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Research article

Assessing the economic efficiency of green investments in the context of sustainable development of the territory

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Abstract: This article proposes theoretical and analytical foundations for the economic assessment of the results of green investments in terms of promoting territorial sustainability. The green investments are presented as resources aimed at reducing the economic damage from environmental pollution through the creation of conditions or direct impact activities. However, the discounting application distorts their significance. The result of real green investment is capital, which is often specific and difficult to assess. It distinguishes them markedly from other investments. Green investments do not require directive advantages, such as a social discount rate. It is necessary to address the results of green investment in terms of their value for the sustainability of socio-economic systems. The accounting of total costs and results for the system when making decisions will allow for reducing territorial exploitation by social groups. Overcoming the discounting contradictions while assessing the economic effectiveness of green investments requires improving the adequacy of green investments results' evaluation in terms of the territory's sustainability transition, the differentiation of discount rates for various results, their costs and the years of their appearance and the use of compounding to assess the accumulation of the total result of a project based on the analysis of its entire life cycle. The study proposes a system for assessing the economic value of the growth of an ecosystem's assimilation potential and the consequences of its decline in relation to the costs of building the assimilation potential, the increase in the maximum allowable load on the ecosystem and the environmental pollution damage. To estimate the economic effect of the growth of an ecosystem's assimilation potential, it is necessary to consider the rate of return for its owner. The results of this study will allow

for reducing the assessment distortions and informational limitations of the managerial decision-making process.

Keywords: green investments; economic efficiency; economic value; environmental policy instruments; emissions of pollutants; economic damage; environmental protection

JEL Codes: Q56, Q58, R11

Abbreviations: SDG: Sustainable development goals; MAL: Maximum allowable load on the ecosystem; CU: Currency units.

1. Introduction

The transition to sustainable development of the territory requires ensuring the balance of the ecological, social and economic components of sustainable development (Duran et al., 2015; Rasoolimanesh et al., 2019). Green investments can allow for reducing the exploitation of the natural environment and establishing a balance of territorial sustainability components. The quality of the environment depends on technogenic pressure on the ecosystem, the legal and economic situation in the region, the possibility of scientific and technological progress, the availability of the modern technologies in the domestic market, etc. Furthermore, the specifics of the negative impact assessment also influence environmental quality. The empirical research proves the positive impact of AI and information and communication technologies on the long-term viability of the territory (Balsalobre-Lorente et al., 2023). The energetic security of the territory remains an important element of every sustainability component, though researchers cannot reach a consensus on the contribution of energy consumption to economic growth (Abbasi et al., 2021). Knowledge exchange and innovations are essential to various systems and mechanisms of territorial management to boost sustainability (Abbas, Hussain, et al., 2019). Organizational decisions can mitigate the uncertainty and increase the efficacy of using the available resources. The economic structure, the synthesis of technologies, social organization and resources' availability have relevance for carbon neutrality (Shah, Zhang, Abbas, Balsalobre-Lorente, et al., 2023). The strategy of ensuring optimal integration of elements of the socio-economic system for the transition to sustainable development of the territory depends on the subject of management, objectives, methodology of assessment and decision-making. In fact, the shortcomings of the natural and economic assessment of damage from chemical pollution and the effectiveness of green investment underestimate the importance of social and environmental aspects of life.

In world practice of economic indicators' evaluation, the investment project's flow of revenues and expenditures is time-adjusted and usually applied in this form (Malik, 2019; Hill, 2018). However, the implemented procedure of discounting, which is using compound interest, contains a significant drawback: the discount rate has a great influence on the assessment of the effectiveness of environmental projects (Alpizar et al., 2023; O'Mahony, 2021; Kossova et al., 2016; Mauleón, 2019). In essence, the use of this indicator, which is often directive, at the return rate level of alternative investment projects underestimates the long-term results of green investments and passes environmental problems on to future generations. The adoption of the recommended (underestimated) discount rate can discredit effective short- and medium-term projects. Yet, the effective functioning of

the integrated territorial management system cannot be achieved without evaluation, comparison and selection of the best option. Depending on the task, the existing indicators can act as an investment project's efficiency criteria, both independently and as a core of an integrated set. When calculating such indicators, taking the results of any investment into account adequately is necessary to optimally distribute the material resources in terms of sustainability.

In our opinion, conjunctural preferences when assessing the effectiveness of various projects make it difficult to adequately compare green and other types of investments nowadays. This study aims to make a contribution to the existing scientific literature in the following ways: determining the causes of distortion in green investment efficiency assessment, proposing an approach to the evaluation of economic value and the economic effect of increasing the environmental sustainability of the territory due to the boost in its ecosystem's assimilation potential, summarizing the indicators of green investments economic value and presenting the directions to improve the existing indices of green investment project efficiency assessment based on conducted analysis.

The synopsis of the research is as follows. Section 2 consists of a literature review on green investments and their effectiveness evaluation. Section 3 illustrates the methods used in this study. Section 4 represents the analysis of factors that affect the green investment efficiency assessment. Section 5 provides the theoretical and analytical basis for green investment value assessment. Section 6 presents directions for developing indicators of economic effectiveness for green investments. Sections 7 and 8 include the discussion, limitations, conclusions and recommendations.

2. Literature review

Green investment is a term covering various approaches to economic management of the transition to sustainability (Chiţimiea et al., 2021; Han et al., 2022; Pasquale Marcello Falcone, 2018; Xing et al., 2019; Pekovic et al., 2018; Mokhov et al., 2018). It can represent a concept, be a part of a broader field of investment knowledge or be integrated into a complex of approaches to economic development management (Chiţimiea et al., 2021).

It is necessary to consider the green investments in three dimensions: the basic concept (Mokhov et al., 2018; Pasquale Marcello Falcone, 2018; Pekovic et al., 2018; Xing et al., 2019; Chiţimiea et al., 2021; Han et al., 2022), the positive effects of their implementation at the company level (Zhang et al., 2015; Pekovic et al., 2018) and the factors affecting their efficiency and cost-effectiveness (Mokhov et al., 2018; Pekovic et al., 2018; Yen, 2018; Du et al., 2019; Chiţimiea et al., 2021).

Conceptually, an open and dynamic approach to defining green investments is the most productive. In a broad sense, *green* refers to sustainable investments, including environmental, social and administrative funding as well as responsible and socially responsible investments (Escrig-Olmedo et al., 2017; Chiţimiea et al., 2021). In practice, the following definition is most commonly used: "The investment necessary to reduce greenhouse gas and air pollutant emissions, without significantly reducing the production and consumption of non-energy goods"(Inderst et al., 2012).

The introduction of green investment in companies creates many benefits, which include raising funds from the state budget, satisfying consumers demands for green consumption and environmental protection, tax incentives, etc. The other advantage lies in increasing the satisfaction of investors interested in environmentally responsible financial allocation (Yen, 2018; Xing et al., 2019; Pimonenko et al., 2020; Chiţimiea et al., 2021; Han et al., 2022).

Green investments are often associated with the voluntary contributions of businesses. Corporate social responsibility (CSR) is considered both a tool of transition to territorial sustainability (Abbasi et al., 2021) and a way to increase the stability of a company's activity (Abbas et al., 2019). The global challenges to humanity such as COVID-19, environmental problems and economic crises, require unifying the efforts of all interested parties as well as elaborating prognoses and plans that are adequate to the threats (Micah et al., 2023). Under the informational and methodological limitations, for example, when estimating the consequences of the CSR strategy implementation (Zhong et al., 2023; Akporiaye, 2023; Guinot et al., 2023; Kurt et al., 2021; Ahmad et al., 2023), the management entities have to make decisions based on personal preferences, under pressure and solely in the interests of various stakeholders. With these informational asymmetries, a more well-informed and well-resourced party can take advantage of their situation. Reducing the informational limitations that occur during the assessment of the economic results of green and other investments is an important scientific and practical issue.

