



Methodology for assessment of inclusive social responsibility of the energy industry enterprises

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ARTICLE INFO

Handling Editor: Dr. Govindan Kannan

Keywords:

Energy sector
Indicators aggregated system
Inclusive sustainable growth
Sustainability
Socially responsible attitude

ABSTRACT

Enterprises of the energy industry, trying to keep up with the rapid development of scientific and technical progress, often do not study and predict the potential negative consequences of their innovative activities for society and the environment in hyperdynamic conditions. However, economic growth in this way can be accompanied by increased income inequality and population poverty, deterioration of environmental conditions, the disproportionality of territorial development, etc., which requires increased social responsibility. The concept of inclusive social responsibility of energy industry enterprises can be at the forefront of solving this problem, which is designed to ensure the maximum inclusion and interaction of all members of society of all strata of the population in economic activity to increase the level of employment, social responsibility, social and territorial unity. The authors proposed a methodology for assessing the state of inclusive social responsibility of energy industry enterprises, which considers the industry specifics of fuel and energy enterprises. The offered method of assessment of inclusive social responsibility, unlike the existing ones, includes in its focus the following components: social (taking into account vulnerable categories of the population), socially responsible attitude (definition of the main values, law-abiding enterprise, thrifty attitude to ecology, etc.) and economic, emphasizing the importance of the company's profit-making to ensure its sustainable and inclusive development; each of the proposed indicators has a universal character, helps the energy company to examine its internal business processes and find bottlenecks in its operations, and using them as an aggregated system has a synergistic effect. Because all indicators of the presented system are characterized by percentages or certain levels and are evaluated in points, a competitive evaluation can be carried out among enterprises that have different sizes and different scopes of activity, also without reference to their location. The methodology is based on the calculation of the integral indicator, the synergistic effect and the relationship of 20 indicators of the aggregated system, including the methodology of expert assessments, mathematical modelling, in particular, transported matrices. The proposed methodology was tested on a sample of innovatively active enterprises in Ukraine's fuel and energy complex; the volume of activities for 2020 amounted to 250 million euros or more and confirmed its effectiveness.

1. Introduction

A key point in the further development of Ukraine-EU relations in the energy sector is the transformation of the energy market model and the emergence of competition between domestic electricity producers, which will cause threats, but at the same time, contains numerous opportunities for successful development of Ukraine's energy industry (Prokopenko et al., 2017; Shpak et al., 2019; Malynovska et al., 2022).

The complex modern conditions of the functioning of the economy encourage enterprises of the energy sector to constantly search for and introduce new technologies, goods and services, and organizational mechanisms in their activities to survive, strengthen competitive positions, enter new markets and obtain greater profits. As a result, energy industry enterprises, trying to keep up with the rapid development of scientific and technological progress, often do not study and predict the potential negative consequences of their innovative activities for society

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<https://doi.org/10.1016/j.jclepro.2023.136317>

Received 20 August 2022; Received in revised form 28 January 2023; Accepted 1 February 2023

Available online 9 February 2023

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and the environment in hyperdynamic conditions (Anadon et al., 2016; Durmanov et al., 2019).

However, economic growth in this way can be accompanied by increased income inequality and population poverty, deterioration of environmental conditions, the disproportionality of territorial development, etc. Ecological cleanliness of production is ensured not only by the latest technologies using modern equipment but, above all, by the awareness of the need for this and the desire to implement it in economic activity. The problem lies in need to overcome the gap between the innovation process and the social responsibility of its stakeholders and subjects.

The energy industry is the basis of the economy and industry; in many countries, energy industry enterprises are strategically important and the base of the country's economy (Sotnyk et al., 2021). Ukraine's signing of the Paris Climate Agreement provided an additional impetus for reassessing the role of nuclear energy as a low-carbon technology for electricity production in the national energy mix and its contribution to the low-carbon economy of countries. However, in the conditions of the rapid, unpredictable growth of innovations, enterprises mainly do not study and do not predict their possible negative consequences for society and the environment, although institutions of the education and health care systems state a constant deterioration of the state of physical health, an increase in emotional tension, aggression and manifestations of deviance in different social strata. Overcoming the gap between the innovation process and the social responsibility of its subjects and stakeholders in the innovative economy is possible due to the formation of inclusive social responsibility, which systematically harmonizes their interests based on the principles of sustainable smart development.

