Transformation of the Economy to the Low-Carbon Path of Development: Criteria and Indicators

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Abstract— **Extensive way of natural resources consumption as well as waste and pollution formation have obvious resources and environmental constraints. At present and in the nearest future similar model of the economy will not be able to provide sustainable development of society; serving the needs of the present generation impairs future generation abilities in serving their needs. Implementation of the sustainable development strategy requires balance between economic growth, environmental security and social well-being. Applying traditional economic criteria are not enough to assess the ecological impact of industrial corporations' activities; there is a need for integrated assessment system of economic, environmental and energy efficiency, especially in energy production and consumption. The problem is relevant for energy intensive industries of modern Russia, striving to follow the path of low carbon development. The article analyzes the need for increasing responsibility of Russian corporations in ecological sphere through raising the informativeness of non-financial reporting on energy efficiency, management of greenhouse gas emissions as well as eco-logical management in transition to low-carbon economy. In order to solve this problem, the authors examine the existing system of assessing environmental efficiency and offer additional criteria and performance indicators to assess the efficiency of environmental management system from the point of view of de-creasing in carbon intensity and increasing in energy efficiency of manufacturing.**

Keywords— *Sustainable Development; Environmental Indicators; Energy Resources, Greenhouse Gases*

1. INTRODUCTION

For the sustainability of Russia's socio-economic system in the context of realizing the concept of low-carbon development energy saving and reducing greenhouse gas (GHG) emissions are necessary.

The forecast of energy intensity and carbon intensity of the Russian economy [1] determined three scenarios for changing emissions: "without measures," "with measures," and "with additional measures."

Achieving the targets of greenhouse gas emissions in the scale of the Russian economy is possible if the third scenario is implemented by increasing efficiency and changing the structure of fuel using; reduction, absorption, compensation of GHG emissions [2].

In order to achieve that, it is necessary to assess the company's activity in terms of energy and carbon intensity, reducing and removing (compensating) GHG emissions. However, at present, most Russian enterprises do not include activities in the field of GHG emission control into the regular perimeter of business.

Therefore, the task of assessing the effectiveness of corporate environmental management requires further research, especially in the context of the low-carbon development (LCD) concept implementation.

2. RELEVANCE, SCIENTIFIC SIGNIFICANCE OF THE ISSUE WITH A BRIEF REVIEW OF LITERATURE

Environmental criteria and environmental quality indicators necessary for making ecologically responsible decisions at different levels of management are as a rule outside standard market assessments.

In the past and the present times, the leading international organizations such as the United Nations, the World Bank, the Organization for Economic Co-operation and Development (OECD), the European Community, the research teams [3- 7] deal with elaboration of individual indicators and systems of indicators of sustainable development at the global and local levels.

In 1996 the Commission on Sustainable Development of the United Nations proposed the first comprehensive development, which is a system of four groups of sustainable development indicators (social, economic, environmental and organizational). The World Bank (World Development Indicators), OECD (the system of environmental indicators "pressure - state - response") made the next noticeable step.

In addition to the indicator systems for assessing the sustainability of development at the macro level, aggregated indicators are used: indices of adjusted net savings, human development index, natural capital; the "Living Planet Index" of the World Wide Fund (WWF), the Ecological Footprint.

Among scientific publications in this area the works of the following authors can be marked: C. Fan, J.D. Carrell, H.C. Zhang [8], M. A. Rosen, H. A. Kishawy [9], L. Elgert, R. Krueger [10], E. Amrina, S.M. Yusof [11], Belik I.S, Starodubets N.V., Mayorova T.V., Yachmeneva A.I. [12].

In the context of the development of a low-carbon economy, it is necessary to research the criteria and construct a system of indicators that comprehensively characterize the environmental performance of the enterprise.

3. RESEARCH OBJECTIVE

In Russia, as part of the implementation of the LCD concept, the following main goals of the development of

national economy's branches for the period up to 2035 are named:

reducing the electrical capacity level of GDP by 40%, energy intensity - by 50% by 2035 of the level of 2010;

ensuring the level of greenhouse gas emissions by 2035 is not more than 120% of the level of 2010;

integration of sustainable development indicators into the key performance indicators system at the corporate level;

development of non-financial reporting and improving the quality of reporting on sustainable development.

To date, in the key indicators system of environmental management (EM) and non-financial reporting of most Russian enterprises, there are no indicators that reflect the results of activities in accordance with the objectives of the LCD implementation.

As a result, the authors formulated additional strategic objectives for EM, which reflect the enterprise's contribution to (LCD), basic principles and criteria for assessing the effectiveness of environmental management in relation to the goals of low-carbon economic development [13].