Among the factors influencing the results and effectiveness of green investments, there are three groups: political, economic and ecological. Political factors have a significant impact on sustainable investment through the creation of objects and the implementation of rules and laws to protect the environment. Those factors rely on the political will of state administrations to encourage *green* producers by providing subsidies for sustainable investments, tax incentives, etc. and to reward consumers, for example, through discounts on organic products. The punishment of *brown* manufacturers that do not comply with pollution limits can be implemented through environmental taxes, fines, etc. (Chiţimiea et al., 2021). Economic factors are the strongest drivers of green investment, maximizing corporate practices to create a healthy environment (Pekovic et al., 2018; Yen, 2018; Du et al., 2019). Economic factors identify the relationship between carbon emissions, energy consumption and sustainable financial development. An important component of the effectiveness of green investments are environmental factors, which include the direct reduction of emissions of pollutants and greenhouse gases and the abatement of their impact on the environment (Chiţimiea et al., 2021).

Another approach to classify the factors that affect the company's performance in terms of sustainable development is:

- internal factors such as corporate culture, *green* marketing and advanced staff training in sustainable development goals (SDG)
- external factors caused by the influence of various levels of administration, competitors, suppliers and customers (Paul et al., 2017)

Green investments as a financial tool to achieve SDGs can be regarded as:

- private and public (Du et al., 2019; Tao et al., 2021)
- real and virtual (Bracking, 2015; Maltais et al., 2020)
- direct impact investments (funding the prevention and elimination of environmental disasters consequences as well as improving and maintaining the favorable quality of the environment as a whole and its individual components) and creation of conditions for achieving SDGs (Inderst et al., 2012; Paul et al., 2017), etc

Such groups as business, investors, the government, stock exchanges, rating agencies, society, the media and international organizations are the main stakeholders in the green investment market (Hörisch et al., 2014; Freeman et al., 2018). The state is the most influential and interested party in the green investment market, performing the functions of goal-setting and stimulating other groups of

stakeholders and coordinating their activities in the context of the transition to sustainable development (Hörisch et al., 2014).

The behavior of large and medium-sized businesses in the green investment field relies significantly on a number of external and internal factors. On the one hand, investments in environmental protection can contribute to the innovative capacity of enterprises, increase energy and resource efficiency and effectively reduce pollution, thereby increasing their operating return. On the other hand, the intensity of enterprises' investment in environmental protection is not only subject to macroeconomic laws and regulatory acts but also limited by corporate profits, investment funds and the ecological and monetary policies of the state (Tao et al., 2021). In this regard, enterprises can only actively implement environmental management activities with sufficient funds and an efficient allocation of resources. Thus, state-owned enterprises have a broader scope of environmental management than private ones (Tao et al., 2021).

Green investments, like any other project, exhibit various types of efficiency: budgetary, commercial, social, environmental, technical and general economic. Each of these categories is determined by the ratio of the activity result to the costs and expenses necessary to achieve this result. The calculation of commercial efficiency considers only the financial indicators of green investments, for example, their profitability, net present value, etc. Budgetary efficiency reflects the tax revenues of *green* companies on state budgets. Social efficiency covers the social results of green investment such as quantitative indicators of population exposure to pollutants prevalent in a given territory, characteristics of public health risk, welfare growth, etc. General economic efficiency assessment involves all results and costs, including those that go beyond the immediate economic interests of stakeholders (the so-called indirect and associated economic effects) (Bartošová et al., 2015; Malik, 2019; Gilchrist et al., 2021).

The problems of evaluating the effectiveness of green investments are associated with the lack of an unambiguous definition of the concept of corporate environmental friendliness and, consequently, the consistency of its definition, as well as the inaccessibility of data. Most scoring systems combine environmental, social and governance aspects, which does not allow evaluating the firm's true performance in terms of sustainability in practice. This way, an enterprise with a high level of negative impact on the environment can fully fulfill its social obligations to employees and have an effective corporate governance system, which results in a high sustainability rating (Gilchrist et al., 2021).

Discounting is an integral part of any public policy, but in the context of sustainable development, this practice is quite controversial. From a holistic environmental perspective, the arguments for discounting (time preference, opportunity cost of capital, uncertainties and risks) implicitly condone negative environmental impacts and irresponsible use of natural resources to achieve immediate interests (Malik, 2019). At the same time, the establishment of underestimated social discount rates to substantiate the effectiveness of long-term investment projects (O'Mahony, 2021) distorts the efficiency of short- and medium-term environmental protection programs. It is thus necessary to consciously use an integrated system approach to social and natural systems when considering the core issue of sustainability in an overarching context, i.e., economic sustainability, environmental sustainability and social justice (Malik, 2019).

Therefore, the funding of any activity or the creation of conditions to achieve the SDG (for example, a system of environmental policy instruments in the territory) can be regarded as *green* investment. The framework of this study involves, primarily, real investments aimed at reducing the damage from environmental pollution in the territory. The decision-making process is largely

dependent on the evaluation of alternatives. It is an essential stage of the modern process of efficient management of any object. The reduction of informational and methodological limitations when assessing the economic consequences of green and other investments is an important scientific and practical task.

3. Methodology and data

The institutional environment in the territory, in many ways, shapes the behavior of economic agents. The informal institutions formed in the business environment and implemented at the enterprise level affect the laws' execution in the territory as well as business efficacy as a whole (Yan Li et al., 2022). Organizational decisions directed at reducing transactional costs allow for ensuring innovations' stability and increasing business efficiency (Abbas et al., 2020). Innovation technologies can support business development among various social groups, even amidst cultural limitations and the COVID-19 crisis (Ge et al., 2022). Life quality in the territory largely defines the preferences and priorities of environmental policy (Shah et al., 2023). These and other factors have an impact on decision-making in the territory, including ones regarding the green agenda. The hypothesis of this study suggests that gaps and limitations in assessment methodology distort the significance of green investments. The identification and analysis of these gaps and limitations, along with the development of proposals for their correction, allow for reducing the assessment distortions and informational limitations of decision-making.

The general scientific methods such as analysis and synthesis, system approach, deductive method and method of analogies are employed to solve the problems of the study. Besides, the research implements special methods and concepts from various subject areas: sustainable development, transaction costs and their types, discounting and compounding; comparative analysis, assimilation potential of an ecosystem, which is the ability of its structural elements to consume and recycle the pollutants introduced to the ecosystem (Badalyan et al., 2015; 2022), maximum allowable load (MAL) on the ecosystem, which is the pollutant's mass that can both be neutralized by the ecosystem's assimilation potential and rule out the formation of concentrations of impurities in the air that are dangerous to humans and nature (Badalyan et al., 2022), stakeholders, i.e., individuals, social groups and organizations influencing or being influenced by the system (Freeman et al., 2018; Hörisch et al., 2014).

To compare the conditions for making decisions about green investments in different countries, we have analyzed the application of various schemes of CO_2 emissions economic regulation according to the World Bank.

To compare with discount factors (i.e., capital accumulation calculated with the use of the compound interest formula), we adopted the conditional coefficients of increase in the estimation outcomes of green investment results of 2 and 4 (section 4.2). The values of these coefficients may vary widely. Section 4.1.2 confirms this thesis. The conditional return rate is an estimation of its appropriate value for various commercial projects.

4. Analyzing the factors influencing the assessment of green investment effectiveness

The analysis of the elements of the formula for the net present value estimation allows for highlighting the main factors that affect the assessment of green investments' effectiveness: the results and costs evaluation, the discount rate and the process of adjusting the multi-temporal flows to one

period of time. Consideration of the types of transaction costs makes it possible to reveal the following restrictions on the process of making optimal management decisions: methodology, set up conditions for decision-making and dishonest behavior (damage to the socio-economic system of the territory in terms of sustainable development).

An analysis of these limitations is performed below.

4.1. Assessing green funding effectiveness

4.1.1. Assessment methodology

The analytical tool set, which includes the assessment of the effectiveness of green investments, is a part of a more general methodology for the transition to sustainable development (in the framework of this study at the territory level). Development goals and their implementation rules should act as a higher-level driver in the formation of the territorial evaluation methodology than the prevailing views on solving similar problems in other decision-making conditions. These conditions include a different institutional environment, economic development goals, balance of powers and level of contradictions between social groups, stakeholders' competition, etc.