Such a situation requires an increase in social responsibility from two sides – both on the part of the participants in the activity process and the users of its results. The concept of inclusive social responsibility of enterprises in the energy industry, is designed to ensure the maximum inclusion and interaction of all members of society of all strata of the population in economic activity to increase the level of employment, social responsibility, social and territorial unity, can be at the forefront of solving this problem.

The issue of social responsibility becomes especially relevant in the conditions of the state of war in Ukraine and the next stage of its development, the post-war recovery and revival of the liberated territories of the country, taking into account the specifics of this stage, features, opportunities and threats, especially for socio-economic activity.

Inclusiveness of socio-economic processes ceases to be just a characteristic; it becomes their essence. Because the scientific community appreciates the certainty of the era of universal inclusion (for example, the unification of the world around the war in Ukraine, the consolidation of society in Ukraine for the sake of victory is a direct example of universal inclusion, when everyone is involved in the process and everyone has their special meaning, including vulnerable categories of the population, the number of which increased sharply with the beginning of the war in Ukraine), social responsibility also acquires inclusive features.

Enterprises of the energy sector and energy infrastructure are the ones that suffer the most during the war, so their recovery and the restructuring of the energy market itself to approach EU standards are among the top priorities. Also, the problem of returning the population to Ukraine, providing them with jobs, and guaranteeing a decent standard of living for every member of society and especially vulnerable categories of the population, is acutely on the agenda.

Inclusive social responsibility is based on using inclusive business models that create the potential for business both in terms of making a profit and meeting social interests. Thanks to the implementation of inclusive business models, companies can take advantage of opportunities to develop their innovative activities and create innovative solutions necessary to serve remote areas that were traditionally considered inaccessible, provide access to products or services and increase the

purchasing power of the poor by offering relevant goods and services at a lower price.

Highlighting unresolved issues. Despite a sufficient number of scientific studies in this direction and already existing methods for assessing the social responsibility of business, including well-known international indices such as the Domini Social Investment Index (DSI 400), Dow Jones Sustainability Index, FTSE4Good Index, Corporate Philanthropy Index, the issue of taking into account interests of vulnerable groups of society remains open. The method of the London Benchmarking Group (Celis, 2015; Parlińska and Stawicka, 2018; Fatenok-Tkachuk and Voronko, 20219), which is more focused on the analysis of social inclusion of enterprises, is built on the methodology of cooperation between enterprises and communities according to four main types: charitable donations, social investments or investments in the community, commercial initiatives and business practices.

This method is closer to our understanding and the possibility of measuring inclusive social responsibility; evaluation according to this method also includes evaluation from the side of the process and the side of the result of the company's activity; however, this method does not emphasize the importance of the company's earning of profit and consideration of the economic indicators of the company's activity.

The offered method of assessment of inclusive social responsibility, unlike the existing ones, includes in its focus the following components: social (taking into account vulnerable categories of the population), socially responsible attitude (definition of the central values, law-abiding enterprise, thrifty attitude to ecology, etc.) and economic, emphasizing the importance of the company's profit-making to ensure its sustainable and inclusive development.

The purpose of the study is to develop a methodology for assessing the inclusive social responsibility of enterprises and its approbation at enterprises of the energy industry and to identify "bottlenecks" in the direction of inclusive socially responsible activities, the elimination of which will contribute to the growth of socio-economic support for the development of both the enterprises themselves and the human potential of the country and reducing the level of social vulnerability of the population.

2. Literature review

2.1. Social responsibility and its assessment

Futuristic projects regarding the progressiveness of the information economy and post-industrial development have already been destroyed by the harsh reality of the lack of financial and material resources in world markets, which only leads to increased competition. The experience of recent times shows that the rapidity of scientific and technological progress, modernization of the economy and economic growth can be accompanied by an increase in income inequality, social inequalities and the strengthening of disparities between the city and the countryside. These trends actualize the problems of social stratification in the process of development.

Currently, the gap between the rich and the poor is widening everywhere. In the UNDP (2022) report, it is noted that 1.2 billion people are multidimensionally poor. According to the World Bank, the pandemic pushed some 70 million people into extreme poverty in 2020, the most significant single-year increase since poverty monitoring began in 1990. As a result, according to estimates, the number of those who lived on less than \$2.15 a day by the end of 2020 was 719 million people (The World Bank, 2021).

