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# Management of the Economy in the Field of Environmental Management and Energy Security as Components of Sustainable Development

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## ABSTRACT

In current conditions, economic management issues in environmental management and energy security are increasing due to the high level of depreciation of existing capacities and the lack of financial resources for their renewal. The issues of reliability of energy supply, the transition to energy-saving technologies, and the development of alternative energy are being updated. The purpose of the article is to analyze the current state and develop ways to improve the management of the economy in environmental management and energy security on the principle of synergy to ensure the sustainable development of countries. The authors have proposed an economic model of sustainable development of environmental management and energy security. The authors identified sources of threats and risks, the occurrence of which may threaten the fuel and energy complex. This made it possible to develop a mechanism for reducing threats to energy security for the region's economy and the population—Mechanism of economic management in environmental management and energy security. The authors have developed a Management decision matrix for managing the economy in environmental management and energy security. All this will allow



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redirecting the management of the economy in the field of environmental management and energy security towards sustainable development.

**KEYWORDS:** energy security; environmental management; fuel and energy complex; sustainable development

## INTRODUCTION

The modern world economic system and our entire civilization over a long history after the emergence of human society were formed as a result of the extensive use of natural resources, which included the basis of almost all types of economic activity [1,2], and the principles of the conquest of nature—the foundation of ethical imperatives, moral principles, laws of society and the entire political structure of states. Scientific and technological progress has created conditions under which, with constantly decreasing costs of human labour, ever-larger volumes of natural resources are involved in production while ensuring their deep processing and high growth rates in the volume of goods [3]. However, unlimited growth in the use of world wealth is impossible.

Today, economic activity has become not only a geological force but also the most potent force that destroys the biosphere: depleted natural resources, polluted environment, ozone holes, climate change, deserts, and the disappearance of forest masses [4–6].

Another vital aspect is energy security. Increasing energy security contributes to ensuring the stability of the energy supply and meeting the needs of the economy and the livelihoods of the population [7,8]. Ensuring energy security is an essential part of the entire national security system and one of the conditions for the stability of economic, social and environmental parameters of the population's quality of life and serves as an effective indicator of public administration.

To raise a voice on social and economic reforms in the country until the environmental policy and institutions are relaxed, to control more environmental efforts and the necessary changes in legislation. These factors have led to a decrease in the efficiency of economic management in the sphere of natural resources and energy security on the sovereign and regional levels.

Thus, the purpose of the article is to analyze the current state and develop ways to improve the management of the economy in environmental management and energy security based on the principle of synergy to ensure the sustainable development of countries.

## MATERIALS AND METHODS

The theoretical and methodological basis of the study was the scientific works of Ukrainian and foreign scientists-economists on the problems of improving energy security and economically sustainable development, as well as materials from international conferences, reports of international

organizations on the issues of economic management in the field of environmental management and energy security of countries. The research made it possible to develop the theoretical and methodological apparatus in the designated research areas. A systematic approach to studying economic processes and phenomena has been implemented as a methodological base. When conducting this study, the authors used the following methods: economic and statistical analysis (calculation of relative values, tabular, graphical display of information, matrix and indicative methods), general scientific methods (comparison, analogy, classification, observation and generalization).

## RESULTS

In just 100 years, the population has tripled, the species of bioorganisms have decreased by 20%, the area of deserts has increased by 156 million hectares, and the size of land disturbed by economic activity has increased by three times (Figure 1).