The common concepts of sustainable development (strong, weak and critical) and their respective rules of decision-making (Bolis et al., 2014; Brand, 2009; Kuhlman et al., 2010) allow the elimination of a portion of methodological restrictions. However, the inertness of changes in methodology and attempts to consider the interests of domineering social groups (justifying the decisions by securing, in fact, the short-term sustainability of the existing economic component) impede the effective synthesis of approaches and the transition of territories to sustainability.

The assimilation potential of the ecosystem, its ecological endurance, indicators of the ecological sustainability of the territory, etc. can serve as critical limits for environmental impact on the territory. In this study, within the framework of the concept of critical environmental sustainability, the indicator of the MAL on the ecosystem is used to assess the environmental sustainability of the ecosystem of the territory. In this case, the MAL on the ecosystem reflects the mass of pollutant that is safe for the ecosystem and the health of the population of the territory. The MAL allows bringing the dimensions of the control system parameters necessary for making effective management decisions into a general form (Badalyan et al., 2022).

When assessing the economic damage from environmental pollution, researchers and decision makers face a number of problems, for example, health damage evaluation (Van Der Kamp, 2019; McAlister et al., 2022; Dutta et al., 2023; Limaye et al., n.d.; Andersson, 2020; Schlander et al., 2017; Zubova, 2022), *willingness-to-pay* assessment (Mor et al., 2022; Jiang et al., 2023; Markandya et al., 2019), global consequences (Reis et al., 2022; Mueller et al., 2023), economic interests of various stakeholders (Qian et al., 2023; Liu et al., 2022; Sharpe et al., 2021; Hadj, 2020; Zaman, 2023), etc. The choice of an assessment methodology by stakeholders, which largely reflects their interests under informational limitations, reduces the adequacy of such evaluations for the territory's transition to sustainable development.

The social component of the sustainable development of the territory can be aimed at the reduction of social conflicts, the growth of the social potential of the territory, its maximum implementation, etc. These goals are interconnected and a strategy achieving them is formed in accordance with the concept of development, methodology for assessing and making decisions,

prevailing conditions and other factors. Linking social goals with environmental pollution, it is important to note that the economic damage to public health is determined and depends largely on the following factors: *willingness to pay*, the standard of living which largely determines the significance and value of alternatives, the management system, the dominant assessment and decision-making methodology (in which losses in socio-economic system may not be visible), the level of development of the economy of the territory, the institutional environment, transaction costs, etc. The deviation of the existing trajectory of territorial development, which is shaped by the existing methodology and the current conditions, from the sustainable one determines the lost opportunities and damage that can be expressed economically. If the assessment methodology on the territory does not fully (or at all) take such a deviation into account, then the decisions made on its basis will not enable the transition to sustainable development. An assessment of such a deviation for the social component of sustainable development can be based on the opportunity cost. At the same time, if the socio-economic system of the territory is aimed at the development of human potential, then the most successful representatives of this territory community can be selected as the standard and equivalent of the alternative. Accordingly, the deviation from this assessment (as well as the damage determined on its basis) will indicate damage to the stability of the socio-economic system.

However, if the socio-economic system of the territory is aimed at reducing human potential and its realization, then this deviation reduces the contrast between the implemented development goal and an underestimated health damage. On the other hand, it exacerbates the contradiction between the very goal of the territory's transition to sustainable development (the possibility of such a transition) and the SDG, management system and decision-making methodology. Thus, with personality degradation within the existing development trajectory in the territory, the value for the individual there decreases, as does the assessment outcome of damage from negative consequences for the individual. It ultimately reduces the effectiveness of decisions aimed at mitigating such social losses and limits the possibility of increasing the stability of the territory in general.

An analysis of the environmental component of territorial sustainability by analogy shows that the less profitable use of the territory forms the value of the environmental component and stimulates a wasteful attitude. As a result, the economic strategy in the territory, which ignores the alternative cost estimation of the projects for the socio-economic system as a whole, forms resistant models of environmentally unscrupulous behavior.

The assessment of losses (including lost profits) in the economic component of the sustainable development of the territory is also largely related to the assessment methodology and dominant stakeholders. Removal of these contradictions, for the most part, makes it possible to ensure that results and efficiency evaluation shifts from the stakeholders' view to the entire socio-ecological and economic system with incorporation of the total costs and results. Therefore, considering the interests of all the stakeholders in the territory is necessary to achieve the sustainability of the management system and development of the territory. However, this component is more subject (in terms of the rate of change) to the influence of decision-making conditions.

4.1.2. Conditions of decision-making

On the one hand, the development of conditions for the green transition, for example, the advancement of a set of environmental policy tools is an important element of green investments' classification. On the other hand, it is a factor that largely determines the effectiveness of investments.

From an economic perspective, there are two main mechanisms for regulating greenhouse gas emissions: the carbon tax (carbon tax) and emissions trading (cap-and-trade or emission trading system). Both systems internalize by pricing emissions, but the approaches differ significantly. Taxation schemes are classified as emissions price management approaches, while cap-and-trade is a quantitative emissions' management system.

For different users of natural resources, the optimal level of pollution (and, accordingly, the tax burden), which is characterized by the equality of marginal environmental costs and marginal damage prevented, can differ significantly. If the marginal cost of green technology is low or the marginal cost of pollution damage is high, a government seeking to maximize social welfare should opt for a green subsidy policy. Otherwise, it must apply an emission tax (Yi et al., 2022). Establishing the optimal tax burden is hampered by the information limitations of the territory's administrations. In theory, the solution to this problem is the market mechanism for trading quotas (Kurdyukov et al., 2022; Mardones, 2019; Guo et al., 2022; Wei et al., 2021).

While the cap-and-trade system encourages businesses to reduce emissions autonomously, the carbon tax provides an additional option for companies that are not part of the system.

A carbon tax is a more direct approach to combating global warming, as the policy results in immediate reductions in greenhouse gas emissions. However, this is somewhat controversial, as the dynamic integrated climate economy model shows that a sharp decline in production is detrimental to the economy. A carbon tax reduces greenhouse gas emissions to a certain extent, but excessive taxation is bad for the economy. While a carbon tax becomes effective rather quickly, carbon trading is more efficient from a long-term perspective in terms of economic benefits and social acceptance (Barragán-Beaud et al., 2018). Shi, Yuan, Zhou et al. conducted a comparative analysis and concluded that a coexistence strategy strikes a balance between carbon tax and trade restriction in terms of reducing emissions and enterprise costs (Shi et al., 2013). Though a dual-directional strategy is beneficial at the national level, a single approach should be applied at the enterprise level (trade restriction or carbon tax) to avoid excessive liabilities (Hu et al., 2020).

In addition, since abatement costs are uncertain under a cap-and-trade system, a sharp increase in certificate prices is possible whenever abatement costs and resulting demand for emission certificates are high. This could result in a disproportionate burden on issuers (Hofbauer Pérez et al., 2020).

To compare different approaches and the level of the tax burden, we propose to consider information on greenhouse gas emissions and the implementation of payment mechanisms at the national level (table, figures 1, 2). It becomes clear that in terms of territorial coverage for 2022, the carbon tax prevails. Due to the relative novelty of cap-and-trade systems, their application area is much smaller. However, if we judge the effectiveness of regulatory mechanisms by indicators such as the share of taxable emissions and budget revenues, we can conclude that the emission trading system covers most of the emissions and has a higher profitability. Indeed, the cap-and-trade system covers 27.4% of the gross emissions in the territories under consideration. At the same time, total revenues to the budgets of states amount to 50103 million dollars, which is 104% higher than the income from taxes on emissions.

Table 1. Application of various schemes of economic regulation of CO_2 emissions in the countries of the world according to the World Bank.

