Efficiency of regulation of investment activity of an ecological orientation at industrial enterprises

Abstract. Environmental issues are becoming more and more relevant in the modern world. Industrial enterprises play an important role in environmental pollution, and investment in environmental projects is becoming a key strategy to reduce the negative impact. This research paper examines the effectiveness of environmental investment regulation in industrial enterprises and evaluates its impact on environmental sustainability and economic growth.

Modern society is facing the threats of climate change, the depletion of natural resources and the deterioration of the quality of the environment. Industrial enterprises, as one of the largest consumers of resources and sources of pollution, have an important role to play in solving these problems. Investments in environmental projects in industrial enterprises can help reduce the ecological footprint and contribute to sustainable development.

1 Introduction

According to the Kyoto Protocol, signed by Russia in 2005, the national economy of our country should allocate from 5 to 7 billion rubles to eco-efficient investment projects, so the task of finding and selecting the most effective projects is especially relevant, since it is due to limited investment resources and the need to achieve the most significant results.

Investment policy of the Kabardino-Balkarian Republic is aimed at implementing the strategic goals defined by the Investment Strategy until 2034, and first of all, we are talking about environmental safety, which includes mainly the implementation of investment projects that do not have a negative impact on the state of the environment and the use of resource-saving technologies.

Today in the republic there are a number of problems related to the environmental situation:
2 Materials and methods
In our opinion, the use of the “cost/benefit analysis” methodology for the purpose of determining the effectiveness of the economic mechanism for regulating investment activity can be divided into two parts. The first concerns the issues of determining and assessing costs for the design and implementation of investment projects; the second—issues of assessing results, both economic and environmental. It should be noted that the results are in the form of effect and/or effectiveness.

### 3 Results and discussion

Considering the first part of the methodology, we attribute the following to the costs: full (cumulative) costs; marginal costs. The first type—full costs includes all costs for the design and implementation of measures to reduce the level of environmental pollution and/or prevent possible pollution. Full costs are denoted as MAC—marginal abatement cost.

Marginal cost is a concept widely used in the scientific literature and economic research, which reflects the level of increment of investment costs per unit of reduction in the level of pollution of one or more environmental components and can be represented in Fig. 1, where the abscissa shows the costs in monetary units, and the ordinate shows the level of pollution of the environmental component in percent.

It is quite obvious that the marginal cost function, which in Fig. 1 type of MAC, increases as the level of environmental pollution decreases. The magnitude of the change in this function depends for a particular industrial enterprise on the type of technological processes for the production of products, the service life of the equipment—technological, as well as controlling the maximum permissible concentrations and the actual level of emissions and discharges of harmful and polluting substances, treatment equipment.

For a city, the MAC curve, reflecting the growth of marginal costs, depends on the number of industrial enterprises, their location, belonging to industries, the number of environmentally harmful and hazardous industries and their share of eco-efficient industries, and for such a metropolis as St. Petersburg—on the number of cars, degree their physical wear and tear, the number of used car tires.

Thus, the MAC curve in Fig. 1 shows that at the initial stages of the implementation of investment projects of an environmental orientation, there is a reduction in the level of pollution by an amount equal to the segment X₀-X₁. Such a reduction is achieved by relatively small costs for the elimination of the most significant sources of environmental pollution. However, as the level of pollution decreases by 30-40% from the initial level, the change in the MAC curve becomes more significant, since further improvement in the quality...
of the components of the natural environment, as practice shows, requires more substantial investment. According to our understanding, the level of pollution, with any, even fairly high, investment volumes cannot drop to zero.

So, for example, for atmospheric air, this level, designated as $X_2$, corresponds to the maximum purification and is 90-95%. Therefore, when assessing the expected investment costs for improving the quality of any component of the natural environment, one can use the Pareto law, according to which the proportions of 80:20 are established. In the context of the methodology under study, these proportions should be interpreted in such a way that out of the total volume of investment investments, a share of 20% of the initial investment will reduce the level of pollution by 80%, and the next 80% of investments will be able to improve the quality of the environmental component by the remaining 20%. This leads to the conclusion that it is necessary to invest in eco-efficient projects at the initial stages of introducing technologies, manufacturing products that pollute the environment, and we can also formulate a rule: the longer the development and implementation of environmental investment projects is postponed, the more investment will need to be spent to achieve the same results.

