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Eco-management in condition of metallurgical production digitization

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Abstract. Efficient use of natural resources, improvement of living standard and quality are increasingly attracting public attention; as a result, data characterizing company financial and non-financial indicators are in strong demand nowadays. Integrated reporting (complex of financial and non-financial indicators) is becoming one more competitive advantage of companies which are ready to submit transparent and reliable data displaying impact exerted by company activities on economy, environment and social medium to interested parties. Authors, aiming to investigate the information content of environmental constituent reflection in company activities under economy digitization condition, performed comparative analysis of ecological indicators recommended for disclosure in non-financial reporting of Global Reporting Initiative and Russian Union of Industrialists and Entrepreneurs (RUIE). Authors, for fuller reflection of results of company activities in the sphere of greenhouse gases emissions and energy consumption monitoring, identified additional indicators enabling eco-management efficiency assessment. Using the proposed indicators it is possible to form an integrated digital block of indicators enabling the researcher to adequately evaluate the level of enterprise eco-safety.

1. Introduction

Business, in present social development condition, is facing two fundamental tasks: make profit and earn public trust. Therefore, the question arises as to whether it is required to certify eco-management system and disclose information about ecological activity results in non-financial reports presented by industrial enterprises. Integrated reporting (complex of financial and non-financial indicators) is becoming a further competitive advantage of companies desiring to submit to interested parties the transparent and reliable data which would display impact exerted by company activities on economy, environment and social medium. One of society's top-priority issues is level of life, and, therefore, the demand arises to disclose information about financial indicators and non-financial aspects of company activities, compliance with environment impact requirements and efficiency of natural resources utilization. For the society it essential to have tools integrated into a unified digital block of indicators enabling efficient evaluation of company ecological safety level. On the other hand, business is also interested to obtain balanced economic and social results and to make them widely accessible, inter alia, by means of non-financial accounting [1, 2], this is why, during transition to digital eco-



monitoring system it is expected that establishment of eco-safety monitoring system and integrated system of technological and economic process control will become a top-priority issue.

Over the past 25 years, a number of scientists took efforts to develop tools which could be used for the purpose of non-financial accounting harmonization [3, 4]. Guiding principles of sustainability reporting became widely spread among specialists involved in non-financial reports compilation. Global Reporting Initiative (GRI) established in 1997 by Coalition for Environmentally Responsible Economies (CERES) in partnership with United Nations Environment Program (UNEP) was intended to improve sustainability reporting and to integrate it with appropriate financial accounting level so as to ensure compatibility, integrity, reliability, preciseness and verifiability of information provided for reporting. GRI standard is one of most commonly used sustainability reporting systems; report is generated using Triple Bottom Line principle: company financial indicators, ecological compatibility and social policy [5]. Authors, aiming to investigate informative value of company-on-environment impact retrieving, performed comparative analysis of ecological measures which will be disclosed in non-financial report furnished in accordance with GRI and RUIE regulations. Analysis shows that, on one hand, particular standard elements in ecological category G4 were expressed in more details, on the other hand, the majority of parameters were expressed in absolute values and were, therefore, not easy to construe. In view of urgency of climate change issue, GRI G4 management is paying particular attention to greenhouse gas emission. RUIE recommends construing the results of nature protection activities in terms of ecological indicators characterizing the efficiency; they include more parameters, however, do not reflect some essential aspects. Information about particular ecological aspects like "Biodiversity" (G4-EN11 – G4-EN14, EN26), "Products and services" (G4-EN27, EN28), "Compliance" (G4-EN29), "Transport" (G4- EN30), "Supplier Environmental Assessment" (G4-EN32, 33), "Environmental Grievance Mechanisms" (G4-EN34) is not disclosed in non-financial reporting of Russian companies because it is not stipulated by the RF legislation. Therefore, it is not included in automated analytic accounting data. Currently, applicable legislation does not require accounting, assessment and tariffication of direct and indirect greenhouse gases emissions [6, 7].

Ecological criteria and environment quality indicators necessary for making ecologically responsible decisions at any management level are normally outside standard market evaluations. Development of individual sustainability indicators and indicators systems on global and local levels has been always the issue for international organizations: UN organization, World Bank, Organization for Economic Cooperation and Development (OECD), European Community, various scientific associations [5, 6]. Apart from indicators systems used for sustainability assessment on macro level, the following aggregate indicators are used: adjusted net savings, human development index, natural capital, WWF living Planet Index, Ecological Footprint.

