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Review Paper

Ecological and Economic Assessment of the Possibilities of Public-private Partnerships at the National and Local Levels to Reduce Greenhouse Gas Emissions

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ABSTRACT

The issue of reducing greenhouse gases is of concern to the international community, as the possibility of an environmental catastrophe in the next ten years is becoming more and more real. Therefore, the search for effective tools to regulate, control and monitor private sector activities is a pressing issue. The use of restrictions is ineffective and contributes to slowing down economic development. From this perspective, the importance of the study lies in the qualitative means of building a public-private partnership to address greenhouse gas issues. The importance of the article is due to the need to find mutually beneficial compromises between the state and the private sector to achieve global strategic goals. The article aims to study the environmental and economic feasibility of building an effective model of private-public relations in the area of greenhouse gas emissions reduction. Control over the private sector should be enshrined at the national level, and specialized decentralized public authorities should be established to monitor the activities of the corporate sector. The article focuses on the current environmental situation in European countries and Ukraine and outlines the most efficient model of interaction between private and public relations to overcome negative environmental consequences. The main tasks are to find optimal solutions for the functioning of the private sector and possible government intervention while minimizing negative economic consequences.

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The research methodology involves disclosing the theoretical and methodological foundations of public-private partnerships, conducting statistical analysis of environmental threats, and determining the most appropriate model of public-private partnerships. The results of the study can improve the interaction of public administration with the private sector, as well as create the most effective model of their interaction under internal socio-economic and geopolitical circumstances.

HIGHLIGHTS

- The article analyzes the environmental situation of European countries and Ukraine and outlines an effective model for overcoming negative environmental consequences.
- The theoretical and methodological principles of public-private partnership, statistical analysis of environmental threats and determination of the most acceptable model of public-private partnership are outlined.

Keywords: Public-private partnership, environment, public administration, corporate sector, ecology, greenhouse gases

The issue of greenhouse gas emissions is a global problem in the world, as it is one of the key threats to the existence of natural resources posing a threat to the existence of humanity. If the rate of greenhouse gas emissions continues, humanity will face global environmental shocks such as warming, uncontrolled migration, and the emergence of areas uninhabitable for life. Under such conditions, there is a need to develop an effective public-private sector policy that could control the destructive processes of industrial enterprises. Moreover, regulating their activities is a key task not only for a single country but also for the international community as a whole.

The private sector is the main source of air pollution and the object of production of harmful substances that are synthesized into a greenhouse gas. Therefore, to address global environmental issues, control and monitoring policies should be implemented. Building a public-private partnership can not only restrict business, but also help create an effective mechanism for ensuring the development of the country's economy by attracting investment, creating new product markets, and increasing corporate social responsibility. This, in turn, will result in positive social consequences.

The functioning of public-private partnerships is used in developed EU countries, which manage to partially overcome the negative impact of greenhouse gas emissions, but the danger remains significant. For the domestic space, it is necessary to form a regulatory framework, since the legal nature of regulating the private sector is a prerequisite for ensuring the country's economic policy in the field of reducing greenhouse gas emissions. To achieve these goals, the development of a master plan, as well as the use of decentralization and the creation of specialized institutions, can help improve the quality of implementation of the international community's priority goals. In addition, the issue of greenhouse gases can help attract additional funding, which creates economic space for the state's policy of interaction with the corporate sector of the economy. From this perspective, conducting a study is important for achieving an environmentally sustainable situation and ensuring economic development.

Literature Review

The development of public-private partnerships at the national and local levels is important in the implementation of environmental policy, as it can improve the living standards of the population, create high-quality effective conditions for the development of commodity markets, and help attract investment. Moreover, modern scientific views on public-private partnerships are subject to discussion and selection of the most appropriate model for its implementation. According to Bazzanella, 2017, it is necessary to introduce the use of the corporate sector to achieve the economic and strategic goals of the state, as it can reduce the bureaucratic burden and decentralize the management of the implementation of the environmental vector of the state. Dilkes-Hoffman, 2019 agrees with this, as public-private partnerships in any form have beneficial consequences for any state, as they can address the problem in more detail. Zaloznova, 2016 identifies the key disadvantages of public-private partnerships as the fact that with the participation of the state in the environmental environment, strict regulation of the policies of industrial enterprises or their participants

is possible. To overcome the negative consequences of public-private partnerships, Rezaei, 2019 suggests using effective models of cooperation based on the example of EU countries, where the prerequisite for the development of public-private partnerships is the development of regulatory and legal legislation.