It is proposed to introduce additional criteria characterizing the energy consumption structure and greenhouse gas emissions management: the greenhouse gas emissions intensity; decarbonization of production; energy intensity of production; energy efficiency of production [14].

The proposed methodological approach increases the evaluation objectivity of the EM efficiency in the transition to the LCD model.

4. THEORETICAL

The authors, relying on the biosphere approach [15] and remaining within the framework of a common logic for constructing an indicator system characterizing the environmental performance of an enterprise in accordance with the recommendations of the ISO 14031 standard, proposed a combined approach to improve EM and assess its effectiveness.

For a comprehensive assessment of the EM effectiveness, they proposed a methodology for calculating indicators, which includes:

basic and additional indicators characterizing the activity of the enterprise using the "pressure-state-response" model;

summary and partial indices calculated by groups of "pressure", "state", "reaction" on the basis of normalized basic and additional indicators;

integral indicator of the EM efficiency [16].

The authors propose a method for calculating additional indices:

GHG emissions intensity index:

$$I_{PG} = \frac{1}{2}\left(\tilde{x}_{7.1} + \tilde{x}_{8.1}\right),$$

$\tilde{x}_{7.1}, \tilde{x}_{8.1}$ - standard additional indicators of direct and indirect GHG emissions.

energy intensity index of production:

$$I_z = \frac{1}{2}\left(\tilde{x}_{9.1} + \tilde{x}_{10.1}\right),$$

$\tilde{x}_{9.1}, \tilde{x}_{10.1}$ - standard additional indicators of fuel and energy consumption.

decarbonization index of production:

$$I_D = \frac{1}{2}\left(\tilde{x}_{20.3} + \tilde{x}_{21.3}\right),$$

$\tilde{x}_{20.3}, \tilde{x}_{21.3}$ - standard additional indicators of GHG removal.

Measurement of activities results in the field of GHG emissions control and consumption of hydrocarbon fuels makes it possible to assess the current situation, to determine (specify) strategic and tactical environmental goals, to track the achievement of EM results.

5. PRACTICAL RELEVANCE

To date, Russian enterprises reporting contains transparent information about traditional pollutants: SO_2, NO_x, ash, dust emissions in the atmosphere, wastewater discharges and placed waste products. The process of accounting for and controlling direct and indirect greenhouse gases emissions, and consequently, the program of their reduction in the environmental policy of most Russian enterprises is not traceable [17,18].

In addition, the analysis of the dynamics of greenhouse gas emissions at the Russian economy sectors shows steady growth, with the largest amount of greenhouse gas emissions in industrial processes attributable to metallurgy, of which technological feature is using a large amount of hydrocarbon fuel [19].

In this connection, the authors, on the basis of the proposed integration principle introduced non-financial reporting reflecting the LCD, among the basic ones, additional environmental indicators were introduced on the aspects of "Energy", "Vigils, discharges, wastes" [20]. The following Table 1 presents recommended indicators of energy intensity, energy efficiency, decarbonization of production and intensity of greenhouse gas emissions.

Table 1. Recommended indicators reflecting LCD.

Aspect	Indicator name
Energy	Specific consumption of hydrocarbon fuel in physical terms, GJ / units
Energy	Efficiency of hydrocarbon fuel consumption, RUB / GJ
Energy	Energy efficiency, RUB / GJ
Emissions, discharges, wastes	Specific emissions of direct and indirect greenhouse gases in physical terms, TOE / units.
Emissions, discharges, wastes	Reduction of greenhouse gas emissions, TOE / units.
Emissions, discharges, wastes	Removal of greenhouse gases: absorption as a result of the implementation of measures, TOE / unit.

Including additional non-financial indicators in the reporting increases the awareness level of internal and external users about the company's activity.

6. CONCLUSIONS

The investigation of the role and importance of environmental management in solving the LCD problem allowed to establish criteria and additional indicators for assessing the effectiveness of environmental management and develop recommendations for their introduction into the environmental management system and corporate non-financial reporting of the enterprise.

The introduction of additional indicators reflecting the results of the company's activity in the field of LCD aims the targets of environmental management at changing the structure of energy consumption, reducing greenhouse gases emissions, and implementing environmentally significant measures aimed at developing a low-carbon economy.

The basic environmental indicators, supplemented by indicators and indices of greenhouse gas emission intensity and energy efficiency, will help Russian enterprises create a balanced and adequate representation of their environmental performance indicators and will allow improving the environmental management system, monitoring, control and evaluation of key results in the development of a low-carbon economy.

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