

**ICEST 2021****II International Conference on Economic and Social Trends for Sustainability of Modern Society****ASSESSMENT OF THE ECOLOGIZATION EFFICIENCY OF AN  
INDUSTRIAL ENTERPRISE**

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**Abstract**

As an element of sustainable development, the ecologization of industrial enterprises should be based on the introduction of fundamentally new, improved non-waste or low-waste technologies, reducing the formation of pollutants. The article discusses directions of the ecologization of industrial production and the problems of the implementation of these directions. Attention is paid to the following areas: - reducing the share of nature- and energy-intensive sectors of the economy in its overall structure, reorientation of export potential from raw materials orientation; - rational placement of environmentally unsafe industrial complexes, taking into account the environmental sustainability of the territory in relation to man-made impacts; -the introduction of improved energy-efficient, no-, low-waste, environmentally and technologies that contribute to the prevention of environmental pollution by industrial waste. The main directions of the environmental policy of the industrial enterprise JSC "Uralelectromed" operating in the Sverdlovsk region of the Russian Federation are investigated. Based on the analysis of the main directions of ecologization of the production of JSC "Uralelectromed", the investment project on the modernization of the outdated wastewater treatment technology, by replacing the horizontal type settling tank with the reverse osmosis technology and the use of PRAYESTOL 2505 flocculants was proposed. The efficiency of the investment project was assessed and it was concluded that this project would not only improve the quality of wastewater treatment, but also obtain a positive economic effect by reducing energy and time costs, reducing the amount of fines for exceeding the maximum permissible norms for discharges into surface waters.

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## 1. Introduction

The default font for this template is Times New Roman. In modern conditions of countries' transition to sustainable socio-ecological and economic development, it becomes imperative to change approaches to environmental management. The environmental problems that have accumulated over a long period of development of society and the decrease in the assimilation potential of the ecosystem require a radical revision of the guidelines for rationalizing environmental management. Rational environmental management should be based on the introduction of fundamentally new technologies of industrial production, which exerts a colossal technogenic load on all components of the ecosystem. Modern managerial, economic, environmental, technological and other decisions taken at the national level and at the level of industrial enterprises must take into account long-term environmental consequences. The decisions made, in the opinion of Chugunova and Khlobdanova (2016):

Should contribute to the ecologization of industrial production - to minimize the negative impact of industrial enterprises on the environment by the rational use of natural resources and natural conditions, the introduction of improved non-waste or low-waste technologies, the reduction of the formation of pollutants (waste treatment facilities, decontamination of industrial wastes), etc. (p. 169)

The ecologization of the industrial sector should be facilitated by an improved environmental policy of the state and industrial enterprises, aimed not only at reducing the adverse impact on the ecosystem, but also at obtaining an economic effect.

## 2. Problem Statement

The activity of industrial enterprises, which negatively affects all components of the ecological system is one of the main reasons for the deterioration of the quality of the environment. According to expert assessments, industrial enterprises emit more than 200 million tons of carbon oxide and dioxide, 150 million tons of sulfur dioxide and other harmful substances into the air. Discharges into water bodies of insufficiently treated wastewater from industrial enterprises (lead, mercury, cadmium, oil products, synthetic surfactants, etc.) have a negative effect on the hydrosphere. As a result of the activities of industrial enterprises, heavy metals and chemicals (nitrogen, phosphorus, potassium, etc.) get into the soil, which ultimately leads to erosion, salinization and other negative consequences (Belik et al., 2019).

Environmental problems require their immediate solution, through the ecologization of industrial production. According to Tikhonova (2011): "Greening production processes is a steady and consistent introduction of technical, technological, organizational measures that increase the efficiency of consumption and use of natural resources, while reducing environmental pollution by emissions, effluents, wastes" (p. 268).