In Fig. 1 shows two curves - $MAC_1$ and $MAC_2$, which reflect the dynamics of investment investments in two industrial enterprises - 1 and 2. The different shape of these curves can be explained by the use of different technologies - more expensive and less expensive. There is an opinion that old technologies (MAC curve 2) require significantly higher costs for the implementation of eco-efficient projects, and new ones (MAC curve 1) require less. This is also confirmed by the total total costs, which have the form of the area of figures (a) and (b).

It is obvious that the first - a new industrial enterprise, to reduce the level of pollution of any component of the natural environment from $X_0$ to $X_1$, will need as many total costs as it occupies the area of figure (a), and the second - the old enterprise, to achieve the same result, will need such an amount total costs, which is depicted by the area of the figure (a), and (b), that is, (a + b). And if costs increase, then efficiency decreases, despite...
the fact that the effect determined by $X_0 - X_1$ remains the same for both industrial enterprises. Based on the foregoing, when planning investments, it is necessary to foresee the period during which these investments will be attracted. In real economic conditions, as the development and implementation of an investment project increases, the price of investments will increase, due to the level of inflation. This price, which is called the real price, can be represented as a formula:

$$I_t = I_0 \cdot (1+p)^t$$

where $I_0$ – is the amount of investment required for investments in eco-efficient projects in the initial – zero year, monetary units; $I_t$ – is the amount of investment required for investments in the same eco-efficient project in any year $t$, monetary units; $T$ – duration of the investment project implementation period, including years $t = 0, 1, 2, 3, \ldots, T$, years; $p$ – inflation rate (deflator), percent per year; $t$ - is the number of years counted from the zero year. Hence, we can conclude that it is necessary to reduce the time for investment and development of investments, that projects requiring significant investment should be carried out jointly with public and private sources of financing costs in order to reduce the time and, consequently, reduce the amount of real investment.

The economic mechanism of state control and regulation of investment investments currently provides, for example, preferences only for taxation for the period of actual payback of the project and for two years after this payback. In our opinion, the economic mechanism for regulating investment activities in eco-efficient projects is based only on the existing Federal Law “On Environmental Protection”, in which we divide all methods of economic regulation into several groups. The first group of methods sets limits on emissions and discharges of pollutants and microorganisms, disposal of production and consumption waste and other types of negative impacts on the environment. The second group includes payments for negative impacts on the natural environment, the third group relates to the economic assessment of natural objects and the impact of economic activities on the environment. And only the fourth group concerns tax and other benefits for the introduction of the best existing technologies, non-traditional types of energy, the use of secondary resources and waste recycling, as well as for the implementation of other effective measures to protect the environment.

Consequently, investment activity is regulated by limits and fees for environmental pollution, which are factors aimed at activating the process of attracting and developing investments in eco-efficient projects. Tax benefits do not relate to the degree of innovation or environmental friendliness of technology, but only to the amount of investment. Thus, the need to improve the mechanism of economic regulation is fully justified, since at present the functioning of the economic mechanism is practically not taken into account when compiling state forecasts and strategic directions for socio-economic development based on environmental forecasts, developing federal environmental programs and targeted programs in the field of environmental protection, planning current environmental protection measures in order to prevent possible harm to this environment.

In recent years, investments in environmentally efficient projects in accordance with Article 14 of the Law of the Russian Federation “On Environmental Protection” have been carried out from the following sources: the state budget of the federal and constituent entities of the Russian Federation, environmental funds and environmental insurance funds of two levels - federal and regional, own funds of industrial enterprises, bank loans, voluntary contributions from the population, foreign legal entities and individuals, and other sources.
Information on investments in fixed capital of environmental projects in Russia, the North Caucasian Federal District and the Kabardino-Balkarian Republic, starting from 2000, according to form No. 18-1KS (annual) is presented in tables 1 and 2.