In 2020, around 1 in 4 people lacked safely managed to drink water in their homes, and nearly half the world's population lacked safely managed sanitation (UNICEF, 2021), 13% of the world do not have access to electricity (Ritchie et al., 2022) and 5.4 to the Internet; 2.5 billion people do not have accounts in financial institutions. Thus, under the current socio-economic development model, inequality is increasing, absolute poverty is not decreasing, and a significant

proportion of the population is not improving their well-being (Piketty, 2014).

The welfare of society is a multidimensional concept. It consists not only of the growth of real GDP and material income of the population but also includes such areas of human life as education, health care, personal safety, ecology and many others. The fact that the "sustainability" parameter alone is not enough for economic growth is also taken into account: it must be inclusive, i.e. positively affect the well-being of the broadest possible strata of the population and at the same time not have a threatening impact on the natural environment. Inclusive growth should give people equal opportunities to realize their human potential, regardless of socio-economic conditions, gender, place of residence and ethnic roots (Lewicka, 2020; Wolak-Tuzimek and Duda, 2021).

The problems of researching the essence of inclusive economic growth, its main characteristics and its impact on clean production and sustainable development are actively discussed in the scientific literature, in particular in foreign works (Agudelo et al., 2020; Nagar, 2021; Lee and Yang, 2022; Miller et al., 2022), as well as Polish (Wirth et al., 2016; Beck-Krala et al., 2018; Lewicka and Rakowska, 2017; Dyduch and Krasodomska, 2017; Sukiennik and Bąk, 2019; Nawrocki and Sz wajca, 2021) and Ukrainian scientists (Filyppova et al., 2017; Yermak, 2019; Frolova et al., 2021; Makhonin, 2020). The social responsibility problems in the energy sector attract even more attention from scientists and practitioners: almost 1000 articles (in the Google Scholar database) and 770 (in the Scopus database) from 2000 to 2022. Due to such a significant number of scientific sources, let's focus our attention on the research subject: social responsibility assessment.

Thus (Smachilo and Balyaba, 2015), lay fragmentary foundations, namely, a list of evaluation indicators of social responsibility and recommend distinguishing three zones of social responsibility of enterprises. The disadvantage of this methodology for our study is that it is designed for construction enterprises considering their specific characteristics.

(Nadeiko, 2020) offers a methodology for evaluating the priority areas of social responsibility activities to achieve the desired success factors based on expert assessments; also, the research was carried out based on a survey of executive authorities, which means a significant influence of the subjective factor.

Contrary to this study, a team of scientists (Dinçer et al., 2019) proposes more accurate methods for assessing social responsibility – economic-mathematical (fuzzy DEMATEL and MOORA approach), which basically involve a choice among alternatives. However, the disadvantages of these methods are that they are used primarily in the decision support system and determine the ranking of options based on their interdependence. Other criteria are not included in the decision-making problem.

The method of Urusova and Lepokhin, 2022), which propose to evaluate social responsibility through a generalized indicator of corporate social responsibility with Harrington's desirability function, is worthy of attention. However, the drawback of this methodology is that the authors only consider internal indicators of social responsibility, not the company's impact on the environment.

Stjepcevic and Siksnelyte, 2017 do not offer a methodology for assessing social responsibility but outline the factors and features of social responsibility in the energy sector.

Nawrocki and Sz wajca, 2021 identify three aspects of energy sector responsibility and evaluate Polish energy companies using a methodology based on a generalized indicator of social responsibility, which divides indicators into stimulators and destimulators using the formula of the arithmetic mean of normalized sub-indicators. The main drawback of this technique is its dependence on the availability and reliability of quantitative data published by enterprises, which usually differ.

Thus, the study showed progress in assessing the social responsibility of enterprises in the energy sector; however, they all have a perspective for improvement, which proves the relevance of the development. Also,

when developing the methodology, it will be considered the international standard ISO 26000:2010 "Management on social responsibility"; therefore, it is advisable to evaluate the enterprise's social responsibility according to its problems [ISO 26000 Social Responsibility].

2.2. Inclusive economy and inclusive social responsibility

Inclusive economy and inclusive economic growth, or socially oriented growth, the fruits of which benefit the entire population, in recent years have become a central theme in the documents of international and supranational organizations (the International Monetary Fund, the Organization for Economic Cooperation and Development, the European Bank for Reconstruction and Development, the World Bank (World Bank, 2008, 2021)).