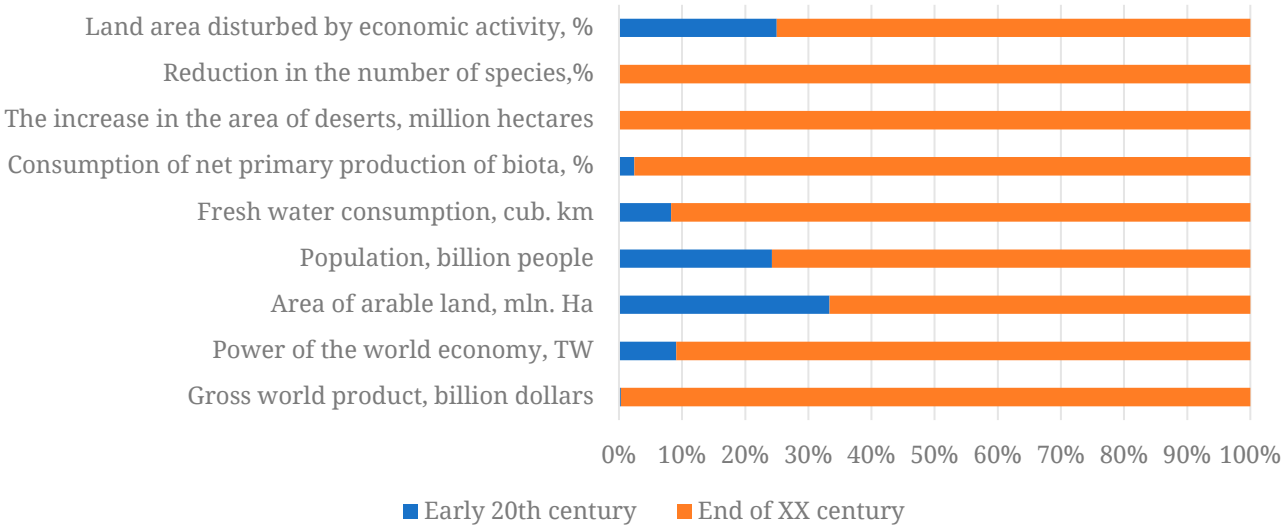


**Figure 1.** Changes in the subsystem of the economy and the global ecosystem in the twentieth century (according to the data [5,9]).

Sustainable development (harmonious development, balanced development) is a process of economic and social changes in which natural resources, the direction of investments, the orientation of scientific and technological development, the development of the individual and institutional changes are coordinated with each other and strengthen the current and future potential to meet human needs and aspirations [10]. There are such components of sustainable development (Figure 2).


**Figure 2.** Components of sustainable development [10].

Thus, the studies in the article are directly related to 2 components of sustainable development, which must be considered in combination to obtain a synergistic effect of the proposed activities.

Sustainable development is a process of directed logical changes, qualitative structural transformations or alterations. Stability of motion is possessed by those systems that do not change their characteristics and properties under perturbations.

The state's sustainable energy lies in the sustainable development of the industry and energy enterprises at the regional level. The sustainable development approach considers the fuel and energy complex an open, dynamic system. (Figure 3).

The state of the fuel and energy complex depends on the stability of each element of the system [11].

The essence of the fuel and energy complex activity lies in the movement of information, energy, and materials associated with processing input values of data, financial resources, and material resources and obtaining the desired output result (energy resources, services, profits, information etc.). If the system is stable, its reaction to the impact of destabilizing factors may consist of the following: adaptation, prevention of possible violations, and offset adverse effects. If the system is unstable, then the consequence of destabilization may be stagnation and stagnation of the system.

The sustainable growth of the fuel and energy complex is the system's transition from the previous state to a new state, which characterizes the unique properties and characteristics of the system, corresponding to the trends of modern times. Resilience is that after you move from one situation to another simultaneously, the stability parameters of the system at least do not change for the worse; that is, they are within the stability

limits. For an outline of economic sustainability, the primary condition for sustainable development is the provision of resources at the right time in the right amount, in an acceptable form. Resources in the form can be attracted in the form of material and financial flows, technologies, personnel, and innovations.

The main task of the fuel and energy complex is to ensure the stable functioning of the economy and support the livelihoods of the population of the region. Improving energy security involves the identification, systematization and classification of events, the occurrence of which may pose a threat to the fuel and energy complex, the regional economy and the population. Threats to energy security can change over time, turning from potential to real and vice versa. They can arise under interrelated factors, and threats can interchange or complement each other. The implementation of some threats may proceed to the performance of others. Let's consider the main ones (Figure 4).

