

The System of Effectiveness Indicators of Environmental Security of an Enterprise under the Conditions of Transition to Low-Carbon Economy

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Abstract - The effective use of natural resources, the raise in the level and quality of life are increasingly attracting public attention, as a result of which the data characterizing both the financial performance and non-financial of a company are currently in high demand. Traditional economic evaluation criteria are not enough; a comprehensive system for the assessment of economic, environmental and energy efficiency of companies is needed. In order to study the information content of the reflection of environmental component of enterprises, the authors conducted a comparative analysis of environmental indicators recommended for disclosure in non-financial reporting. The authors offer additional criteria and indicators that allow an objective assessment of the level of environmental safety of an enterprise from the standpoint of reducing carbon intensity and increasing the efficiency of using various types of energy.

Keywords— *non-financial reporting; environmental indicators environmental management; greenhouse gases; energy consumption*

I. INTRODUCTION

In the current state of the development of society, business faces two global tasks: to make a profit and to gain public trust. In this regard, the question arises about the need for certification of environmental management systems and

disclosure of information on the results of environmental activities in non-financial reports of industrial enterprises.

One of the priorities of modern society is the standard of living, and, therefore, there is a need for disclosing information about financial performance and non-financial aspects of a company, their compatibility with the requirements for environmental impact and the efficiency of natural resources. For society it is important to have the tools formed into a single digital block of indicators, which allows an objective assessment of the level of environmental safety of an enterprise.

Transparent and reliable data on the impact of an enterprise's activity on economy, environment and social environment as part of integrated reporting (a set of financial and non-financial indicators) are becoming an additional competitive advantage.

On the other hand, for business it is also important to achieve balanced economic, environmental and social results, to make them publicly available, among other aspects, through non-financial reporting. Moreover during the transition to digital management, including environmental processes, the establishment of an environmental control system and a common management system of technological and economic processes becomes relevant.

Over the past 25-30 years, a number of efforts have been made in order to develop tools that can be used to standardize non-financial reporting [1-3]. The reporting guidelines of sustainable development have become widespread among non-financial reporting professionals.

In 1997 the Coalition for Environmentally Responsible Economies (CERES), in partnership with the United Nations Environment Program (UNEP), launched the Global Reporting Initiative (GRI) with the goal of increasing the relevance and quality of sustainability reporting to a level comparable to financial statements. One of the main tasks of GRI was and remains the development of a standard that ensures compatibility, integrity, reliability, accuracy and verifiability of the information reflected in the statements.

The GRI standard is one of the most common reporting systems in the field of sustainable development; the report is based on the principle of the Triple Bottom Line: financial performance of a company, environmental compatibility of production and social policy [1].

In order to investigate the information value of the identification of the environmental impact of company's activities, the authors conducted a comparative analysis of environmental measures that will be disclosed in non-financial reporting in accordance with the Global Reporting Initiative and the recommendations of the Russian Union of Industrialists and Entrepreneurs.

As a result of the analysis, the following conclusions were drawn: on the one hand, the specific standard elements in G4 environmental category reflect the environmental impact of an enterprise in terms of resource use and waste management, on the other hand, most of the parameters are expressed in absolute values, which makes their interpretation more difficult.

Due to the urgency of the climate change issue, GRI G4 management pays special attention to greenhouse gas emissions.

Most Russian enterprises in order to reflect the key performance results of companies in corporate non-financial reporting use basic indicators of economic, social and environmental performance recommended by the Russian Union of Industrialists and Entrepreneurs [4].

In comparison with the system of standard elements reflected in G4 environmental category, the basic performance indicators recommended by the Russian Union of Industrialists and Entrepreneurs to be disclosed as a part of non-financial reporting allow interpreting the results of environmental protection activities in the form of relative environmental indicators characterizing the efficiency of activities and include more parameters, but without reflecting on some significant aspects.