Country	GHG emissions in the territory, Mt CO_2	Carbon tax			ETS		
		CO_2 emission fee, USD /t	Share of taxable emissions	Budget revenues, million USD	CO_2 emission fee, USD /t	Share of taxable emissions	Budget revenues, million USD
Argentina	397	4.99	20.00%	272	-	-	-
Canada	762	39.96	22.00%	4798	39.96	7.00%	264
Chile	126	5	29.40%	160	-	-	-
China	13740	-	-	-	9.2	32.75%	N/A
Denmark	49	26.62	35.00%	468	-	-	-
EU	4001	-	-	-	86.53	40.72%	34326
Finland	775	85.1	36.00%	1547	-	-	-
France	451	49.29	37.00%	8400	-	-	-
Germany	874	-	-	-	33.16	40.00%	7940
Japan	1270	2.36	75.00%	1800	-	-	-
Korea	758	-	-	-	18.75	73.00%	243
Liechtenstein	0	129.86	85.00%	7	-	-	-
Luxembourg	10	43.35	65.00%	241	-	-	-
Mexico	801	3.72	44.00%	314	-	-	-
Netherlands	222	46.14	11.70%	N/A	-	-	-
New Zealand	85	-	-	-	52.62	49.00%	1648
Norway	71	87.61	63.00%	1716	-	-	-
Portugal	70	26.44	36.00%	331	-	-	-
Singapore	71	3.69	80.00%	153	-	-	-
South Africa	574	9.84	80.00%	94	-	-	-
Spain	333	16.58	1.87%	77	-	-	-
Sweden	65	129.89	40.00%	2267	-	-	-
Switzerland	48	129.86	33.00%	1262	64.22	10.60%	18
UK	464	23.65	21.00%	690	98.99	0.28%	5664
Uruguay	39	137.3	0.11%	N/A	-	-	-
Total indicator	26056	-	10.8%	24597	-	27.4%	50103

The tax burden and the system of environmental policy instruments in the territory factor significantly in the effectiveness of green investments. At the same time, softer environmental legislation can provide a short-term advantage to territories in their competitive confrontation. The approaches to assessing the results (and, accordingly, the effectiveness) of projects also differ depending on the decision-makers and beneficiaries. To avoid distortions in the assessment in terms of the sustainable development of the territory, it is necessary to carry it out in relation to the socio-economic system as a whole and not just regarding the stakeholders. In this regard, the evaluation of the cumulative results and costs to the territorial socio-economic system that are associated with green investments is important. Particularly, this reduces the possibility of exploitation of the social and environmental potential of the territory.

4.2. Discount rate and rate of return: differences between green and financial capital

The implementation of all activities with a positive economic effect in terms of total costs and benefits is necessary. Otherwise, losses and lost profits accumulate. The discount rate is a tool for risk accounting. The result of the calculation of net present value of green investment, including infrastructural and scientific investments, technology development, etc., based on the commercial project discount rate is often negative. It leads to the need for manipulations, which are used to substantiate long-term environmental projects and disregard for the limitations and distortions of the existing methodology in the territory. In the conditions of excessively soft environmental legislation in the territory, green investments are mainly aimed at saving natural resources which leads to restrictions and incomplete realization of the territory's potential. With an overly rigid environmental policy, there are risks of reducing the stability of the socio-economic system in the territory.

The results of green investments can be categorized by sustainable development components as follows:

- reduction of damage to public health
- improving the efficiency of the use of resources and factors of production
- increasing environmental sustainability and the opportunities for restoring the ecological and social potential of the territory
- improving the efficiency of the management system (e.g., budget and tax system) of the territory.

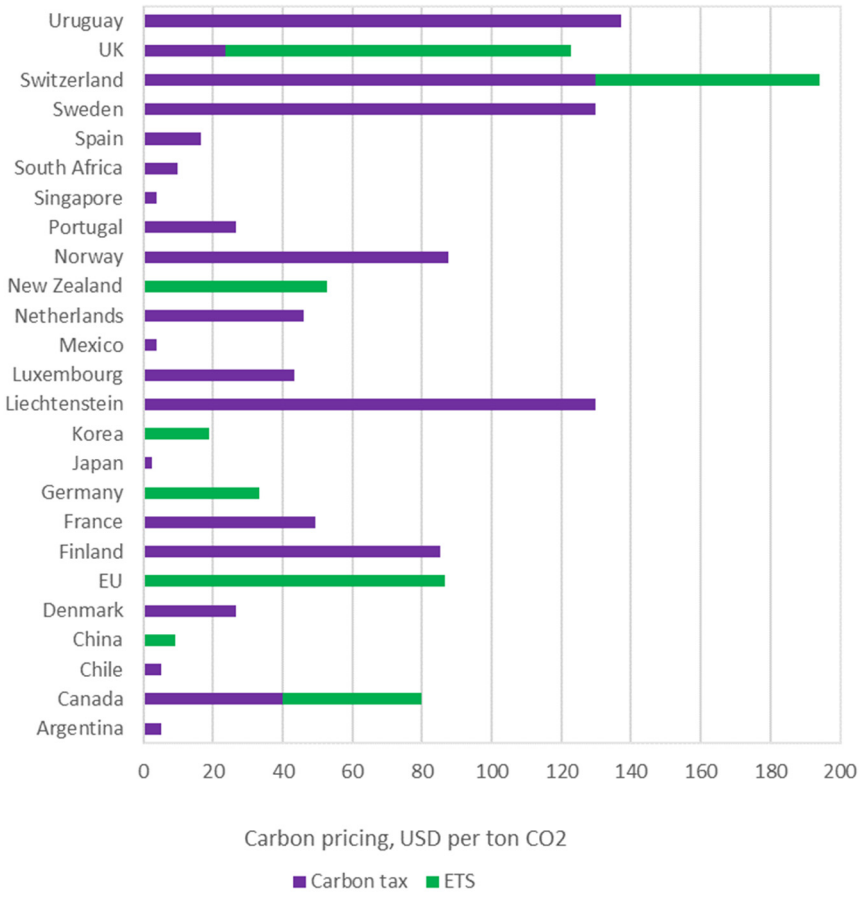

Figure 1. Payment for 1 ton of carbon dioxide using various schemes.

Comparing real green investments and financial capital, it can be noted that the result of the former will be the saving of various resources, i.e., the stock of specific resources, which in turn can be represented by specific capital.

By type of resource, the following results of green investments can be distinguished:

- natural resources which consist of resources associated with the dominant technologies in the territory (for example, hydrocarbons), resources that create conditions and habitat (for example, assimilation potential and homeostasis of the ecosystem of the territory), potential resources (for example, plants and organisms, the study of which will make it possible to make scientific discoveries in medicine, ecology, and, among other things, affecting the sustainability of the socio-economic system of the territory) and so on.
- human resources that include an increase in life quality and expectancy for the population of the territory, which can be interpreted through the opportunity cost. Additional life expectancy can give a significant increase in results (and their profitability) due to the creative component (science, art, education, transfer of experience, etc.).
- human-made resources, which consist of technology, infrastructure, means of production, information and culture, that can save and reduce the losses of human and natural resources as well as stimulate the growth of some resources.