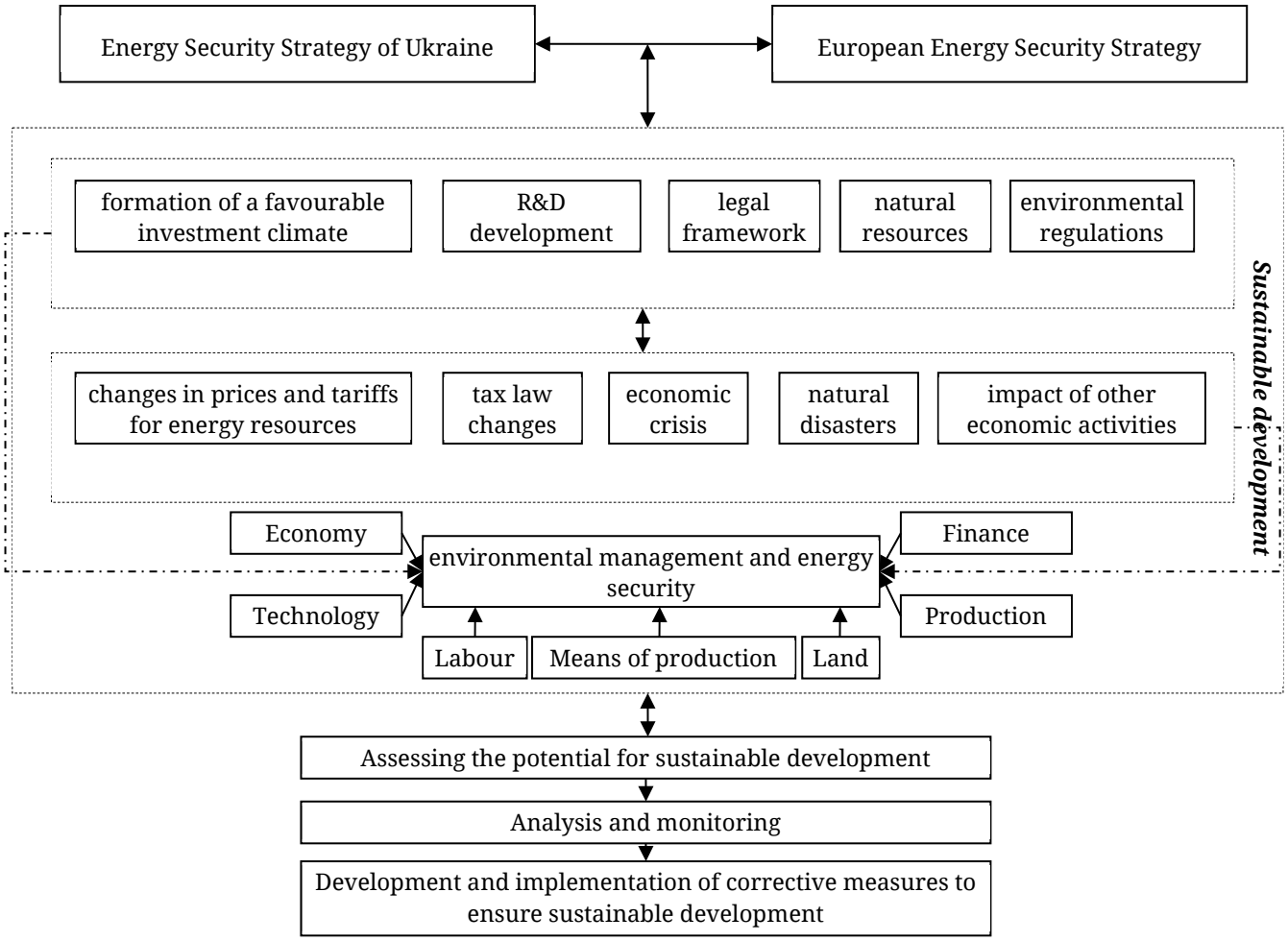


**Figure 3.** The economic model of sustainable development environmental management and energy security (author's development).