In European countries, the concept of inclusive sustainable growth has gained wide popularity. Several scientists initially developed its introductory provisions from academic circles. These provisions were developed by members of the Commission on Growth and Development under the leadership of Nobel Prize laureate M. Spence, which prepared the report "The growth report. Strategies for Sustained Growth and Inclusive Development" (World Bank, 2008). The report identifies critical factors and political levers capable of helping countries achieve high, sustainable and inclusive growth; provides a complete analysis of those ingredients that, when used in the right combination for a given country, can provide economic growth and lift the country's population out of poverty.

Despite the reasonably quick acceptance of the concept of inclusive growth by a wide range of specialists, there currently needs to be a single definition of this concept. Thus, the World Bank defines inclusive growth as high and sustainable, widespread in all sectors of the economy, involves a significant part of the workforce and is characterized by equal opportunities in access to the market and resources (World Bank, 2008). The main emphasis in this definition is on productive employment for all population groups, including women, more than on income distribution. The European Commission, when preparing the Europe 2020 strategy, noted that inclusive growth includes: full use of labour potential, reduction of poverty and its consequences, development of social inclusion, and elimination of regional disparities.

Economic growth is not an end in itself. However, it allows individuals and businesses to accomplish other essential tasks. It can free the mass of people from poverty and exhausting work, and form reserves to support health care, education and other development goals recorded in the Millennium Declaration, to which the whole world has declared its commitment. According to the report (World Bank, 2021), growth is necessary and perhaps sufficient for more progressive development and giving people the opportunity to become productive workers and creative individuals.

The term "inclusion" was first proposed in the United States of America in the 1970s when researchers began to spread the concept of social integration (inclusion), which meant increasing the participation of citizens in improving social processes.

In the works of modern economists J. Robinson and D. Acemoglu et al. (2010, 2012), it is determined that the concept of "inclusion" is close in meaning to the idea of "integration" and is opposite to segregation and extraction. In work "Why nations fail: the origins of power, prosperity, and poverty", scientists use the terms extractive and inclusive economic institutions.

Most scientists whose interests are innovations (Anadon et al., 2016; Yermak, 2019; Waqar et al., 2020; Frolova et al., 2021)) recently consider their management for unforeseen circumstances but without the social responsibility of the innovation process's subjects. Recently, researchers have increasingly concluded that development should be both innovative and inclusive (Smachilo and Balyaba, 2015; Durmanov et al., 2019; Yermak, 2019; Fang, 2020; Wolak-Tuzimek and Duda, 2021; Gupta et al., 2021)) because the reverse side of profitable, innovative activity is the state environment, health and welfare of the nation.

There is a question of research and popularization of inclusive social responsibility among all subjects of innovative activity, which will increase the safety of every nation member and reduce the riskiness of the innovative economy in current conditions. The thesis that social responsibility minimizes the risk of conflict with stakeholders is supported by (Becchetti et al., 2018), justifying the expediency of risk-oriented management and a smart approach, which is based on smart management and smart development (Severo et al., 2018; Zemigala, 2019; Ye et al., 2020; Britchenko et al., 2022).

However, they also underestimate the connection between the social responsibility of innovators and manufacturers and the instrumental-purpose blocks of the state innovation policy and social development strategy. Therefore, it can be argued that inclusive social responsibility has not been highlighted at the macro level of management in the context of innovative development, which confirms the study's relevance.

3. Materials and methods

To assess the state of inclusive social responsibility of the subjects of the innovation process (ISRSIP), a system of indicators was determined and combined into three groups. These groups, in the opinion of the authors, most fully reveal the essence of inclusive social responsibility of the energy industry enterprises (economic indicators (X), social indicators (Y) and indicators of socially responsible attitude (Z)).