Such environmental aspects as: "Biodiversity" (G4-EN11 - G4-EN14, EN26), "Products and Services" (G4-EN27, EN28), "Compliance" (G4-EN29), "Transport" (G4-EN30), "The environmental assessment of suppliers" (G4-EN32.33), "Environmental complaints handling mechanisms" (G4-EN34) are not reflected in non-financial reporting of Russian

companies, since Russian legislation does not require it. Therefore, it is not included in the data of automated analytical accounting. It should also be noted that the system of accounting, the assessment and tariffication of direct and indirect greenhouse gas emissions at Russian enterprises, the largest consumers of fuel and energy, began to form only in 2016.

Until 2016, in Russia, the accounting and control of greenhouse gas emissions were not a legal requirement and the current accounting system does not contain information on greenhouse gas emissions by specific enterprises. Therefore, it is necessary to create reliable indicators of environmental and energy efficiency in order to comply with environmental requirements for economic activities at the global and national levels and to develop and implement effective environmental policies and setting targets for reducing greenhouse gas emissions.

In order to make environmentally responsible decisions at different levels of government, the system of environmental criteria and indicators of environmental quality is needed. These criteria are usually outside the standard market valuations and they are not reflected in traditional financial statements, which make it difficult to assess the performance of an enterprise from a sustainable development perspective.

In the development of individual indicators and systems of indicators of sustainable development at the global and local levels were previously engaged and are engaged today the leading international organizations such as the United Nations, the World Bank, the Organization for Economic Cooperation and Development (OECD), the European Community and various research teams.

In addition to indicator systems, the aggregate is used to assess the development at a macro level: indexes of adjusted net savings, human development index, natural capital; The Living Planet Index of the World Wide Fund for Nature (WWF), The Ecological Footprint.

Among the scientific publications in this field it is necessary to mention the works of such authors as E. Amrina, S.M. Yusof [5], L. Elgert, R. Krueger [6], M.A. Rosen, H.A. Kishawy [7], N.R. Khalili [8], T.M. Parris, R.W. Kates [9].

The analysis of the system of indicators in the field of sustainable development in the publications of Russian and international authors on the research topic showed that the main set of environmental indicators that are not included in the standard market parameters, but which are necessary for evaluating and making environmentally responsible decisions, can give a complete description of all types of industrial environmental impact, however, does not take into account the quantity, dynamics and types of energy resources consumed, direct and indirect emissions of greenhouse gases.

Consequently, they cannot serve as a source of information for the creation of common automated management system, which is necessary for the assessment of the effectiveness of environmental management of an industrial enterprise.

The authors concluded that it is necessary to supplement the list of environmental indicators disclosed by Russian

companies in non-financial reports in order to show the results of companies' activities on reducing the consumption of hydrocarbon fuels and greenhouse gas emissions.

II. METHODS AND MATERIALS

According to the authors the method of selecting and grouping environmental indicators in accordance with the principles and methodology of the Organization for Economic Cooperation and Development (OECD) using the "pressure-state-response" model [10] characterizes the relation between the state of economy, environmental protection and efficiency of environmental management.

The environmental indicators of the "pressure" group reflect the intensity of use, formation and emissions of pollutants into the environment, formation and neutralization of industrial wastes.

The environmental indicators of the "state" group characterize the quality of the environment, the quantity and quality of natural resources, reflect the balance of ecology and economy at national, regional and local levels, and characterize the distribution and development of production, taking into account the carrying capacity of ecosystems.

Environmental indicators of the "response" group characterize the results in the field of prevention, mitigation and compensation of negative environmental impact, which present consequences of the enterprise's activities - air pollution, water pollution, soil, land degradation, depletion of natural resources and climate change.

For Russian enterprises, the authors proposed environmental performance indicators, taking into account the compatibility of environmental indicators used in world practice with indicators for the assessment of the effectiveness of environmental management.

These indicators are grouped by sections: "Water consumption", "Emissions into atmosphere", "Waste treatment" and "Environmental protection measures" and characterize the company's activities in accordance with the "pressure - state - response" model.