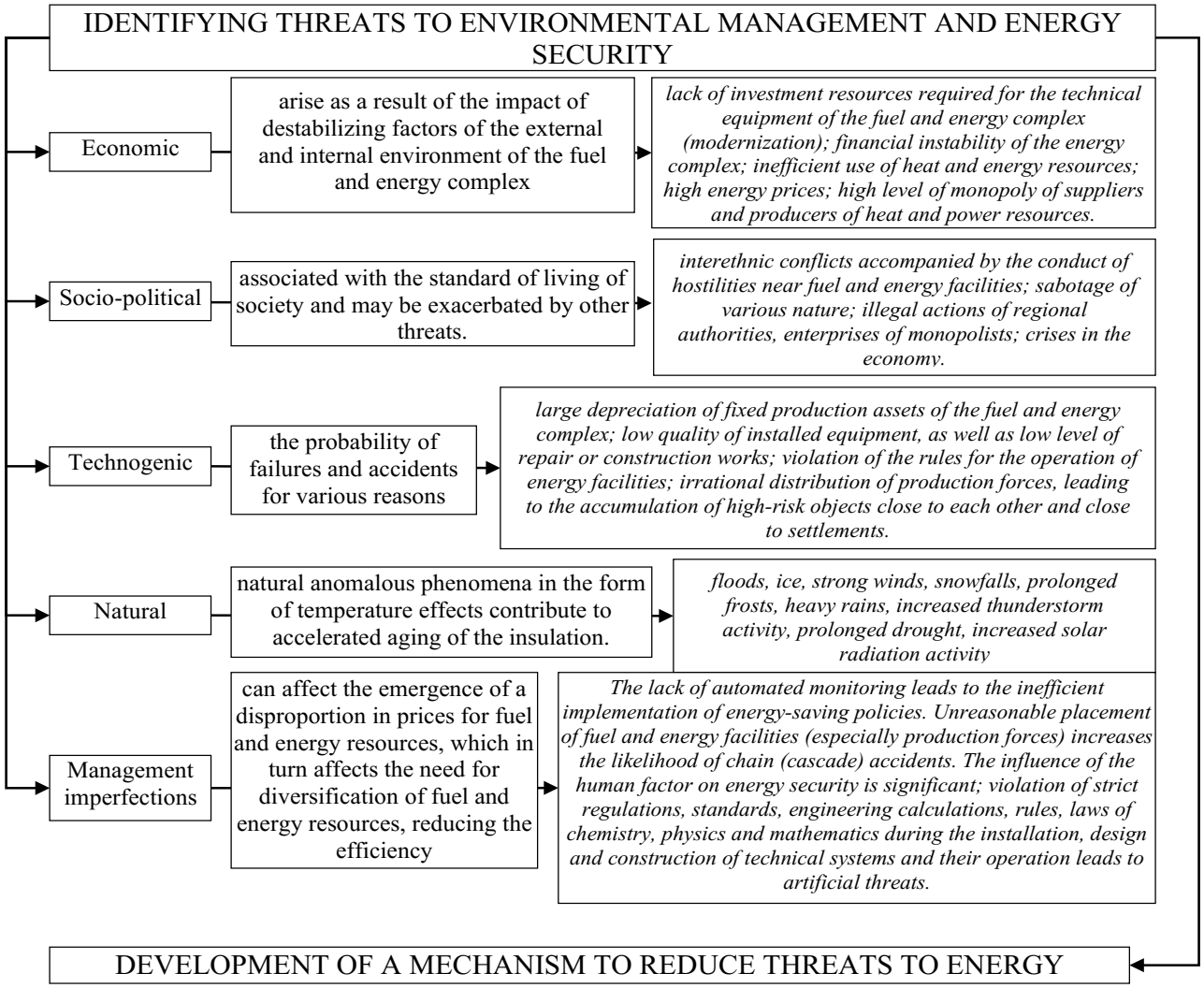


**Figure 4.** Threats to environmental management and energy security (according to the data [12–17]).

Identification of the main groups of threats will make it possible to develop mechanisms to reduce the threats to energy security for the economy of the region, as well as for the population.

The mechanism of economic management in environmental management and energy security (Figure 5) is based on the synergistic effect of the two blocks.

The first block—energy security—includes seven blocks:

*economic*—reflects the economic viability and independence of the energy complex;

*fuel supply*—evaluates the quantity, type and availability of a reserve of fuel used;

*production and energy*—characterizes the volume of installed capacities of energy sources, energy production, the level of consumption of heat and electricity per capita;

*transit*—characterizes the electricity received from outside the region, the state of interconnections, as well as their capacity and availability of reserves;

*natural and climatic*—evaluates indicators that destroy or destabilize the work of the fuel and energy complex (anomalous temperature, rain, hurricane, etc.);

*reliability*—characterizes the operation of equipment (number of failures), wear, investment in the material and technical base of the energy sector;

*environmental*—evaluates the impact of energy on the environment.

