. Case study	+	–	–	–

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based on a quantitative assessment of emissions of harmful substances into the atmosphere, the impact of the project on water resources and biodiversity of the territory.

Thus, there is currently no unified methodology or approved approaches to environmental efficiency assessment of investment projects. In most cases, EIA is reduced to a quantitative assessment of the negative impact on the environment: the volume of emissions/discharges of harmful substances, the volume of waste generation, the area of the territory used, etc. In this regard, comparing several investment projects of different scales is incorrect and can lead to errors in the decision-making process. In addition, in the USA and the EU, it is necessary to involve third-party specialists and organizations in conducting the assessment, while the right to choose the methodology remains with them, which in some cases may reduce the effectiveness of the assessment. For example, different approaches to assessing the impact of proposed activities on atmospheric air may lead to different results and conclusions regarding the effectiveness of the project, especially if projects from different countries are compared.

To carry out a deeper assessment, specialists and specialized organizations could use various approaches: LCIA, cost–benefit approach, cost-efficiency approach, multicriterial analysis, which are mentioned in the documents under consideration, but this is not a prerequisite for conducting an EIA.

3.3 Overview and comparative analysis of regulations for EEA

The energy efficiency assessment of an investment project can be characterized as an EIA component: the higher the energy efficiency of the project, the lower the use of natural resources (in particular, energy carriers) and, consequently, the negative impact on the environment [31].

Currently, there is no unified regulatory and legal apparatus for assessing the energy efficiency of investment projects. However, in the USA, EU countries, and Russia, there are a number of documents containing goals, principles, recommendations, and methods of energy efficiency assessment that can be resorted to as part of evaluating the effectiveness of investment projects.

3.3.1 Guidebook for Energy Efficiency Evaluation, Measurement, and Verification: A Resource for State, Local, and Tribal Air and Energy Officials

This is a detailed guide to conducting an energy efficiency assessment at the national, regional level, at the level of an individual enterprise or investment project. The document contains requirements for evaluation, principles, approaches and indicators, case studies and served as the basis for the creation of similar methodological recommendations in many countries of the world.

3.3.2 Commission recommendations on Energy Efficiency First: From principles to practice

Since 2012, Directive 2012/27/EU [36] has been in force in the EU, which prescribes the need to increase energy efficiency in the EU through the use of incentive measures to increase it in all sectors of the economy. The Directive sets out a general framework for improving energy efficiency and contains five key principles: (1) Energy, security, solidarity and trust; (2) A fully internal energy market; (3) Energy Efficiency first; (4) Transition to a long-lasting low-carbon society; (5) An Energy Union for Research, Innovation and Competitiveness. The directive covers existing enterprises in all sectors of the economy, public and private programs, social projects and investment projects.

3.3.3 Regulatory document "Commission Recommendations on Energy Efficiency First: From Principles to Practice"

Commission recommendations on Energy Efficiency First: from principles to practice" is an extensive methodological guide that includes not only the process of assessing energy efficiency, but also theoretical and practical issues of implementing and achieving targets.

3.3.4 Methodological recommendations for evaluating the effectiveness of the implementation of energy saving and energy efficiency measures in industry (the Order of the Ministry of Economic Development of the Russian Federation N 468 of July 29, 2019)

This provides the main approaches to assessing the effectiveness of energy saving and energy efficiency measures at the planning stage. Recommendations can be used for EEA of investment projects. It contains the theoretical basis and principles of evaluation, simplified evaluation procedure and indicators. It should be noted that Russia is currently implementing the state program of the Russian Federation "Energy Efficiency and Energy Development" [37], which is aimed at improving the energy efficiency of all sectors of the economy.

3.3.5 Family of ISO 50000 "Energy Management Systems"

From the point of view of the EEA evaluation of investment projects, the following ISO standards are of the greatest interest:

- ISO 50006:2014 "Energy management systems – Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) – General principles and guidance";
- ISO 50015:2014 "Energy management systems – Measurement and verification of energy performance of organizations – General principles and guidance";
- ISO 17743:2016 "Energy savings – Definition of a methodological framework applicable to calculation and reporting on energy savings".

By analogy with the ISO 14000 family of standards, ISO standards for energy efficiency assessment in general can be applied for both planned and ongoing projects. The standards contain general principles and approaches to energy efficiency assessment and are applied worldwide. The main advantage of ISO standards containing approaches to EIA and EEA is their high compatibility with each other.

Table 5 provides the results of the comparative analysis of regulations in EEA.

All the documents reviewed provide almost the same approach and principles for assessing the energy efficiency of investment projects. That fact indicates a sufficiently high degree of their uniformity, and the possibility of comparing alternative investment projects planned for implementation in different countries

The first analysed document is "Guidebook for Energy Efficiency Evaluation, Measurement, and Verification: A Resource for State, Local, and Tribal Air and The Energy Officials" developed by the EIA in the USA which meets all eight criteria of comparative analysis, while the document prepared in the EU is meeting six out of eight. The methodological recommendations for assessing energy efficiency in Russia meet four criteria, but contain key information: principles, approaches and indicators of EEA.

Thus, it can be concluded that the documentation in the field of EEA has the greatest international consistency in comparison with regulatory documents, official recommendations and standards for the overall assessment of the effectiveness of projects and EIA.

EIA and EEA are currently the components of the efficiency assessment procedure of the investment projects, i.e. documents from all three groups can be used simultaneously to evaluate one or a group of investment projects.

4 CONCLUSIONS

According to the given results, the authors note the feasibility of developing a unified methodological approach to conducting an environmental and economic assessment of the effectiveness of investment projects. At the present stage, the formation of such unified approach requires taking into account the basic principles of the circular economy. The reviewed regulatory documents mainly contain the principles and procedure for assessing the environmental effectiveness of projects, in the absence of methodological guidelines and indicators, or refer to additional regulations, adopted standards or guidelines. The creation of a single international document (for example, on the basis of UNIDO) with a list of approaches and guidelines for their use would allow the creation and consolidation of an international EIA standard.

In addition, in order to improve the effectiveness of the assessment and objectivity in the selection of projects, it is necessary to conduct a comprehensive assessment of the EIA, including the EEA, not only according to uniform methods, but also taking into account the specifics of different sectors of the economy. The ISO 14000 and ISO 50000 family of standards represent a systematized methodological toolkit that can be used in the process of EIA and EEA, respectively, and in the future can become the basis for creating unified approaches to the environmental and economic assessment of investment projects.

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