In order to ensure a more complete reflection of the results of company's activities to control greenhouse gas emissions and energy consumption, the authors developed additional performance indicators based on the proposed criteria for the effectiveness of environmental management [11, 12]:

- the decarbonization of production;
- the energy intensity of production;
- the intensity of greenhouse gas emissions

In order to calculate additional indicators that will be included in the basic set of initial parameters characterizing the effectiveness of environmental management in the field of resource use intensity, waste generation and disposal, the following parameters were included:

- direct greenhouse gas emissions, t CO₂ equivalent / unit of production;

- indirect greenhouse gas emissions, t CO₂ equivalent / unit of production;
- the consumption of hydrocarbon fuel, GJ / unit of production;
- total energy consumption, GJ / unit of production;
- the reduction of greenhouse gas emissions, t CO₂ equivalent / year;
- the absorption of greenhouse gases, t CO₂ equivalent / year.

The proposed additional indicators that take into account the consumption of various types of energy and direct and indirect emissions of greenhouse gases characterize the impact of an enterprise on environment by the intensity of use of energy resources and greenhouse gas emissions; therefore they are included in the "pressure" group.

The proposed additional indicators which reflect the reduction and absorption of greenhouse gases characterize the effectiveness of environmental management in the field of the management of greenhouse gas emissions, so they are included in the "response" group.

Accordingly, additional indicators are included in the calculation of environmental efficiency ratios for the "pressure" and "response" groups.

III. RESULTS

For a comprehensive assessment of the effectiveness of environmental management, the authors propose the use of the following indicators:

- a set of basic and additional indicators characterizing the activity of an enterprise in accordance with the "pressure-state-response model";
- environmental performance indicators calculated for the "pressure", "state" and "response" groups are based on nominal basic and additional parameters;
- integrated indicator of environmental performance (table 1) [11].

TABLE I. THE INDICATORS OF THE ASSESMENT OF ENVIRONMENTAL MANAGEMENT

Basic and additional indicators characterizing the activities of an enterprise in accordance with the "pressure-state-response" model
<i>The indicators of «Pressure»</i>
<i>Basic:</i>
Total water supply, m ³ / year Water consumption from surface objects, m ³ / year Discharge of pollutants into water objects, tons / year Emissions of pollutants into the atmosphere, tons / year Specific emissions of pollutants into the atmosphere, t / unit. Waste generation, t / year
<i>Additional:</i>
Direct greenhouse gas emissions, t CO ₂ -eq. / Unit. Indirect greenhouse gas emissions, t CO ₂ -eq. / Unit. Consumption of hydrocarbon fuels, GJ / unit. Total energy consumption, GJ / unit
<i>The indicators of «State»</i>

Basic and additional indicators characterizing the activities of an enterprise in accordance with the "pressure-state-response" model
The indicators of «Pressure»
Basic
Concentration of pollutants in the atmosphere, mg / m ³ Concentration of pollutants in water objects, mg / m ³ Area of polluted (disturbed) land, sq. km
The indicators of «Response»
Basic
Circulating water supply, m ³ / year Reduction of discharges into the water supply system, tons / year Reduction of wastewater, m ³ / year Payment for environmental protection services, rubles / year The cost of collection and treatment of wastewater, rubles / year Reduction of emissions of pollutants into the atmosphere, tons / year Payment for environmental protection services, rubles / year The cost of air protection, rubles / year Waste disposal, t / year Waste use, t / year Protection and rational use of land, rubles / year Payment for environmental protection services, rubles / year
Additional
Reduction of greenhouse gas emissions, t CO ₂ -eq. / Year Absorption (conservation) of greenhouse gases, t CO ₂ -eq. / Year

The data was generalized by the authors on the basis of research [11-12].

In order to interpret the aggregated indexes for the pressure, state, response groups, individual indicators of energy intensity of production, the intensity of greenhouse gas emissions and decarbonization of production, as well as an integrated indicator of the company's environmental management effectiveness, the authors proposed five levels of qualitative assessment of indexes and a five-point scale ratings (table 2).