Papers written by L. Elgert, R. Krueger [8], E. Amrina, S M Yusof [9], M.A. Rosen, H.A. Kishawy [10], C. Fan, J.D. Carrell, H.C. Zhang [11], I. Belik, N. Starodubets, T. Mayorova, A. Yachmeneva [12] are worth mentioning. Analysis of documents compiled by Russian and foreign authors shows that main economic indicators which are although not included in standard market parameters but necessary for assessment and for making ecologically responsible decisions may fully describe all probable technogeneous environmental impacts but do not take into consideration quantities, dynamics and types of consumed energy resources, direct or indirect greenhouse gases emissions [13, 14]. Therefore, they cannot be the source of information used for establishment of common automated control system which is necessary for industrial enterprise eco-management efficiency assessment.

2. Purposes and tasks of investigation

Authors, aiming to ensure progress monitoring and provide ecological indicators integrating into enterprise economic activities, performed investigations with purposes as follows:

1. Improvement of indicators of eco-management assessment efficiency in the course of transition to digital economy.

Tasks:

1. Define directions of improvement for corporate eco-management and non-financial reporting systems,
2. Propose indicators of eco-management efficiency assessment based on criteria and indicators characterizing enterprise contribution to sustainable development.

3. Methods of investigation

Authors consider method of eco-indicators selection and classification complying with OECD-developed “pressure–state–response” model to be the best method characterizing correlation between economic condition, environment protection and eco-management efficiency. Eco-indicators of “pressure” group are reflecting intensity of utilization, disposal and emission of contaminants to environment of industrial wastes generation and removal [15, 16]. Degree of ecological and economic balance on national and international levels, distribution and development of production with account to eco-systems bearing capacity are reflected by eco-indicators of “state” group which are characterizing quality of environment, quantity and quality of natural resources. Eco-indicators of “response” group are characterizing the results of prevention, mitigation and compensation of negative environmental impacts which were caused by human activities, for instance, air, water resources and soil contamination, lands degradation, natural resources natural resources depletion and climate change [17, 18].

Authors, based on indicators compatibility principle intended for eco-management efficiency assessment with the help of eco-indicator systems used worldwide, selected eco-efficiency indicators for Russian enterprises; these indicators are classified into sections as follows: “Water consumption”, “Emissions to atmosphere”, “Processing of wastes” and “Environment protection activities” which are characterizing company activities in compliance with “pressure–state–response” model. Authors, aiming to ensure better reflecting of company activities in the sphere of greenhouse gases emissions and power consumption, identified additional efficiency indicators based on proposed eco-management efficiency criteria [19]:

- greenhouse gases emissions rate;
- decarbonization of production process;
- production energy content.

Authors, in order to calculate additional indicators for standard package of initial parameters which are characterizing eco-management efficiency in terms of water consumption, environment protection and wastes processing, included the below listed parameters:

1. Direct greenhouse gases emissions, t CO₂- equivalent / production unit;
2. Indirect greenhouse gases emissions, t CO₂- equivalent / production unit;
3. Consumption of hydrocarbon fuel, GJ / output unit;
4. Total consumption of power resources, GJ / production unit;
5. Reduction of greenhouse gases emissions, t CO₂- equivalent / per annum;
6. Absorption of greenhouse gases, t CO₂- equivalent / per annum;

Additional indicators ref. 1–4 are characterizing the production-caused pressure exerted on environment by particular company in terms of power resources utilization and greenhouse gases emission rates, this is why they were included in “pressure” group. Additional indicators ref. 5 & 6 are characterizing eco-management efficiency in terms of greenhouse gases emission resistance this is why they were included in “response” group. Additional indicators ref. 1-4 were included for eco-efficiency coefficient calculation in “pressure” group; additional indicators 5 & 6 – in “response” group [20].

4. Results

Authors proposed to use the following indicators for the purpose of comprehensive assessment of eco-management efficiency:

- package of basic and additional parameters characterizing the company in compliance with “pressure-state-response” model;
- indicators of eco-efficiency calculated for groups “pressure”, “state” and “response” on the basis of nominal main and additional parameters;
- integrated indicator of eco-efficiency (table 1) [18].

Table 1. Indicators of ecological management efficiency assessment.