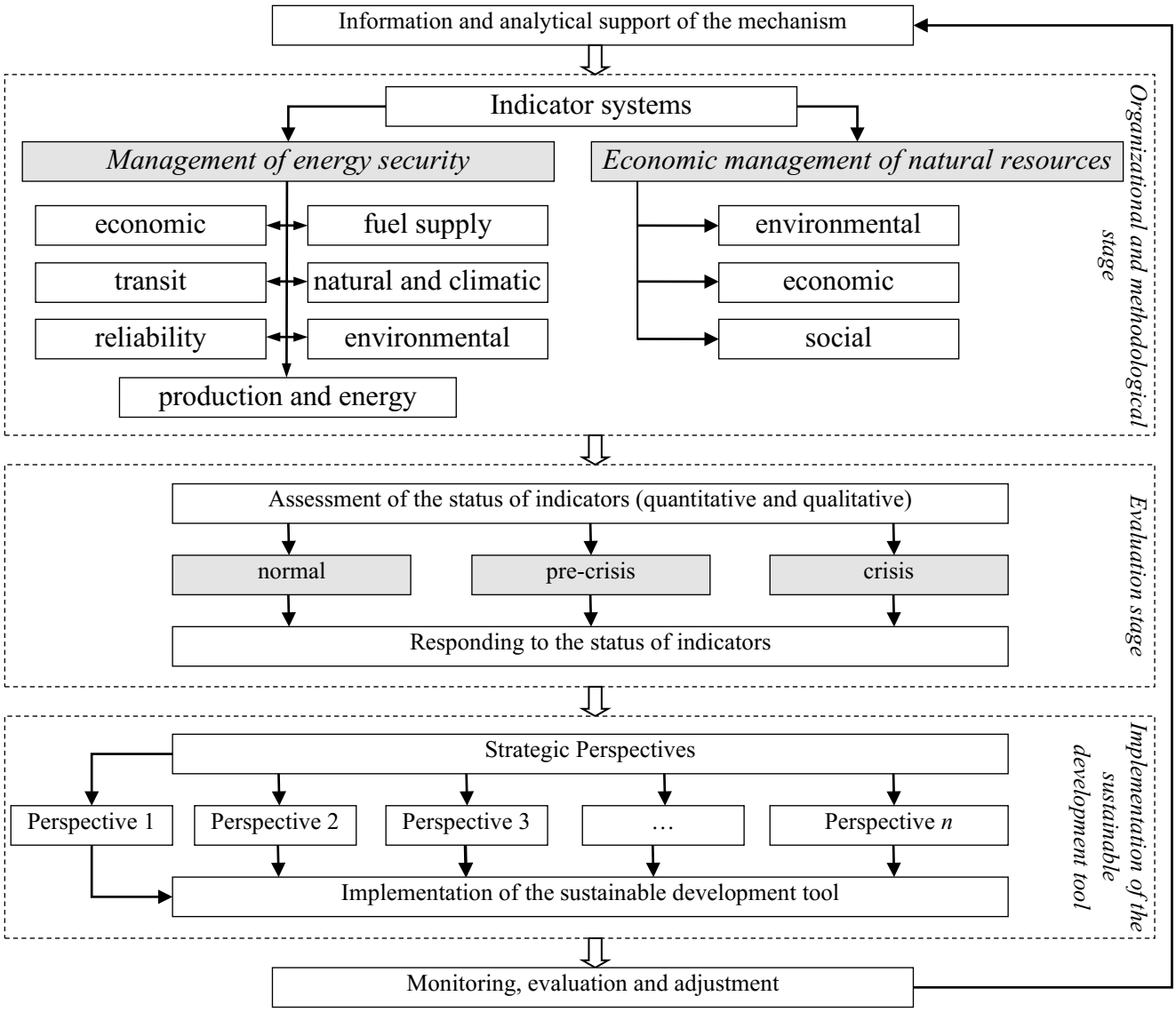


**Figure 5.** The mechanism of economic management in the field of environmental management and energy security (author's development).

The proposed method for determining the threshold values for assessing the sustainable development of the fuel and energy complex includes the study of random variables of the dynamic series, then selecting the mean and standard deviation.

The second block—economic management of natural resources—includes three blocks:

- environmental;
- economic;
- social.

To not clutter up the scheme, provide a transcript of these indicators in Table 1.