In 2022, Prokopenko and the authors studied the economic features of the use of electric vehicles in delivery services in Estonia, which can be applied to Ukrainian realities By using such approaches, the continuous functioning of the economy can be ensured. Lutkovska, 2020 believes that the issue of greenhouse gas emissions is an acute issue for the international environment, as it concerns the global environment, not individual countries. According to Mishenina, 2017, the importance of corporate sector participation in international projects, as well as government participation in these processes, is a catalyst for the development of the country's investment climate, as well as strengthening the country's brand in the international arena. Under such conditions, the specifics of public-private partnerships at the national and local levels play a key role in reducing greenhouse gas emissions. It is necessary not only to study the methodology for implementing such interaction but also to create an economic environment that could function in the face of global challenges. Zheng, 2019 believes that the war in Ukraine is destroying the domestic ecological state and has negative consequences for the world community, as a significant number of destroyed industrial enterprises and increased emissions of harmful substances negatively affect the situation globally. Margasov and his team, 2022 studied the importance of greening production as the main direction of ensuring the sustainability of the production activity of enterprises and considered increasing their economic security.

In 2019, Kasych and a team of authors developed modern management tools for the sustainable development of mining enterprises, and Pinchuk and the authors 2019 proposed various implementations of elements of the circular economy in mining regions. Berezyuk, 2019 agrees with this and believes that in the context of geopolitical threats, the issue of corporate sector integration both in cooperation with the state and participation in international projects can become a key factor in the development of ecology and ensure the safe existence of humanity in the long term. According to Rossiter, 2019, the world's biggest problem is stratospheric damage due to greenhouse gas emissions, as well as the lack of attention of the international community to the existing problem, because by the 2030s, at the current rate of emissions and damage to the biosphere, the number of natural resources may decrease by 10-12%, which poses a key threat to the world. The industrial sector is the main factor in the environmental damage caused by greenhouse gases. Shpak with a team of authors, in 2022 studied macroeconomic indicators and CO_2 emissions in EU regions and analyzed the most polluted regions of the world for CO_2 emissions and their macroeconomic indicators. Therefore, the issue of state involvement and regulation of its activities should be implemented under public monitoring and control bodies, which will help to solve this problem. In 2022, Margasov's team of authors proposed modeling the harmony of regional economic development in the context of sustainable development. Nekrasenko and co-authors, 2015 justified the proposal to introduce a carbon tax as the main tool of environmental management in Ukraine. Prokopenko and the team, 2020 propose an adaptation to the development of ecological entrepreneurship. In 2013, Prokopenko and Kasyanenko developed a comprehensive approach to scientific substantiation when choosing an eco-oriented option for innovative development at different levels of management.

Research Aims

The research is aimed at identifying effective tools for establishing public-private partnerships to reduce greenhouse gases in the context of aggravating environmental problems and geopolitical challenges. The analysis of the current state of the atmospheric air due to greenhouse gas emissions indicates the need to strengthen the role of state influence in the activities of the private sector. It is necessary to build a cost-effective model that could contribute to economic development while avoiding the negative effects of bureaucratic processes. Using such approaches, building public-private partnerships is a key principle for the international community. The research focuses on the search for effective tools for establishing cooperation between the corporate and public sectors, since using such approaches

can not only solve environmental issues but also promote economic development. Implementation of high-quality greenhouse gas emission controls is a priority for the international community. The results of the study characterize the basic economically beneficial principles for establishing the work of the public and private sectors, which is the main objective of the study in the article.