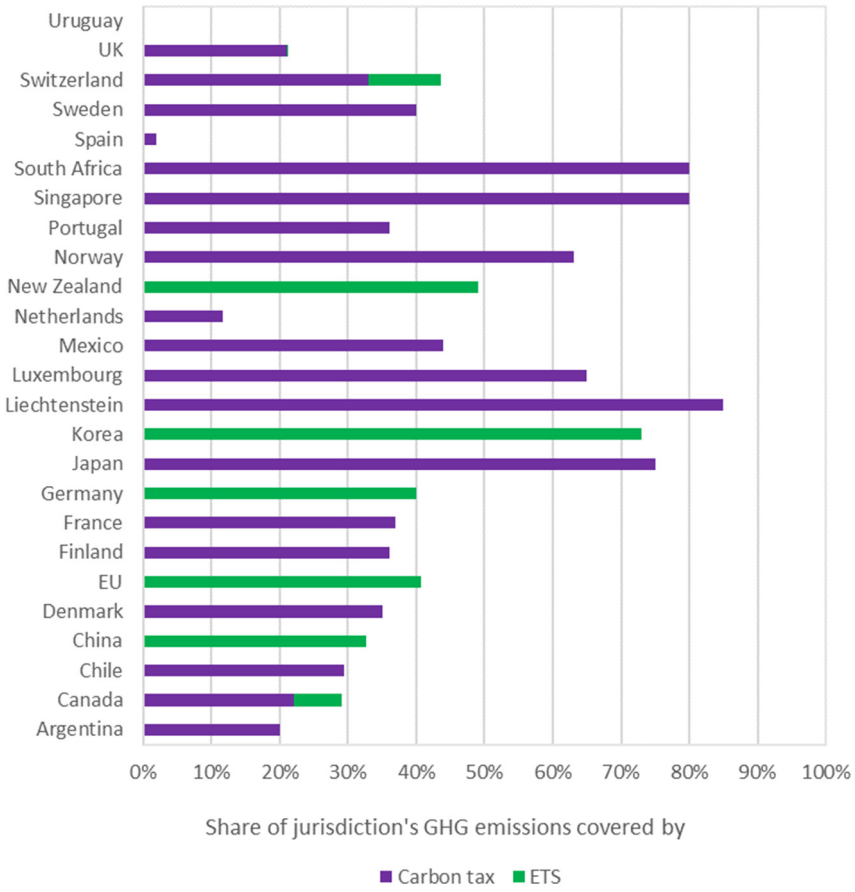

Figure 2. The share of emissions covered by payment, as a percentage of gross CO_2 emissions in the territory.

Over time, under new conditions the significance of resources can change significantly. Throughout history, there have been many examples of a sharp change in the value of resources as a result of scientific discoveries, organizational decisions and other factors such as:

- technology development, for example, the growth in hydrocarbons' consumption by various economic sectors (BP p.l.c., 2022; Litvinenko, 2020) and the increase in diverse metals' usage as a result of the development of electronics and transport, e.g., lithium for batteries (Berger et al., 2004; Feng et al., 2022; KPMG, 2017), non-ferrous metals in electronics (KPMG, 2017)
- discovery of new properties of bioresources to use when creating new drugs (for more details, for example, see Carmona and Pereira 2022; Daliu et al. 2020), methods of restoring health (Tajima et al., 2023; Dick et al., 2022), etc.
- preservation of the natural habitat of the territories that influenced their attractiveness for tourists (for more details, for example, see Pelletier, Heagney, and Kovač 2021; Costanza 2020) and maintenance of the assimilation potential of the territories.

The profitability of specific resources of such kinds from a long-term perspective can significantly exceed the increment of financial capital. Ignoring the value of saving and preserving such resources reduces the ability to ensure the sustainability of the socio-economic system of the territory. It can be characterized by economic losses.

The analysis of the functions of the discount factor and the ratio of the assessments of the results of the implementation of the green investment project allows us to compare the significance of the factors: discount rates and assessments of the results (Figure 3).

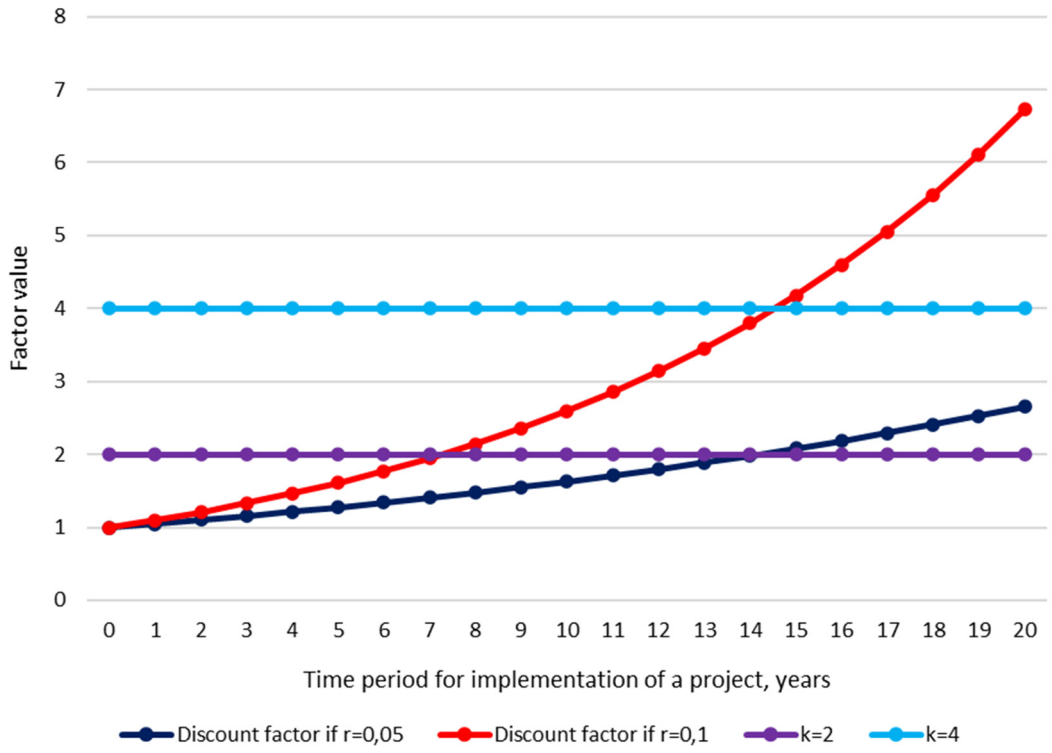

Figure 3. Comparison of the change in flow cost and the coefficient of exceedance of the economic assessment of the consequences of green investments: k is the factor of ratio of the values of different assessments of the results of green investments and r is rate of return (discount rate).

A comparison of two- and four-fold increases in the estimates of the results of green investments with capital accumulation at of 0.05 and 0.01 rates of return leads to the following conclusion. A more adequate assessment of the results of green investments for more than 13 years compensates for the capital growth at the presented return rates. The ratio of values for assessing the results of green investments in different countries can differ by several times and by orders of magnitude. The first statement is supported by the difference in payments for carbon dioxide emissions (see Figure 2). The example of the last one is the following fact. In Russia, with the lack of an established CO_2 cost and the implementation of the cap-and-trade system on a pilot project level in certain regions, carbon pricing can be estimated only indirectly. The means for such an assessment can be the emissions costs for methane and carbon monoxide. Their value, however, even with the respective increase factors and higher aggressiveness of these substances, can differ from the maximum CO_2 (carbon) cost in other countries by numerous orders of magnitude (Government of Russia, 2016; Ministry of Natural Resources and Ecology of Russia, 2021). The assessment of the effectiveness of green investments and their attractiveness, accordingly, can vary greatly in different territories. Given that tax rates should strive to equalize marginal prevented damage and environmental cost limits, the problem of valuation arises again.

The prescriptive inflation of the results and underestimation of the discount rate seem like tempting ways of increasing the significance of the long-term results of an investment project. Under the informational limitations and the costs of finding and measuring alternatives, it may seem logical to prescriptively increase the value of results for a local area. At the core of this decision lie the experience of assessment in other countries (charges for emissions, etc.) and the achievements of specific individuals (for example, in science). However, the analysis of alternatives to ensure the sustainability of the socio-economic system should adequately reflect the consequences of certain management decisions. Consider the case where the development strategy of the territory is aimed at the realization and enhancement of human potential. Then, the opportunity cost of its loss (e.g., damage from environmental pollution) must be estimated not by the minimum, but by the weighted average or maximum value. This conclusion is caused by the fact that such a specific resource can be involved in the process of generating income under the same conditions of growth. Furthermore, the tendencies toward increasing social potential and improving the terms of its implementation will make it possible to raise the yield of such a specific resource. Reducing losses and saving resources when using them in the same project allows relying on the maximum or real profitability of that same project. The choice of profitability according to the opportunity cost increases the stability of the system, reduces risks, minimizes losses and maximizes the realization of the potential of the territory. This is possible with the maximum realization of the potential of each individual or striving for this within the framework of the territory development strategy.