Pressure	State	Response
1. Intensity of greenhouse gases emission	– direct greenhouse gases emissions – indirect greenhouse gases emissions	– decarbonization of production process
2. Production energy content.	– consumption of hydrocarbon fuel – total consumption of power resources	– reduction of greenhouse gases emission – absorption (preservation) of greenhouse gases
Integrated indicator of ecological efficiency		

Summarized by authors on the basis of [17, 18, 19].

Authors, in order to construe aggregated indicators for groups “pressure”, “state” and “response”, individual indicators of intensity, energy content and decarbonization and integrated indicator of company eco-management efficiency, proposed: five levels of indicators qualitative interpretation and five-grade scale of marks (Table 2) [18].

Table 2. Qualitative assessment of relative integral characteristics of enterprise ecological and economic efficiency.

Range of indicator relative values	Assessment in points	Qualitative interpretation of relative values
0 – 0.1	0	No activities
0.1 – 0.3	1	Very low efficiency
0.3 – 0.5	2	Low efficiency
0.5 – 0.7	3	Insufficient efficiency
0.7 – 0.9	4	Sufficient efficiency
0.9 – 1	5	High efficiency

Proposed indicators were tested on RF largest metallurgy enterprise PJSC Magnitogorsk Iron and Steel Works [18] for the purpose of eco-management efficiency assessment. Analysis of activities performed by PJSC Magnitogorsk Iron and Steel Works on the basis of proposed eco/energy efficiency assessment criteria displayed poor efficiency of ecological activities maintained by PAO PJSC Magnitogorsk Iron and Steel Works. Indicator of greenhouse gases emission reached 2 points, i.e. no measures are taken to check and control greenhouse gases emission (as affirmed by zero cost of de-carbonization index); production energy content index demonstrates high efficiency (5 points) – it is characterizing simultaneously economic (cost savings) and ecologic efficiency because it strongly depends on [expensive] coke amount and on power resources consumed for technological process being the main source of greenhouse gases emission.

Authors gained the following results:

1. Upon analyzing available international tools, identified directions of eco-management and corporate non-financial reporting improvement;
2. Substantiated the principle of eco/energy criteria integrating into common automated control system which is necessary for production enterprise eco-management efficiency assessment;
3. Proposed methodological approach to eco-management efficiency assessment whose specific feature consists in using ecological and energy criteria which are disclosing enterprise contribution to environment protection;
4. Performed analysis of anthropogenic influence exerted by PJSC Magnitogorsk Iron and Steel Works on environment on the basis of proposed methods.

5. Conclusions

Main package of basic eco-indicators is adequately reflecting all types of anthropogenic influence exerted on environment, however, it is not accounting for amount, dynamics or types energy resources consumed and direct or indirect emissions of greenhouse gases and, therefore, cannot be used as a source of information necessary for proper assessment of industrial enterprise ecological management efficiency.

Authors, for the purpose of more profound reflection of company activities on greenhouse gas emission and power consumption control and development of eco-monitoring system within the framework of common automated technological/economical process control system, identified additional indicators displaying efficiency of ecological management in terms of greenhouse gases emission monitoring which are characterizing industrial pressure exerted on particular company's environment. These additional indicators are included in eco-efficiency index calculation for groups "pressure" and "response". Relative values of integrated indicators for groups "pressure", "state" and "response" and for integrated indicator of company eco-management received qualitative evaluation based on five-grade scale developed by the authors. Analysis of efficiency of PJSC Magnitogorsk Iron and Steel Works based on newly established criteria of eco/energy efficiency enabled the authors to find out tendencies of industrial enterprise ecological management development. Unified digital block of indicators displaying results of company activities on greenhouse gas emission and hydrocarbon fuel consumption control (within the framework of common automated control system) will make it possible to evaluate the current situation and to define strategic and tactical eco-targets, to distribute responsibilities, to develop efficient managerial solutions and to track the process of achievement of ecological management results.

6. Directions of further investigations

As an outlook for further investigations, it is proposed to use the criteria developed hereunder for investment projects modeling with the use of digital technologies, inter alia, on the basis of eco-indicators which are characterizing environment condition in vicinity of industrial enterprise. Such measures will make it possible to enhance attractiveness for investors, business-partners, government authorities and to improve enterprise manageability in terms of sustainability adaptation.

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