Methods

The study was conducted using scientific research methods, which involves the method of synthesis and analysis, with the help of which a statistical analysis of air pollution in European countries was carried out. Based on open data, the analysis was conducted among the most naturally rich countries - Scandinavia and the largest industrialized countries. It has been determined which tools have been used by the EU countries to partially solve the problem of greenhouse gas emissions. For Ukraine, in the context of war, the data on the content of solid, toxic, and harmful substances in the air, as well as the share of greenhouse gases, have been studied. Based on these results, a model for building a public-private partnership that considers the economic factor of development and strengthening the social responsibility of the corporate sector is built using the method of deduction and induction. The methodology of the work involves drawing analogies of state policy-making in the development of an effective system of management and monitoring of industrial enterprises, which are a key source of pollution, based on the use of foreign experience. The use of the method of abstraction and systematization made it possible to build the key principles of public-private partnerships used by the public sector of developed countries to establish cooperation with the private sector to ensure long-term strategic goals. The proposed methodology can be implemented for countries wishing to improve the environmental situation in the country, as well as to apply an effective mechanism for building economic space and attracting investment. The article uses a methodological approach to ensure and disclose the essence of public-private partnership, which provides for mutually beneficial terms of cooperation, as well as to assess the economic effect and search for positive consequences of such partnership. Approaches to building public-private partnerships can not only improve the quality of the state's policy in addressing environmental and economic issues but also create positive social impacts from the integration of the private sector into state projects. The study, by synthesizing modern practices of states, proposes to use an effective model that could not only realize the country's environmental goals but also create high-quality business conditions for industrial enterprises and business organizations involved in the supply of environmental infrastructure elements and special equipment.

RESULTS

The issue of ensuring clean air and mitigating the effects of the industrialization of society plays a key role. Moreover, the development of the industrial complex, the spread of the problem of servicing adjacent territories, and the increasing role of raw material extraction to ensure the functioning of the corporate sector are factors that require strengthening state control over the environmental situation in the country. In European countries, the issues of interaction between the state, special organizations, and local governments are closely integrated and work to ensure the filtering of harmful emissions, and investment projects are being developed at the state level to ensure regulatory and legal regulation, as well as economic incentives to reduce greenhouse gas emissions.

For instance, in Ukraine, the war forced most businesses to suspend operations, which led to an almost threefold reduction in the economy and shut down most industrial enterprises located in the East of the country. However, despite the high level of pollution reduction, in 2022, addressing the issue of public-private partnerships to establish quality interaction between key stakeholders may be key, as it is through the use of such means that the most appropriate and effective ways to minimize the effects of war and the impact of the industrial sector can be created.

The concept of public-private partnership implies close interaction between the corporate sector of the economy and the use of financial resources and fruitful cooperation to improve the environmental situation. Besides that, the development of public-private partnerships can not only improve the quality of environmental development but also

increase the level of the economy and create new jobs due to the emergence of new commodity markets. The importance of forming a public-private partnership in the context of modern development should also include a clear regulatory framework, as the regulation of environmental policy is a strategically important factor in times of war. In 2022, a significant part of the soil and industrial enterprises was destroyed, which created the problem of an environmental disaster in Ukraine. The development of such events in the future may lead to crises, as they may lead to a deterioration of the environment, which will be unfavorable for future life in the post-war period.

The development of domestic public-private partnerships involves several aspects of its implementation: strengthening corporate social responsibility, attracting investment resources, creating new jobs, and overcoming the negative economic consequences that have arisen since the outbreak of war in Ukraine. According to the statistics of the Ministry of Environmental Protection and Natural Resources of Ukraine, the number of harmful substances in the air is as follows:

- suspended particles (dust) - 49.6 μg/m^3 (maximum permissible concentration - 500 μg/m^3);
- dust fraction of 2.5 microns (PM2.5) - 45.2 μg/m^3, dust fraction of 10 microns (PM10) - 48.0 μg/m^3;
- nitrogen dioxide - 16.6 μg/m3 (MPC - 400 μg/m^3).

The share of nitrogen dioxide has significantly decreased compared to 2021, as the average monthly concentration in May 2022 was only 4.8% of the same as in 2021. The decrease in the share of air pollution in Ukrainian cities is due to the massive shutdown of the industrial sector, as well as a decrease in the number of road transport. However, the prospects for air quality should be regulated by the state and supervised by specialized monitoring bodies. Although the level of harmful emissions has become significantly lower, there are still problems with the spread of harmful substances due to the toxicity of ammunition, damage to soil cover, etc. Under such conditions, there is a problem of finding an effective mechanism for state interaction at the regional level, to reduce not only the consequences of the war but also to stabilize the environmental component of the regions both during the war and in the post-war recovery.