TABLE 2. THE ASSESMENT OF QUALITY OF RELATIVE INTEGRAL CHARACTERISTICS OF ENVIRONMENTAL AND ENERGY EFFECTIVENESS OF THE ENTERPRISE

The levels of the assessment of quality		
<i>Range of relative values</i>	<i>Score in points</i>	<i>Qualitative interpretation of relative values</i>
0 – 0,1	0	No activity
0,1 – 0,3	1	Extremely poor effectiveness
0,3 – 0,5	2	Poor effectiveness
0,5 – 0,7	3	Unsatisfying effectiveness
0,7 – 0,9	4	Satisfying effectiveness
0,9 – 1	5	High effectiveness
0 – 0,1	0	No activity

The proposed indicators were tested using the data of the largest metallurgical enterprises of Russia - Magnitogorsk Iron and Steel Works "MMK" in order to assess the effectiveness of environmental management.

The performance analysis of "MMK" enterprise based on the proposed criteria for environmental and energy effectiveness showed a sufficient level of efficiency (4 points) in terms of reducing discharges into the water supply system,

reducing emissions of pollutants into the atmosphere, effective use of various types of energy, waste disposal and recycling.

The high energy efficiency is demonstrated by an index of energy intensity of production (5 points), which simultaneously characterizes the economic efficiency (savings in fuel and energy costs) and environmental aspect, since it largely depends on the amount of expensive carbonite and other energy resources consumed during technological processes.

Metallurgical processes are the main source of greenhouse gas emissions; "MMK" demonstrates low effectiveness of environmental activity in the field of the control of greenhouse gas emissions (2 points). The low effectiveness of environmental activities on indicators of direct greenhouse gas emissions, absorption (conservation) of greenhouse gas emissions indicates that the measures in the field of accounting, control and management of greenhouse gas emissions are extremely insufficient.

The authors obtained the following results:

1. Based on the analysis of international toolkit, the directions for the improvement of environmental management and corporate non-financial reporting have been determined;

2. The introduction of the principle of integration of environmental and energy criteria into a common automated management system, which is necessary to assess the effectiveness of the environmental management of an industrial enterprise and demonstrate responsible business practices in the field of environmental safety, is proved;

3. A methodical approach to the assessment of the effectiveness of environmental management has been proposed, a distinctive feature of which is the use of environmental and energy criteria that reveal the company's contribution to environmental protection;

4. The analysis of the impact of industrial activities of "MMK" enterprise on the state of the environment was carried out on the basis of the proposed methodology.

IV. CONCLUSION

The main set of environmental indicators used in world and national practice to control the environmental situation and environmental safety adequately reflects all the types of industrial impact on the environment.

However, the totality of environmental indicators, as a rule, does not incorporate indicators that makes it possible to take into account the quantity, dynamics and types of energy resources consumed, direct and indirect emissions of greenhouse gases, absorption and conservation of greenhouse gases.

Consequently, such a set of environmental indicators cannot serve as a full-fledged source of information necessary for the assessment of the effectiveness of environmental management of an industrial enterprise in the transition to a low-carbon economy.

For full reflection of company's activities on the control of emissions of greenhouse gases and energy consumption, as well as the development of an environmental control system in the general automated process and economic process management system, the authors developed additional environmental management effectiveness indicators in the area of the management of greenhouse gas emissions that characterize industrial pressure on the environment of a particular company.

These additional indicators are included in the calculation of environmental performance indicator for the pressure group and in the calculation of environmental performance indicator for the response group.

The relative values of the integrated indicators for the "pressure, state and response" groups and for the integrated indicator of the effectiveness of environmental management companies receive a qualitative assessment based on a five-point assessment scale developed by the authors of the research.

The analysis of the effectiveness of "MMK" on the basis of the introduced criteria for environmental and energy effectiveness makes it possible to assess and identify trends in the development of environmental management of an industrial enterprise.

A single digital block of indicators for the assessment of company's environmental activity and ensuring environmental safety, in particular, in the area of controlling greenhouse gas emissions and hydrocarbon fuel consumption, in a general automated management system, will provide the opportunity to assess the current situation and determine strategic and tactical objectives, allocate commitments, develop effective management decisions and monitor the process of the achievement of management results.

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