Greening the industrial sector of the economy is constrained by a number of economic factors. These factors include high capital intensity and long payback periods for investment projects related to ecologization of production. This significantly reduces the economic interest of the owners of industrial enterprises to channel financial resources to the implementation of such projects. In addition, a negatively

influencing factor on the ecogization of industrial enterprises is the low degree of state participation in financing investment projects aimed at ecogization of production. This is evidenced by the data of official statistics: the total amount of funding for the national project "Ecology" for 2019-2024. is 4 trillion. rub. of which only 1 trillion. rub. are budget funds (700 billion rubles - federal funds, 300 billion rubles - regional), the remaining 3 trillion. rub. are extrabudgetary funds. Thus, the share of state financing of investment projects aimed, among other things, at the ecogization of production accounts for only 25%, the remaining 75% are the own financial resources of industrial enterprises.

### **3. Research Questions**

During the research, the following questions were highlighted:

- What are the main directions of ecogization of industrial production?
- What is the experience of ecogization of production at the industrial enterprise JSC "Uralelectromed"?
- What is the effectiveness of the proposed investment project to reduce discharges of pollutants using the example of JSC "Uralelectromed"?

### **4. Purpose of the Study**

The purpose of this study is to assess the effectiveness of an investment project to reduce discharges of pollutants as one of the directions of an industrial enterprise ecogization using the example of JSC "Uralelectromed".

### **5. Research Methods**

The authors used universal methods of scientific research, as well as the method of expert assessments and the method of strategic analysis.

#### **5.1. The main directions of greening industrial production**

In the process of industrial production ecogization, several fundamental directions are distinguished. Firstly, it is a comprehensive, environmentally-motivated, long-term oriented structural reformatting of the economy. This can be achieved by reducing the share of nature and energy-intensive sectors of the economy in its overall structure, as well as reorienting the export potential from raw materials to increasing the share of deep processing products on the territory of our state.

Secondly, the territorial distribution and growth of environmentally unsafe industrial complexes must be carried out taking into account the environmental sustainability of the territory with respect to man-made impacts and not overload these territories with an excessive concentration of nature-intensive industries.

Thirdly, according to Malysheva and Shinkevich (2020): "Prevention of environmental pollution by industrial waste (cleaning of emissions, discharges, decontamination of industrial waste, etc.) is not possible

without the introduction of improved energy-efficient, non-waste, low-waste, environmentally friendly equipment and technologies" (p. 76).

## **5.2. Experience in ecologization of production of the industrial enterprise JSC "Uralelectromed"**

The industrial enterprise JSC Uralelectromed, operating in the Sverdlovsk region, is the parent enterprise of the Ural mining and metallurgical company. The enterprise is one of the largest producers of copper cathodes, which are in demand not only in the Russian Federation, but all over the world. In addition, it produces gold, silver in ingots, copper electrolytic powders and products based on them, copper sulfate, sulphate nickel, selenium, tellurium, platinum group metals concentrate, lead grades C0 and C1, and provides services for hot-dip galvanizing of metal structures.

Over its almost 90-year history (it has been operating since 1934), the enterprise exerts a huge man-made load on all components of the environment, which significantly aggravates the ecological situation in the Sverdlovsk region, which for a number of years has been ranked among the last in the ranking of the ecological well-being of Russian regions.

One of the directions of the environmental policy of JSC "Uralelectromed" is the ecologization of production through the modernization of outdated equipment, the introduction of resource-saving technologies, the installation of modern waste treatment facilities, the arrangement of sanitary protection zones, etc.

Ecologization of production of JSC "Uralelectromed" yields positive results. Thus, over the past 10 years, the total volume of emissions has been reduced by more than three times. Today, the specific emissions of sulfur dioxide are just over 13 kg per ton of manufactured products, and the average European level is 42 kg per ton of blister copper.

To reduce emissions of pollutants into the atmosphere in 2016, the company installed highly efficient sack filters, which made it possible to increase the reliability of the gas cleaning complex as a whole.

In recent years, in the copper-smelting workshop, the enterprise has carried out a technical re-equipment of the gas-cleaning complex of the anode furnace, the purification rate of which is 99.8%, and the amount of dust collected is 600 tons annual. The project cost was 43 million rubles. In 2014 - 2016 the electrostatic filters of the chemical and metallurgical workshop were modernized. The degree of purification there now is 99.7%.