To improve the environmental situation in Ukraine, it is necessary to use effective mechanisms for the development of domestic state and investment policy, and the most attractive measures to achieve the goals. In such circumstances, it would be most appropriate to introduce the European experience into the Ukrainian space. European countries have several authorities that regulate greenhouse gas emissions and the negative effects of industrial activities. For example, in the Baltic States, Germany, and France, there is an extensive system of self-government bodies that monitor the air quality and are also authorized to monitor the quality of corporate sector activities by region. In Ukraine, the role of local governments has been significantly weakened by the war due to the forced displacement caused by the war. In addition, given the importance of planning for infrastructure reconstruction in the post-war period, it will be of key importance. Therefore, the involvement of the country's corporate sector should be implemented according to the EU model, which uses financial incentives to use and improve the quality of service for industrial enterprises. Preferential lending terms should be introduced for companies that use environmentally friendly equipment, safe waste disposal should be mandatory, and transparent reporting should be made available and registered on internal government portals. With this approach, the ability to control and ensure the quality of public policy implementation in Europe is subject to close cooperation between the corporate sector and the state. Table 1 shows statistical data on air pollution in European countries over the past year, with the average, minimum and maximum values.

The data in Table 1 shows that in European space there is a moderate level of particulate matter in the air, and the amount of greenhouse gases is significantly lower than the norm of 50 μg/m^3. The most positive indicator is observed in the Scandinavian countries, which is partly due to natural climatic resources, as the availability of natural and recreational resources affects air quality. However, despite the natural advantages of these countries, it is important to have a government policy to minimize damage from industrial enterprises, as well as clear regulation of the corporate sector,

as the use of such means can improve not only the formation but also ensure the long-term sustainable development of natural resources. Such results are achieved primarily through strict regulation of the supply of equipment used for manufacturing, processing of raw materials, heavy metals, etc. At the state level, a law has been passed on the use of environmentally friendly vehicles. Moreover, industrial enterprises should use special environmental equipment, modernized waste disposal equipment, and contain some modern filters to reduce greenhouse gases.

Table 1: Average air pollution concentration in European countries in 2022, μg/m^3

Country	Average annual concentration of fine particles (PM 2,5)	Highest/lowest rate
Estonia	18	30/9
Finland	20	32/13
Sweden	22	28/14
Norway	24	50/8
Poland	36	89/20
Germany	25	41/9
France	26	65/9
Belgium	34	46/17
Romania	35	51/19
Spain	30	85/8

Source: *Compiled based oni Eurostat*

An important common feature for European countries is not only the strict regulation of the internal policy of industrial enterprises regarding activities that pose a potential danger to the environment but also directly affecting the broad interaction between the state and the work of this segment of enterprises. The state policy is aimed at ensuring the participation of corporations and enterprises in their environmental investment projects, the need for regular reporting, and the creation of appropriate supervisory bodies. In addition, the use of environmentally friendly technologies improves the company's brand, which is widely discussed in the media and the information policy of countries. International organizations that monitor the level of environmental conditions on the European continent and how the greatest pollution occurs in the European space pay great attention to this issue. The issue of greenhouse gases is one of the key areas of discussion between organizations such as the UNDP, the World Wildlife Fund (WWF), the International Union for Conservation of Nature (IUCN), and many others. Based on their activities, important legal acts are created that can stimulate the attention of local municipal authorities to the problems of a particular region. The environmental situation in Europe remains uneven, as there are some areas where the presence of industrial enterprises significantly exceeds the norm, as shown in Table 1, where there is a significant imbalance between the minimum and maximum air pollution values.

Based on European experience, Ukraine or countries with environmental problems and high levels of air pollution should strengthen the integration of the corporate sector with the public sector in the policy of reducing greenhouse gas emissions. The economic effect will help attract investment resources for the country, build a quality brand, and ensure a high birth rate, which is a problem in Europe, as well as in Ukraine, due to the demographic situation. Thus, reducing greenhouse gas emissions as a tool to achieve the goal of ensuring a positive demographic situation due to a high standard of living is one of the state's priorities. For this purpose, based on the European experience, it is proposed to use the following model of public-private partnership, which is shown in more detail in Table 2.