With different growth rates for financial and *green* capital, it is difficult to bring the results of such investments to the same period. Discounting long-term results does not allow them to accumulate at a higher rate compared to financial resources. Different returns on green investments for different results and different years of their appearance are higher than the alternative returns on financial investments. As a result, the discounting process distorts estimates and shifts the opportunity cost towards short-term and low-cost projects.

4.3. Discounting and compounding

Planning and evaluating the effectiveness of investment projects requires applying methods of assessment of the money's value, which changes over time according to the rate of return in the market. When planning long-term investments, two main concepts are considered: the future value of money and its present value. The determination of the future money's value characterizes the process of its increment (i.e., compounding) with the interest accrued on the initial amount at a certain moment. It is a way to predict the effectiveness of investment projects. The discounting is a reverse process, i.e., the determination the present money's value is made through the subtraction of the interest for the examined period from the future money's value. Discounting is usually implemented when it is necessary to obtain a certain cost of investments for a specific period of time at a given return rate (Hill, 2018). At the same time, the interest rate on discounting for different companies varies given the risks associated with management errors and other parameters (Khramov et al., 2021).

The growth rate of the value of the green investments' results can significantly exceed the rate of increase in money's value (the cost of other types of investments). However, the result of green investment appears after a long time and is maximally revealed only under certain conditions. Applying the discounting procedure to the results of such projects can distort their effectiveness. Conditions when different types of capital (results of green investments) have different growth rates can be an additional factor for choosing discounting or compounding.

The possible ways to overcome the contradictions of discounting for green investments are summarized as follows:

- increasing the adequacy of the assessment of the green investments' results regarding the transition of the territorial socio-economic system to sustainable development.
- assessment of the total costs and results for the socio-economic system as a whole and not for individual stakeholders.
- assessment of cumulative costs and results for the entire life cycle.
- applying the various return (and discount) rates for different results of green investments and different years of their appearance.
- assessment of the rate of return and discount for costs and results, while considering that a profit from reducing environmental pollution damage may significantly exceed the opportunity value of money.
- the use of compounding to assess the accumulation of the net result of the project, since the potential and rate of growth in the results of green investments can be significantly higher than alternatives.

5. Theoretical and analytical foundations for assessing the economic value of green investments

To reduce the negative impact of pollutants' emissions from motor vehicles and stationary sources on ecosystems, it is necessary to apply environmental policy tools. Combined with various environmental activities, e.g., as a part of an ecological program (Badalyan et al., 2019), this tool set forms a framework for the responsible behavior of legal entities and individuals within a package of diverse instruments of environmental policy regulation. The implementation of green investment projects comes with known expenses and the expected economic effect of improving the quality of the environment.

In this aspect, to compare the economic efficiency of various green investment projects, it is important to quantify their total costs and purported economic value to the socio-economic system. At the same time, it is necessary to consider not only the costs of the green investment project's executors but also the expenses of nature users, the population and all other stakeholders associated with this activity. The value of green investments is determined by a set of changes that contribute to the achievement of the goal of sustainable development of the territory (improvement of the unfavorable situation in the environmental and socio-economic spheres of life). Hence, the economic value of green investments represents the evaluation of efficiency on the main life-forming parameters of economic development (economic, environmental and social) in each specific region regarding the goal of transitioning to sustainability (Kurdyukov et al., 2020). It is essential to note that moving towards sustainable development is a long-term goal and an objective necessity for a territorial socio-economic system. From this perspective, the proposed indicator for green investment's value can be presented as the utility of green investment for the socio-economic system of the territory.

The effectiveness of a comprehensive green investment program should be presented in line with an assessment of the total costs. In general terms, the amount of annual total costs associated with green investments, in currency units (CU) per year, is advisable to calculate using the formula:

$$C = C_d + C_v + C_i + C_o + C_c + C_{an} \quad (1)$$

where C is the amount of annual total costs CU/year, C_d is the green investment project development cost (staff wages, researches to determine societal attitudes to innovation, etc.) CU/year, C_v is the cost of verifying the feasibility of the designed green investment project (environmental expertise of project, staff salaries, researches, determination of the project's conformance to existing economic and legal systems) CU/year, C_i is the green investment project's implementation cost (the expenditures on additions and changes for legislative framework, the costs of facilities acquisition, staff wages, technical equipment, software, etc.) CU/year, C_o is the cost related with the functioning of green investment project (salaries, equipment, expenses for the maintenance of administrative office premises, etc.) CU/year, C_c is the control-related operation cost of the implemented green investment project (environmental monitoring, audit of institutions responsible for the project's functioning, monitoring for compliance with the established rules and procedures, staff wages, equipment) CU/year, and C_{an} is the amount of another costs (for example, insurance premiums to consider the risk of reducing the planned effectiveness of the green investment project, the expenses of the population and nature user such as environmental taxes, equipment costs, etc.) CU/year.

The given structure of expenses should characterize the total costs for the socio-economic system in the territory during the implementation of a particular green investment project. At the same time, when forming plans, it is advisable to impose requirements on the behavior of project participants in the form of various principles of behavior, for example, cost minimization based on the principle of the best available technologies. The total expenses include the entire life cycle of all elements of the project, accounting for the costs and results of all stakeholders (externalities and transaction costs) and shifting responsibility and costs to others (forms of exploitation and rent-seeking behavior).

The results and efficiency must be considered not for some social group (individual stakeholders) but for the socio-economic system of the territory as a whole in terms of its sustainability. The total annual economic value of green investments is proposed to be calculated using the following expression:

$$V = V_{env} + V_e + V_{MAL} + V_f + V_{rec} + V_{an} \quad (2)$$

where V_{env} is the economic value of reducing damage from environmental pollution CU/year, V_e is the economic value of reducing the energy and resource intensity of the economy of the territory CU/year, V_{MAL} is economic value of increasing the MAL on the ecosystem of the territory (for example, by increasing the assimilation potential of the ecosystem) CU/year, V_f is the economic value of raising funds for environmental or other purposes (income from the operation of environmental policy instruments manifested, for example, from the transfer of the tax burden gravity center from the wage fund, property, etc. to environmentally harmful activities and products (more about greening the tax system, for example, see at Bachus 2016; Li et al. 2022) in an amount equal to a decrease in the total tax burden on the wage fund, property, etc.) CU/year, V_{rec} is the value of the emergence or increase in opportunities to meet recreational needs (Kurdyukov et al., 2020) CU/year and V_{an} is other economic value of green investments (for example, the value of creating or increasing opportunities to meet aesthetic, scientific needs, etc.) CU/year.

The economic value of reducing damage from environmental pollution is the reduction of economic damage from the emission of pollutants by mobile and stationary sources:

$$V_{env} = D_1 - D_2 \tag{3}$$

where D_1 and D_2 are economic damages (in terms of transition to sustainable development of the territory) from environmental pollution before and after the implementation of the green investment project respectively CU/year.

The economic value of reducing the energy and resource intensity of the regional economy after the introduction of a green investment project can be identified with preservation of energy and material resources. In doing so, the environmental and social components of the sustainable development of the territory should not be reduced. The feasibility of eliminating the source of pollution is examined in combination, considering the total costs and benefits.

$$V_e = \sum_{i=1}^{n} \sum_{j=1}^{m} \Delta R_{ij} F_{ij} P_i \tag{4}$$

where ΔR_{ij} is an economy of the i-th type of resource from the j-th type of its use kg/h (m^3/h), F_{ij} is an annual fund of operating time for the j-th type of use of the i-th type of resources h/year, P_i is the price of the i-th type of resources CU/kg (CU/m^3), n is the total number of saved resources, i is resource type; m is the total number of types of resource use in which they were saved and j is type of resource use.

Note that the replacement of a resource of one kind by another in the j-th type of usage to account for under expenditure involves the introduction of a negative value of the total cost of the substitute resource into the calculation. This value is then added to Formula 4, along with the saved resources' total cost.