**Table 1.** System of indicators of sustainable development of economic management in the field of nature management (according to the data [18–22]).

| Critical indicators of sustainable development | Decryption |
|---|---|
| ***Environmental*** | |
| **Use of water resources** | Water consumption for production, household and drinking needs; the growth rate of freshwater consumption for production; volumes of wastewater discharges, part of recycled water use, etc. |
| **Use of land resources** | Land area, its composition, fertilization, land reclamation, etc. |
| **Forest protection** | The forest cover of the territory, the area of the forest fund, reforestation, wood consumption by production, etc. |
| **Biodiversity conservation** | Natural reserve fund, its composition, change. |
| **Atmospheric air protection** | Emissions of harmful substances from stationary sources, vehicles, emissions per 1000 UAH. GDP, rate of change, etc. |
| **Management of solid, hazardous waste** | Production volumes, rate of increase, recycling, etc. |
| ***Economic*** | |
| **GDP index** | Gross domestic product deflator. |
| **Changes in the structure of consumption** | Electricity consumption by sectors of the economy, the rate of change compared to the previous year, the use of fuel and energy resources, the rate of change, etc. |
| **Financial resources and mechanisms** | Consolidated budget expenditures (expenditures on education, health care, science), consolidated budget deficit, state budget deficit. |
| ***Social*** | |
| **Demographic dynamics, human development** | Population, the share of the resident population over 60 years old, GDP per person, average life expectancy, unemployment rate, the percentage of the people with expenses below the subsistence minimum, the intermediate level of total costs, etc. |
| **Health protection** | Child mortality, the number of nursing staff, the number of doctors of all specialities, the number of beds per 1000 population, etc. |
| **Maintaining the ecological state of settlements** | The share of the urban population, the share of the total area in the housing stock equipped with water supply (sewage, central heating, hot water supply), availability of drinking water, etc. |

Each indicator is argued and classified into three-state levels (normal, pre-crisis, and crisis).

Suppose the random value is higher (or lower—when a low level is desired, for example, wear and tear of the equipment or staff turnover) than the average. In that case, energy security is normal; if the average value does not go beyond two standard errors, then the situation can be characterized as pre-crisis; if the average exceeds the established threshold, the state of energy security is in crisis.

The calculated threshold values of indicators for three levels of energy security (normal, pre-crisis, and crisis) are a tool for classifying the stability of the state of the fuel and energy complex.

Sustainable development of the industry, in our opinion, should be considered sustainable economic development; that is, at the moment, for the industry, the economic component of the development is dominant, which does not mean ignoring the problems of social development and environmental conservation. Then the preparation of programs for sustainable development of the region should be based on five main elements of economic growth ("5 M"):

1. Physical resources (Materials)—land, buildings, location, infrastructure, natural resources;
2. Human resources (Manpower)—skilled workers, labour force, opportunities for advanced training;
3. Management (Management)—organizational structure, management apparatus, marketing and sales, SWOT analysis;
4. Markets—market segment, competitiveness, marketing strategies pursued;
5. Money (Money)—financial resources, including investments, loans, subsidies, etc.

At the Monitoring, evaluation and adjustment stage, for greater clarity, a matrix of managerial decision-making is drawn up for economic management in environmental management and energy security (Figure 6).

Crisis threats with a low, medium and high probability of occurrence are in the first, second and third quadrants; they can bring the system out of stable equilibrium. In this case, it is necessary to connect compensatory control mechanisms since the existing structure cannot cope with external or internal negative influences.

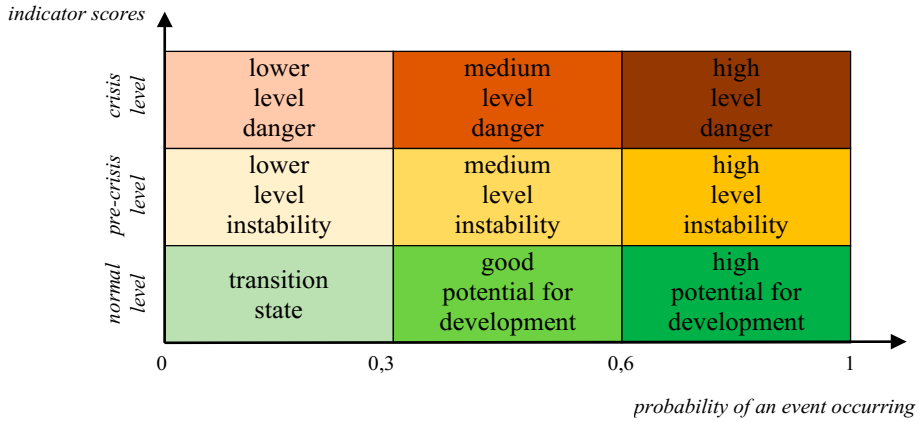


**Figure 6.** Matrix of managerial decision-making for managing the economy in the field of environmental management and energy security (author's development).