Judging by the amounts of investments in general and by area spending, reflected in the tables, the vast majority of investments in the North Caucasus Federal District, measured in the prices of the corresponding year, were directed to the protection and rational use of land. The remaining funds in insignificant remaining volumes were distributed between two other areas - protection and rational use of water resources and the construction of installations for the disposal and processing of industrial and household waste. And, if in 2000 investments in projects for the protection of atmospheric air prevailed, accounting for 71% and 96% of all investments intended for these two areas, then in 2021 82.5% of investments were invested in the third direction - the construction of enterprises and landfills for waste disposal and processing, neutralization, burial of toxic waste, organization of nature reserves and environmental areas, and in 2021 all funds were also invested in this third direction.

Table 1. Fixed capital investments for environmental protection and rational use of natural resources

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Table 2. Investments in fixed capital directed on environmental protection and rational use of natural resources in 2020 (in actual prices; million rubles)

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And investments in fixed capital aimed at protecting the environment and rational use of natural resources include investments in fixed capital aimed at environmental protection measures carried out at the expense of all sources of financing both in newly built enterprises and in existing enterprises. These include the costs of construction, reconstruction (including expansion and modernization) of facilities, which lead to an increase in their initial cost, the acquisition of machinery, equipment, vehicles, accounting for which is carried out in the manner established for accounting for investments in non-current assets.

The volume of investments in fixed capital aimed at protecting the environment and rational use of natural resources in actual prices is presented in Table 2.

A significant part of the investments was carried out at the expense of the organizations’ own funds, which is a negative point, especially considering the unfavorable economic situation. In terms of the direction of investment, it can be noted that the share of funds aimed at protecting water resources has been predominant in recent years. It is obvious that environmental expenditures need to be increased in order to reduce the negative impacts of human activity on the environment. Of course, in recent years, Russian statistics have done a lot of work to improve statistical monitoring of environmental expenditures, but it must be remembered that the level of demand for environmental expenditure statistics against the backdrop of global environmental pollution is only increasing.

Thus, the main sources of investment in environmental projects are the own funds of industrial enterprises and the budget of the region.

Table 3. Main indicators characterizing the impact of economic activities on the environment by constituent entities of the Russian Federation in 2021

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<td>Water abstraction from natural water bodies for use, mln m³</td>
<td>55,963.8</td>
<td>10,892.6</td>
<td>3254.1</td>
<td>194.5</td>
<td>51.6</td>
<td>116.6</td>
<td>116.6</td>
<td>1331.7</td>
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<td>Recycling and successive use of water, mln m³</td>
<td>145 850.5</td>
<td>900.6</td>
<td>10.6</td>
<td>0.0</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>489.8</td>
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<td>Discharge of polluted wastewater, mln m³</td>
<td>11,579.8</td>
<td>357.7</td>
<td>74.9</td>
<td>0.9</td>
<td>11.3</td>
<td>11.9</td>
<td>0.1</td>
<td>776.2</td>
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<td>Air emissions of pollutants from stationary sources, thousand tons</td>
<td>17,207.7</td>
<td>182.1</td>
<td>11.3</td>
<td>1.9</td>
<td>1.9</td>
<td>47,214.2</td>
<td>47,214.2</td>
<td>47.5</td>
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<td>Air pollutants captured and neutralized, thousand tons</td>
<td>47,214.2</td>
<td>92.6</td>
<td>11.9</td>
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And environmentally oriented investment projects bring environmental results, which, according to the nature of their impact on the state of environmental components, are divided into two types—positive and negative. Negative results manifest as environmental damage. Therefore, the task of evaluating the results of the implementation of investment projects of an environmental orientation is, firstly, in determining changes (increments) in quality indicators, and secondly, in assessing the damage caused to the natural environment by pollution of its components.

In our opinion, for environmental investment projects, instead of assessing the damage caused to the environment, it is necessary to determine the damage prevented. Assessment of environmental damage, including prevented damage, can be made by two groups of methods: market assessment; assessment of physical changes in the environment and its components. The first group—market valuation methods—are used to determine the valuation of qualitative changes in the environment. The second group of methods is based on the valuation of quantitative physical changes—market valuation of physical effects. This group of methods makes it possible to assess the damage caused or prevented, reduced damage as a result of the implementation of an eco-efficient investment project.