With an increase in the MAL on the ecosystem, the damage to public health and natural and man-made objects declines. It occurs due to an increase in the assimilation of pollutants by ecosystem elements and a decrease in the concentration of pollutants. Using the MAL concept (Badalyan et al., 2022) and the specific costs of creating and maintaining the assimilation potential of the ecosystem, the economic value of increasing the MAL on the ecosystem in the territory can be expressed as follows:

$$V_{MAL} = \Delta MAL \cdot \gamma_{SD} k_r \tag{5}$$

where ΔMAL is a change in the MAL on the ecosystem relative (r.) kg/year, γ_{SD} is the specific cost of the creation and maintenance of the assimilation potential of the ecosystem (calculated for a specific ecosystem) CU/r. kg and k_r is a rising coefficient that considers the adverse consequences for the population of the region and natural and man-made objects from emissions exceeding the MAL on the ecosystem of the territory (which can be defined, for example, as the ratio of economic damage from harm to public health and natural and man-made objects to the specific costs for creating and maintaining the assimilation potential of the ecosystem).

Formula 5 also allows for quantifying the economic losses from the decline in the ecosystems' assimilation potential and the MAL on the territorial ecosystem.

The economic effect of increasing the assimilation potential and the MAL can be with consideration of the corresponding costs and the profit rate for the owner of the assimilation potential. Then, the economic effect will be the difference between the utility of MAL increasing and these costs:

$$E = \Delta MAL \cdot \gamma_{SD}(k_r - r_{AP}) \quad (6)$$

where r_{AP} is the return rate for the owner of the assimilation potential, which is the ratio of the assimilation potential owner's profit to the costs of creating and maintaining the assimilation potential of the territory within the MAL on the ecosystem (Kurdyukov et al., 2022). The additional costs of creating conditions for stimulating the growth of the ecosystem's assimilation potential can be reflected in total costs.

For the effect in (6) to have a positive value, the rate of profit for the owner of the assimilation potential r_{AP} must satisfy the inequality $k_r > r_{AP}$. The return rate for the owner of the assimilation potential can be brought closer to its limit to stimulate investment activities aimed at increasing the MAL on the ecosystem of the territory (e.g., increasing green areas). If the owner of the assimilation potential is the state, then it can subsidize this activity and reduce its profit rate to zero or negative values. It corresponds to the experience of many countries when ownership rights to the territorial ecosystem's assimilation potential are not specified and its development is carried out through various tools of indirect impact. Among such tools are administratively established standards for sanitary plantings of green spaces, moral and ethical instruments of influence, programs for the conservation and development of biological resources in the territory, etc.

6. Developing evaluation indicators of green investments economic efficiency

The presented assessment of the implementation of green investment projects makes it possible to determine the results of green investments and, separately, environmental policy at the level of the territory and the state. At the same time, in modern conditions of environmental degradation, it is necessary to explore optimal ways to achieve sustainability. New opportunities are opening up in the direction of reducing the emission of mobile and stationary sources to a certain scientifically based safe level, conditioned by the ability of the structural elements of the examined ecosystem to absorb pollutants (Badalyan et al., 2022). In this aspect, environmental policy steps should ensure the maximum reduction of damage from environmental pollution, including the elimination of threats to the life and health of the population in the shortest possible time. To compare green investment projects, whose value and costs vary over time, it becomes necessary to bring them into a comparable form. Below is the analysis of the values and costs of green investment projects.

According to (1), costs represent the financial funds needed at different stages of the *life cycle* of a particular green investment project. The economic value of green investments, expressed by (2), is a resource and benefit that is difficult to fully assess. It can be addressed, among other things, as capital that is difficult to reinvest in other projects (a specific resource that, under certain conditions, gives a significantly higher income in comparison with alternatives).

Solving the complex problem of reducing environmental pollution by mobile and stationary emission sources requires significant capital investments. The existing criteria of economic efficiency do not provide the optimal distribution of financial resources due to the underestimation (as a rule, downplaying) of the results of green investments (Fan et al., 2022; Tong et al., 2022; Malik, 2019). In this regard, and in relation to the conclusions of Section 4, it is advisable to use the proposed approach for evaluating green investments' results, which can eliminate some shortcomings in the distribution of costs between alternative projects.

Due to the often long-term appearance of the results of green investments (after the costs are made), deciding on the effectiveness of green investment projects depends on the choice of the calculation period. Without restricting conditions, the implementation period of the compared projects should comply with the achievement of their main goals and consider their entire life cycle.

The *green* investment projects' net future value for an implementation period T can be represented by formula (7). It is built upon the main indicators of the economic efficiency of investment projects used in world practice (Malik, 2019; Inderst et al., 2012; Gilchrist et al., 2021) in terms of the abovementioned evaluation shortcomings and the proposed approach to the assessment of the economic value of green investments. It enables a fuller reflection of the results of environmental activities.

$$NFV_T = \sum_{t=1}^{T} \sum_{i=1}^{n} (V_{it}(1 + r_{it})^t - C_{it}(1 + r_t)^t) \quad (7)$$

where V_{it} is the i-th type of economic value of green investment project for the period t CU/year, C_{it} is the cost associated with *green* investments and the i-th kind of value for the period t CU/year, T is the duration of the project life cycle, t is the period of implementation of the *green* investment project, r_{it} is the discount (yield) rate for the i-th kind of value in period t, r_t is the discount (yield) rate for the costs associated with the i-th kind of value in the period t and n is a number of economic value types that can be obtained from the *green* investment project.

The return rates of low-risk investment projects can serve as the discount rate for expenses, for example, the return rate on deposits at systemically important banks in the territory or government bonds.

Obviously, from an economic perspective, the most attractive green investment projects should provide the maximum value for the future economic effect. An indicator of investment profitability should additionally be applied to compare the attractiveness of alternative green investment projects

The profitability of green investment (P_{gi}) characterizes the ratio of the value of green investments to the costs associated with them. This indicator demonstrates the economic value of green investment per 1 CU of costs:

$$P_{giT} = \frac{\sum_{t=1}^{T} \sum_{i=1}^{n} V_{it}(1+r_{it})^t}{\sum_{t=1}^{T} \sum_{i=1}^{n} C_{it}(1+r_t)^t}. \quad (8)$$

Formula (8) implies the following rule: an investment decision should be made only when $P_{gi} > 1$.

It is possible to consider the evolution of other well-known indicators in terms of the proposed approach.

It should be noted that the reduction of budgetary costs for green investments (for example, for creating conditions) can be carried out by delegating authority in the implementation of some stages of the green investment project to private organizations. In this case, lower total costs can be ensured due to:

- a more rational use of funds
- reducing the role of state structures to a control function (e.g., when representatives of bureaucratic structures act as an intermediary between the customer and the final contractor)
- reducing opportunities for unfair behavior of stakeholders

Ultimately, the determining factor in choosing alternative green investment projects is the minimization of environmental and economic damage and total costs. An adequate, scientifically based economic assessment of reducing damage (in connection with the considered green investment project) from environmental pollution is also important. The presented indicators of the economic case for green investment projects better reflect the results of environmental protection (in terms of the economic value of reducing environmental pollution damage in the territory and the value of an increase in the assimilation potential and the MAL on the ecosystem). It allows using them as performance criteria for the formation of the territorial environmental policy and solving environmental problems in the territories.

7. Discussion

In a dynamically changing environment, businesses need to find new tools for increasing the efficiency of their activities and making profits. The exhaustion of classic managerial methods' potential and limitations in traditional technologies drive organizations to transform their business processes. Ethical behavior, state-stimulated behavior included, is an important way to increase sustainability at the organizational level as well as at the level of territory (Xiaofeng Li et al., 2022). Corporate culture formation can be a factor in deterring law violations in various territories and stimulating green investments at the same time (Xiaochen Zhang et al., 2022). Big investment projects can also stimulate and attract green investments (Wang et al., 2023). The impact of these and other factors on the formation of the territories' or organizations' development strategies may result in disregarding the semblance of unprofitability of projects. To ensure the long-term sustainability of management objects, the economic feasibility criteria may concede to other criteria and principles. It is especially evident in conditions of limitations in the economic assessment of alternatives. To solve the economic problems, investments can be directed at reducing transaction costs. The use of social media for business communications has shown its effectiveness, especially under limitations related to COVID-19 (Yu et al., 2022). The rise of challenges to territories and their socio-economic systems assumes an adequate answer to ensure sustainability. Such an answer could be technology development, organizational changes, scientific discoveries, big projects, etc. It is necessary to bring the methodology of situational analysis and decision-making closer to the development goal to stimulate these processes. Within the framework of this study, the sustainable development of the territory serves as such a goal.