The proposed model of private-public sector interaction can create an effective policy to ensure socio-economic development and improve the environmental condition of local areas. Moreover, it can be used for any country that needs to optimize its public policy in the area of greenhouse gas emissions reduction. This also applies to countries with a high level of industrial presence, due to the presence of natural resources or a high population concentration. For this purpose, it is worth developing a technological sector that can provide high-quality technologies for filtration, utilization, and modernization of existing industrial equipment used in production to more modern ones. Through their use, it is possible to create the most appropriate means of managing and using such tools, since it is based on such technologies that further commodity markets are formed. Despite the effectiveness of the model, it can be varied following the regulatory and legal policy of the state, its strategic goals, etc.

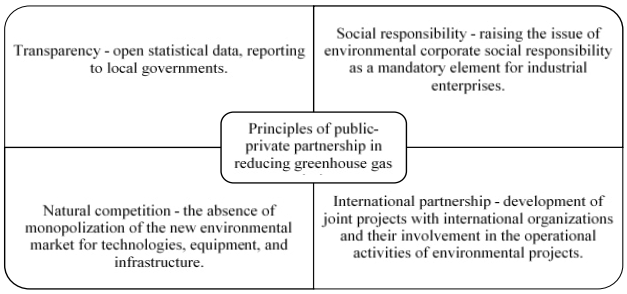
Table 2: A model of public-private partnership interaction at the national level

Private sector	**Public sector**
Functioning	
Offering specialized products and services that can improve the environmental state of the air and reduce the amount of harmful greenhouse gas emissions. Using existing technologies and operating following regulatory and legal frameworks, as well as developing more modern and upgraded filtration equipment, sewage treatment plants, etc.	Performing monitoring, control, and legal interaction functions through specialized authorities.
Financing	
Opportunity to receive additional grants, use funds from international donor organizations, and facilitate the attraction of additional funding to participate in joint domestic regional projects or at the international level. Strengthening the role of environmental business, creating new product markets, and enhancing the role of international technology markets to ensure green air.	Delegation of part of the financial costs to the corporate sector, reduction of the budgetary burden, and improvement of the model of state participation in greenhouse gas reduction.
Joint projects	
Formation of the direction of environmental activities of the enterprise or organizations following the strategic goals of the state, broad integration of the corporate sector into a common policy with the state. Establishment of cooperation with local governmental authorities to regulate, control and monitor greenhouse gas emissions and address environmental issues.	Creation of state investment projects to support the corporate sector and provide grants. Use the infrastructure of the authorities - local supervisory bodies - to improve communications on environmental issues of air pollution.
Advantages and disadvantages	
Advantages: strengthening the company's image, obtaining additional financing, a variety of preferential lending through financial institutions, participation in international and domestic environmental projects, and opening new commodity markets and business areas. ***Disadvantages:*** the growing role of the state in environmental issues, corruption issues, the formation of monopolized commodity markets, and imperfect regulatory and legal framework.	***Advantages:*** the possibility of qualitative control over the current state of the environmental situation, as well as the search for tools to improve it based on statistical data, as well as increasing the efficiency of the implementation of state projects, and shifting partial responsibilities to the private sector. ***Disadvantages:*** increased government involvement in environmental issues, as well as the difficulty of building an effective system of interaction between local governments and the corporate sector. The need to create several institutions and departments to monitor the effectiveness of public-private partnerships.

Source: *Compiled by the author.*

However, in such conditions, it is essential to use the principles of construction that can be taken as a constant in the development of the private-public sector, since the formation and use of such principles can help to achieve success in communication between the state and the corporate sector. The main principles by which a public-private partnership should be formed are shown in Fig. 1.

Four principles, namely social responsibility, transparency, natural competition, and international partnership, should be the basic principles for developing a public-private partnership policy. They can help to achieve a positive economic effect, which consists of attracting investment, and creating and developing a new source of the economy. Moreover, they will also help to improve the quality of the demographic situation, which in the long run may become one of the most important issues in Europe and Ukraine.



Source: *Compiled by the author.*

Fig 1: Principles of effective public-private partnership in reducing greenhouse gas emissions

The issue of reducing greenhouse gases is regulated mainly by international organizations and creates effective means of interaction between states. This is because the damaged stratosphere is not localized but can spread to other regions. Therefore, most developed countries are interested in reducing greenhouse gas emissions, as they have a real impact on the global economic situation and can provide financial support. A corporate sector is a tool for ensuring the state's environmental policy strategy, which should be stimulated primarily through the use of effective means of financing, cooperation, preferential lending, etc.