Environmental damage refers to the consequences of environmental pollution with solid, liquid, gaseous substances, microorganisms, energy, which have a negative impact on human health, components of the natural environment and the entire socio-ecological system as a whole. The valuation of environmental damage is the economic damage from environmental pollution.

The total economic damage from environmental pollution ($Y$) is an additive value determined by the formula:

$$Y = \sum_1^{11} \sum_1^{00} \sum_1^{33} \sum_1^{az}$$

where

- $\sum_1^{11} \sum_1^{00} \sum_1^{33} \sum_1^{az}$ is the economic assessment of the damage caused to material objects, monetary unit;
- $\sum_1^{00} \sum_1^{33} \sum_1^{az} \sum_1^{00}$ is the economic assessment of damage to the health and life of the population, monetary unit;
- $\sum_1^{33} \sum_1^{az} \sum_1^{33} \sum_1^{az}$ is the economic assessment of damage to the natural resource potential and related industries, monetary units.

To assess economic damage, as well as to determine costs, a limit value is used—a function of the maximum economic damage from environmental pollution ($MD$). This function can, in our opinion, be used to assess the benefits (effect) that are planned to be obtained from the implementation of an environmentally oriented investment project. These outputs have the form of an increment in the quality of the components of the natural environment. Figure 2 reflects the relationship between the marginal damage and the level of environmental pollution (X). Such an image in Fig. 2 clearly represents the relationship between the marginal damage and the level of environmental pollution (X).
The relationship between the marginal damage function (MD) and the amounts of pollutants entering the environment. Thus, the point $X_1$ corresponds to some initial level of pollution and the damage $Y_1$. After the implementation of the environmentally oriented investment project, the level of pollution is planned to be reduced to $X_2$, and the damage to $Y_2$. Then the total or cumulative effect will be equal to the area of figure B. The residual damage after the implementation of the project will be equal to the area of figure C. This residual environmental damage in Figure 2 is located under the marginal damage curve between $X_2$ and $X_0$.

**Fig. 2.** Dynamics of changes in economic damage prevented as a result of the implementation of an investment project

Prevented environmental damage is calculated as the difference between initial and residual damage:

$$B = (C_1 + B) - C_1$$

Thus, the economic effect from the implementation of an investment project is defined as the projection of the area of figure B onto the Y axis and is equal to the difference $Y_1 - Y_2$.

The main quantitative methods for determining the amount of prevented economic damage in the scientific literature are the methods of correlation and regression analysis, the combined method and direct counting. The simplest and most convenient, in our opinion, is the direct counting method, which should be used to assess the actually prevented damage, for example, from contamination of the territory with waste in the form of tires that have expired. However, the direct counting method requires a large amount of initial data obtained as a result of monitoring not only the state of the environment, but also sources of pollution and public health. Therefore, we propose to use the method of integrated calculation for three groups of components - the atmosphere, the hydrosphere and the earth as a territory, based on the development of more advanced methods for determining specific damage standards, which is understood as the level of environmental pollution per unit volume or area of an environmental component.

**4 Conclusion**
The environmental performance of industrial enterprises was collected and analyzed. The study included methods such as questionnaires, statistical analysis and modeling.

Effective regulation plays an important role in stimulating environmental investment. Analysis of existing regulations allows us to identify the strengths and weaknesses of regulatory mechanisms and suggest improvements.

The study identifies the main sources and means of financing environmental investments in industrial enterprises. Specific projects and their impact on pollution levels and resource consumption are analyzed.

The results of the study show the impact of regulation on the volume of investment in environmental projects and their environmental and economic efficiency.

The study allows us to conclude that the effective regulation of environmentally oriented investment activities at industrial enterprises helps to reduce environmental impact and contributes to sustainable development. In addition, it can stimulate innovation and the competitiveness of enterprises.

The study highlights the importance of effectively regulating environmental investment activities in industrial enterprises to achieve environmental sustainability and accelerate economic growth. Practical recommendations include improving regulations and encouraging investment in environmentally friendly projects.

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