7.1. Implications

An integral element of effective decision-making is the comparison of alternatives or green investment projects. The determination of the most effective solution from all alternatives must be carried out with consideration of the existing restrictions of the territory. When assessing the total costs of the project's implementation, it is necessary to consider not only the costs associated with the stages of the life cycle but also the total losses, lost profits and opportunity costs in general. The priority of indicators of economic reasoning for green investment projects may change due to the specific features of the territory, restrictions, and limiting factors. It is possible that some types of green investments will act as an opportunity cost for any projects in the territory. The solutions proposed in this study can reduce the errors in the alternatives' evaluation.

7.2. Policy recommendations

To carry out social obligations, the state often has to make decisions that interfere with the economic efficiency analysis results obtained with the use of widespread criteria (Akbulut et al., 2019; Kossova et al., 2016). Recommendations on reducing the limitations of methodology for the efficacy assessment of green investment alternative projects can ensure reduced dependence on conjuncture preferences.

When planning and implementing the big projects aimed at ensuring the sustainability of the territory, it is necessary to consider the total costs of all internal stakeholders (population, business, state and social groups), ecological and socio-economic systems of the territory. It allows for reducing the moral risk of the most influential social groups while estimating the alternatives.

Considering all alternatives and investment directions in accordance with sustainable development components is part of the background for efficient decision-making. When analyzing green investment projects, it is important to assess all possible kinds of economic value components and estimate them adequately for territorial goals. One of the alternatives that is difficult to compare with others is the preservation and advancement of the ecological potential of the territory. The proposed approach to assessing the economic value and economic effect of an increase in the assimilation potential of urban ecosystems can serve as a significant instrument of environmental policy. This approach can also be used for the economic assessment of the consequences of a decline in the assimilation potential of urban territory.

The assessment of indicators of projects' efficiency requires the implementation of compounding, various return rates for different results of green investments and different years of their appearance. It is also essential to consider the projects' entire life cycles. It makes it possible to compare green and other kinds of investments adequately.

7.3 Limitations

The authors acknowledge certain limitations of the presented research, which will be partially solved in further study.

The assessment of the costs and lost profits of the green investment projects is difficult for all stakeholders in the territory and the socio-economic system as a whole. The mixing of stakeholders'

costs can influence the results of the evaluation of green investments. Economic assessment can be complicated by the difficulties of predicting the consequences of green investments in kind.

The difficulties in evaluating the specific damage to population health per pollutant's emission unit in the territory, for example, from motor vehicles, can hinder the implementation of the results of the research (Badalian et al., 2018). The main element of the assessment of the effectiveness of green investments' consequences is the approach to estimating economic damage from environmental pollution. The limitations of the prognosis function in the approach applied in a territory complicate the alternatives' comparison.

8. Conclusions

The underestimation of the results of green investments may be related to the limitations of the methodology and the conditions in the territory. The use of certain types of efficiency to support management decisions in the territory can be a form of unscrupulous stakeholders' behavior in the context of the sustainability. The accounting of the total costs and total results for the system when making decisions will make it possible to reduce the exploitation of the territory by social groups. Instead of evaluating efficiency from the perspective of various stakeholders, it is necessary to assess effectiveness in terms of sustainability and development of the socio-economic system of the territory. In the light of sustainability, the results of green investments should be addressed in terms of their economic value for the socio-economic system of the territory.

An important element in evaluating the effectiveness of green investments can be the use of a compounding procedure. Compounding makes it possible to assess and compare more accurately the change in green investment's value over the life cycle of a project and the alternative return on funds needed for the project's implementation.

The profitability of green investment results can significantly exceed the alternative revenue from financial resources. The use of discounting under these conditions will significantly distort the performance of green investment projects.

In summary, we formulate the main conclusions:

1. Due to the ability of the natural environment to neutralize waste products, the assimilation potential must be considered a strategic resource of the territory and the state. To reduce ecological tension, environmental protection should be based on the properties of natural objects. The green investments should be assessed using scientifically based criteria, the identification of which can be based on the assimilation potential and the MAL of the ecosystem.
2. To rationally select alternative green investment projects, it is proposed to evaluate the results of their implementation using the formula for calculating economic value (2). The use of such a procedure makes it possible to determine the results of green investments in terms of resource, environmental and social parameters of the development of the socio-economic system of the territory.
3. The relation between the emission standards of mobile and stationary sources and the MAL of pollutants on the ecosystem, as well as the fees for the emission of pollutants and the specific costs of the assimilation potential of the ecosystem calculated considering the real assimilation potential of the ecosystem, will make it possible to identify a new type of investment activity, i.e., the use of assimilation potential as an investment object. In order for the effect in expression (6) to have a positive value, the rate of profit of the owner of the assimilation potential r_{AP} must satisfy the inequality $k_r > r_{AP}$. To stimulate investment activities aimed at increasing the MAL on the

ecosystem of the territory (for example, expanding the area of greening), the return rate for the assimilation potential's owner can be brought closer to its limit value. When the state owns the assimilation potential, it can subsidize this type of activity and reduce its profit rate to zero or negative values. It matches the experience of many countries, when ownership rights to the assimilation potential of the ecosystem of the territory are not specified and its development is carried out through various tools of indirect impact. These tools include administratively established sanitary standards for greening, moral and ethical instruments of influence, programs for the conservation and development of biological resources in the territory, etc.

4. The research has proposed an approach to assessing the economic value of an increase in the assimilation potential of the ecosystem. The approach is based on the relationship between the assimilation potential and the costs of the assimilation potential boost, the growth of the MAL on the ecosystem and the economic damage to population health and natural and human-made objects. To estimate the economic effect of an ecosystem's assimilation potential increase, it is also necessary to consider the rate of return for the owner of territorial assimilation potential.

5. Common criteria for supporting investment projects (net present value, profitability of investment) make it difficult to find optimal solutions for green investments due to the underestimation of the environmental activities results. To find effective environmental solutions, the indicator of the economic value of green investments should be used, as it more fully reflects the consequences of the implementation of environmental policy. It will encourage a rational distribution of cash flows between alternative projects. Building an environmental policy based on the presented approach will make it possible to solve the environmental problems of the territory more effectively.

6. The strategy and existing trajectory of development of the territorial socio-economic system are important factors in the formation of the assessment methodology. Directing the goals and mechanisms of development toward the growth and implementation of the human potential influences the increase in the outcome of health damage estimation and increases the demand for green innovations. Personality degradation stimulates the decrease in value of the social (and possibly natural) potential of the territory. It also promotes the economically profitable (under these conditions) exchange of the health and life of the population for less effective (in comparison with nature and human) financial capital. Laid down in the development goals, this contradiction to the sustainability of the socio-economic system in the territory constrains the possibilities of assessment methodology improvement. In our opinion, it is impossible to implement without negative implications for the sustainability of the territorial socio-economic system. Furthermore, the volitional inflating of the relevance of green investments or making decisions despite efficiency assessment outcomes will lead to the buildup of structural problems and a decrease in the sustainability of the socio-economic system in the territory.

There are quite a few developed criteria and decision-making approaches, but the results of evaluating alternative projects based on them may contradict each other. The determination of the most appropriate criterion (or group of indicators) in terms of the transition to sustainable development of a given territory, the assessment of economic damage to the socio-economic system of the territory in terms of its transition to sustainable development, the rate of return on various kinds of economic value and the assessment of the discount rate will be the tasks of future research.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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