A prudent policy to reduce greenhouse gases can be a key to developing the future potential of developing countries. In the Ukrainian context, it is crucial to make balanced decisions not to harm business operations during wartime. However, it is worth starting to create a rational program that will have an economic and social effect in advance.

DISCUSSION

The results of the study indicate the potential danger of an environmental catastrophe in European space. Although the level of pollution in European countries is at a controlled level, due to increased militarization, the growing influence of industrial enterprises in the energy sector, and the disposal of hazardous waste, the issue of further regulation of greenhouse gas emissions should be carried out based on effective tools. Among them, the involvement of the corporate sector in the strategic policy of the state is promising. In Ukraine, the situation remains unfavorable due to significant damage to natural resources and the destruction of industrial facilities that contain a significant amount of toxic and harmful substances that pose a threat to the environment. Therefore, the use of public-private partnerships is a prerogative for any country that needs to improve its environmental situation and contribute to the international program of ensuring an environmentally friendly future.

Prospects for further research should include, first of all, an analysis of internal statistical data on industrial enterprises, how filtration equipment is used, how it can create new product markets and a business line that will be useful primarily for the corporate sector, and how the state can support it. Furthermore, the information component on investments in environmental projects and financing of organizations involved in reducing greenhouse gas emissions may become one of the key features of the countries' future policies to ensure their activities in the face of the growing environmental crisis.

An important issue for discussion is building a working model at the regulatory level for the corporate sector of Ukraine that will not interfere with business operations if pressure on the environmental component of its conduct is increased. Therefore, the planned implementation of the public-private sector can be realized, first of all, with the help of international partners and organizations, by creating a high-quality infrastructure to ensure the minimization of greenhouse gases. The corporate sector can use technological innovations in the area of equipment and filtration. Thus, it is an open question to what extent the use of such means in cooperation with international organizations can bring real economic benefits to the country, taking into account demographic factors and improving the living standards of the population.

Regulatory and legal regulation, as well as the development of a monitoring and control system not only for a single state body but also the creation of effective regional control bodies that can ensure the quality of implementation of public-private partnership programs, remain equally important in the area of public-private partnerships to reduce greenhouse gas emissions. The results of the study show that the use of a decentralized system of supervision over the implementation of public-private partnership policy contributes to the improvement of the environmental situation, as proven by the example of European countries. However, the question of how to ensure the optimal model in the context of the war in Ukraine remains.

CONCLUSION

Thus, the results of the study indicate the need to create and develop a further model of public-private partnership. The advantages of using this approach can reduce the bureaucratic burden on government agencies and involve the corporate sector in ensuring the strategic goals of the state. Moreover, the industrial sector, when interacting and participating in specialized government projects, can create a

platform for creating new product markets and ensuring business development, which will have a powerful economic effect. The example of European countries shows that at the first stages, it is necessary to build an effective regulatory framework that can regulate the activities of industrial enterprises, and create mandatory reporting for local control and monitoring bodies. As an economic incentive, it is necessary to obtain preferential lending for business, attract additional financing, and strengthen the company's brand both in the domestic market and ensure its reputation at the international level.

In 2022, the war in Ukraine caused damage to most natural resources, and the level of damage from destroyed industrial enterprises became a key catalyst for increased emissions of harmful substances into water bodies, the air, and soil poisoning. These circumstances create the need for an effective mechanism that can ensure the environmental cleanup of the country from harmful substances and environmental damage caused by the aggressor. To implement such a policy, it is necessary to use the corporate sector as a means of ensuring the functioning of the environmental force, as the need for financial, human, and technological resources may become a burden for the state. Therefore, it is necessary to create new business areas, a commodity market that can function to restore the environmental component with the use of international assistance.

Further research on the restoration of environmental infrastructure should rely on the involvement of the corporate sector and include a state program on the policy of its implementation in the context of war and unfavorable economic conditions. However, the basic principles that can create a positive economic effect will be the use of social responsibility, transparency, natural competition, and international partnership. The issue of international partnership and participation of industrial enterprises in joint environmental programs and environmental organizations can help not only improve the environmental component but also contribute to a significant inflow of investment resources into the country. Investments can be one of the key factors in ensuring a quality environmental situation in times of war. Such a policy would make it most appropriate for the industrial segment to participate in the environmental problems of the state.

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