One of the significant environmental problems created by the enterprise is the discharge of wastewater with a high content of chemical substances into Lake Klyuchi, the waters of which flow into the Kara Sea. In recent years, due to annual reductions in discharges into surface waters and modernization of the plant's equipment, the quality of the water in the lake has improved, but remains unsatisfactory. This indicates that the enterprise does not provide complete treatment of the waters discharged into the lake, for which it pays large amounts of fines (more than 7 million rubles per year).

As for production wastes, the analyzed enterprise keeps a strict record of their generation, placement and transfer for processing. The total volume of recyclable waste is 80%. Solid waste of JSC

Uralelectromed is not subjected to further complete processing, but is stored at landfills, which significantly worsens the environmental situation in the region where it is located.

### **5.3. Evaluation of the effectiveness of the proposed investment project to reduce discharges of pollutants of JSC "Uralelectromed"**

To reduce the negative impact on water bodies, to reduce the amount of fines for the discharge of harmful substances in excess of the MPD and to obtain a positive economic effect, recycling of effluents has been proposed.

At present, JSC "Uralelectromed" uses horizontal water sedimentation tanks. However, this does not have a positive environmental impact. Thus, the existing method of industrial waste treatment requires ecologization and improvement (Zhidko & Mushtenko, 2016).

In our opinion, it is advisable for the enterprise to modernize the outdated wastewater treatment technology by replacing the horizontal type tanks with reverse osmosis technology and using PRAYESTOL 2505 flocculants. This will improve not only the quality of wastewater treatment, but will also give a positive economic effect by reducing energy costs and time, reducing the amount of fines for exceeding the maximum permissible norms for discharges into surface waters.

The proposed investment project to reduce discharges of pollutants from JSC "Uralelectromed" will cost the company about 20 million rubles. The expected revenue is the averted environmental and economic damage. Considering the speed of cleaning Lake Klyuchi and the equipment power, the payback period of the investment project will be about 10 years. Here are the results of the investment project calculation.

To calculate the investment project, a discount rate of 12% was applied. The rate is determined taking into account the key rate of the Central Bank of the Russian Federation (4.25) and the inflation rate (5.2).

Initial data for the proposed investment project are shown in Table 1.

**Table 1.** Initial data on the investment project

Planned indicators	Plan	Expenditures and avoided environmental damage
The amount of funds invested, mln.rbl.	20.0	For the discharge of harmful chemicals not exceeding the MPC - 424110,66 rbl.
Project implementation period, years	10	For the discharge of hazardous chemicals exceeding the MPC -7 mln. rbl. per year
Discount rate, %	12	
Cash flow (income from project implementation), million rubles, incl. annually	60.9 6.09	Current cost: Operating cost on cleaning is 0,83 mln. rbl. per year; workers' salary is about 500 000 rbl. per year

Taking into account the amount of fines of JSC "Uralelectromed" for the year - 7.43 million rubles, for 10 years the introduction of a new technology of reverse osmosis, worth 20 million rubles. will prevent environmental and economic damage in the amount of 60.9 million rubles.

Table 2 shows the calculation of the present value for the proposed investment project.

**Table 2.** Calculation of the present value for the investment project

Years	Future cost of the cash flows, mln.rbl.	Discount ratio, $r_1 = 12\%$	True value, mln.rbl.
1	6.09	0.89	5.45
2	6.09	0.79	4.84
3	6.09	0.71	4.33
4	6.09	0.63	3.86
5	6.09	0.57	3.47
6	6.09	0.50	3.08
7	6.09	0.45	2.75
8	6.09	0.40	2.45
9	6.09	0.36	2.21
10	6.09	0.32	1.95
TOTAL	60.9	-	34.39

Net discounted value (NDV) on the proposed investment project amounted to 14.39 million rubles. (34.39 - 20.0).

The profitability index, showing the investor's profit for each ruble invested by him, will be 1.72 (34.4 / 20.0).

The payback period of the project will be 5.83 years (20.0 / 3.43). The actual amount of the project's net present value (NPV) will be 19.4% ( $12 + (20 - 12 / 14.39 + 1.27) * 14.39$ ).