To restore the sustainability of the development of economic management in the field of environmental management and energy security is necessary to attract additional resources that can return objects to the trajectory of sustainable development.

Metamorphic threats to development sustainability are in the fourth, fifth and sixth quadrants; they can temporarily destabilize the system; in this case, it is necessary to implement regulatory protection mechanisms that require the creation of new effective combinations of resources that can return the system to a state of equilibrium.

The seventh, eighth and ninth quadrants characterize normal sustainable development. Protection mechanisms come into play that "reject" those perturbations that do not exceed threshold values and are considered insignificant for the system. The protection mechanism usually does not require significant resources but is designed to save system resources.

In our opinion, the essence of a systematic synergistic approach to managing the economy in the field of environmental management and energy security as components of sustainable development can be reduced to the following positions:

- setting goals and determining their hierarchy provides for finding the optimal balance between economic, environmental and social development goals of a particular industry;
- achieving goals at minimal cost based on a comparison of alternative ways to achieve them;
- quantitative/qualitative assessment of models and methods of sustainable development of the industry, based on a comprehensive analysis of all possible and planned results of activities.

In this study, the authors, for the most part, proposed a conceptual framework, so the question of quantifying the proposed interventions remains open, which will allow specifically assessing the changes.

## CONCLUSIONS

In this study, the authors:

- developed the economic model of sustainable development environmental management and energy security, which, unlike the others, is based on the principle of synergy, combines the actions of external control and external obstacles and ultimately involves the development and implementation of corrective measures to ensure sustainable development;
- identified and described in detail the sources of threats and risks, the occurrence of which may threaten the fuel and energy complex, which became the basis for developing a mechanism to reduce threats to energy security for the region's economy, and the population.
- developed a mechanism for reducing threats to energy security for the economy of the region, as well as for the population, which differs from the others in that each indicator is argued for and classified according to three levels of state (normal, pre-crisis, crisis), as well as the calculated threshold values of indicators for three levels of energy security (normal, pre-crisis and crisis) are a tool for classifying the stability of the state of the fuel and energy complex.
- developed a matrix for combining threats to the sustainability of the development of the fuel and energy complex and the likelihood of their occurrence, which, unlike the others, makes it possible to effectively apply compensatory, regulatory and reserve mechanisms for making managerial decisions minimize damage.

The management of the economy in environmental management and energy security as components of sustainable development is multifaceted; therefore, we see the disclosure of prospects in the proposed mechanism in further research. So, one of them can be the “Application of Smart Grid digital technologies”, which contributes to improving the quality of electricity transmission; self-healing of the system after failures; network resilience to physical and cybernetic interference; ensuring the synchronous operation of generating sources and power storage units; observability of the course of processes in the energy sector. Or “Improving Energy Efficiency” necessitates the creation of a favourable economic environment; introduction of progressive energy-saving technologies and equipment; formation of a system for accounting for energy resources, etc.

## AUTHOR CONTRIBUTIONS

All authors contributed equally to the design and operationalization of the study;

Olena Sadchenko: Conceptualization, Methodology, Formal analysis, Writing—Original draft preparation, Validation.

Hanna Obykhod: Conceptualization, Methodology, Writing—Reviewing and Editing, Methodology, Formal analysis, Visualization.

Ivan Yaroshenko: Data curation, Investigation, Resources, Writing—Original draft preparation, Validation.

Ludmyla Levkovska: Methodology, Formal analysis, Visualization, Writing—Original draft preparation.

Oleksandr Deineha: Supervision, Conceptualization, Investigation, Resources,Writing—Reviewing and Editing, Visualization.

Tetiana Dombrovska: Conceptualization, Data curation, Formal analysis, Writing—Reviewing and Editing, Visualization.

All authors have read and agreed to the published version of the manuscript.

## CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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