The final indicators for assessing the effectiveness of the proposed investment project are presented in table 3.

**Table 3.** Final indicators for assessing the effectiveness of the project

Project indicators	Criterion value	Target value
Net discounted value, mln.rbl.	>0	14.39
Profitability index	>1	1.72
Payback period, years		5.83
Actual net present value, %	> $r_1=12\%$	19.4

Thus, the recommended investment project to modernize the outdated wastewater treatment technology, by replacing the horizontal type settler with reverse osmosis technology and the use of PRAYESTOL 2505 flocculants is profitable.

## 6. Findings

### 6.1. Directions of industrial production ecologisation

The research of the directions of industrial production ecologisation made it possible to highlight the fundamental:

- reduction of the share of nature- and energy-intensive sectors of the economy in its overall structure, as well as reorientation of the export potential from raw materials;

- rational placement of environmentally unsafe industrial complexes, taking into account the environmental sustainability of the territory with respect to man-made impacts;
- introduction of improved energy-efficient, non-waste, low-waste, environmentally friendly equipment and technologies that contribute to the prevention of environmental pollution by industrial waste (purification of emissions, discharges, disposal of industrial waste, etc.).

However, according to Khetsuriani et al. (2018): “the implementation of these areas is constrained by economic factors - high capital intensity and long payback periods of investment projects related to the ecologization of production” (p. 20).

## **6.2. Directions of ecologization of the production of the industrial enterprise JSC "Uralelectromed"**

Having studied the environmental policy of JSC "Uralelectromed", we can conclude that the company is environmentally oriented. Ecologization of production is carried out at the enterprise through the modernization of outdated equipment, the introduction of resource-saving technologies, the installation of modern waste treatment facilities, the arrangement of sanitary protection zones, etc.

However, all these measures are not enough, since the technogenic load on the environment remains quite high. Despite the decrease in emissions of pollutants into the atmosphere, the volume of industrial waste with a high content of chemical substances discharged into Lake Klyuchi remains high. This indicates that the enterprise does not provide complete treatment of the waters discharged into the lake, for which it pays large amounts of fines (more than 7 million rubles per year).

## **6.3. Evaluation of the effectiveness of the proposed investment project to reduce discharges of pollutants of JSC "Uralelectromed"**

Conclusions can be drawn after evaluating the effectiveness of the investment project to reduce the discharges of pollutants by JSC “Uralelectromed”. The proposed project is cost-effective. It will not only help minimize the expenditures of the enterprise on the payment of fines for exceeding the maximum permissible norms for discharges of pollutants into Lake Klyuchi, but also contribute to the ecologization of the production of JSC “Uralelectromed”. Ecologization of production, according to Glukhov et al. (2018) “will give a reputation effect that enhances the company's image as a socially responsible market participant” (p. 50). This will not only increase the company's chances of receiving additional financial support from the state (tax incentives, subsidies, government loans, guarantees, etc.), but also reach a qualitatively new level that meets global environmental requirements. This will facilitate access to new world sales markets, which will lead to an even greater economic effect.

## **7. Conclusion**

The conducted research has shown the relevance of the issues of rationalization of environmental management and the ecologization of industrial production.

It is possible to ensure the transition to sustainable socio-ecological and economic development by minimizing the negative impact of industrial enterprises on the environment through the rational use of natural resources and natural conditions, the introduction of improved non-waste or low-waste technologies, reducing the formation of pollutants (treatment facilities, decontamination of industrial waste) and etc.

The investment project proposed for JSC “Uralektromed” on modernization of the outdated waste treatment technology, by replacing the horizontal type settler with reverse osmosis technology and using PRAYESTOL 2505 flocculants, is aimed at ecologization of its production. It will allow not only to improve the quality of wastewater treatment, but also to obtain a positive economic effect by reducing energy and time costs, reducing the amount of fines for exceeding the maximum permissible discharge rates into surface waters.

The practical significance of the work lies in the possibility of applying the proposed recommendations in the formation of the environmental strategy, as well as a methodology for assessing its effectiveness at industrial enterprises.

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