- X₁ – profit growth due to the introduction of innovative technologies of innovative products, %, %;
- X₂ – increase in the volume of sales/production, %;
- X₃ – increase in labour productivity, %;
- X₄ – decrease in the cost of production (works, services) %;
- X₅ – growth of intangible assets, %;
- X₆ – cost savings due to the use of energy-saving technologies, %;
- Y₁ – increase in staff income, %;
- Y₂ – improvement of working conditions and safety;
- Y₃ – improvement of the qualification level of employees;
- Y₄ – increase in the share of new jobs, %;
- Y₅ – improvement of product quality;
- Y₆ – degree of coverage of remote areas by the company's products, %;

- Y₇ – the share of vulnerable sections of the population in the total number of personnel, %;
- Y₈ – improvement of the enterprise's participation in the social support of employees;
- Z₁ – the level of definition of the main values at the enterprise
- Z₂ – the level of readiness of the enterprise for innovative changes;
- Z₃ – reliability level characterized by the absence of administrative, legal and technological violations;
- Z₄ – level of corporate social responsibility;
- Z₅ – reduction of negative impact on the environment, %;
- Z₆ – reduction of emissions of harmful substances into the atmosphere, soil, and water.

The obtained aggregated system of indicators for assessing the state of ISRSIP was formed considering the industry specifics of energy industry enterprises, which collectively characterize the general state of inclusive social responsibility. It should be noted that the developed system of indicators for the assessment state of ISRSIP is incomplete. Depending on the individual characteristics of the energy industry enterprise, it can be modified and expanded.

The result of such integration is a synergy effect: 20 indicators of the aggregated system are interconnected, and therefore, the improvement of one of them leads to progress in the other 19, which, accordingly, ensures an improvement in the overall state of the ISRSIP. The recommended rating scale of the given system of indicators is presented in Table 1.

The assessment and distribution of the actual values and indicators of the assessment state of the ISRSIP by the normative were carried out based on a questionnaire in which Polish and Ukrainian experts from the innovative activities of the energy industry enterprises in Ukraine took part. The survey was conducted by online questionnaires (Google forms) and by direct interview. Each respondent was asked to fill out a questionnaire. It was necessary to evaluate the indicators of the state of inclusive social responsibility of the stakeholders of the innovation process for a specific enterprise in the energy sector of Ukraine. A total of 278 respondents participated (online - 82.73%, offline - 17.27%; age from 25 to 65 years; 60.43% of men and 39.57% of women); after the initial processing of the questionnaires, 270 questionnaires remained relevant (about 2%).

The consistency check of the experts' opinions regarding the

Table 1
Groups of ISRSIP indicators and the recommended scale for their assessment.

Indicators	Notation	Scores					
		5 points	4 points	3 points	2 points	1 point	0 points
1. Economic indicators group (X)	X ₁	>15,1	10,01–15	5,01–10	2,01–5	0,1–2	0
	X ₂	>25,1	15,01–25	8,01–15	2,01–8	0,1–2	0
	X ₃	>30,1	20,01–30	10,01–20	3,01–10	0,1–3	0
	X ₄	>25,1	15,01–25	8,01–15	2,01–8	0,1–2	0
	X ₅	>25,1	15,01–25	8,01–15	3,01–8	0,1–3	0
	X ₆	>30,1	20,01–30	10,01–20	5,01–10	0,1–5	0
2. Social indicators group (Y)	Y ₁	>30,1	20,01–30	15,01–20	5,01–10	0,1–5	0
	Y ₂	very high	high	average	below average	insignificant	absent
	Y ₃	every month	once every 3 months	once every six months	once in 1 year	once every 2 years or less	doesn't happen
	Y ₄	>25,1	20,01–25	15,01–20	5,01–10	0,1–5	0
	Y ₅	very high	high	average	low	very low	absent
	Y ₆	>25,1	15,01–25	8,01–15	2,01–8	0,1–2	0
	Y ₇	>15,1	10,01–15	5,01–10	2,01–5	0,1–2	0
	Y ₈	very high	high	average	low	very low	absent
3. Socially responsible attitude indicators group (Z)	Z ₁	very tall	high	average	low	very low	absent
	Z ₂	very tall	high	average	low	very low	absent
	Z ₃	very tall	high	average	low	very low	absent
	Z ₄	very tall	high	average	low	very low	absent
	Z ₅	>25,1	15,01–25	8,01–15	3,01–8	0,1–3	0
	Z ₆	>15,1	10,01–15	5,01–10	2,01–5	0,1–2	0

Source: proposed by authors.

assessment state of inclusive social responsibility of the stakeholders of the innovation process was carried out based on the calculation of the coefficient of variation (ν_i) according to formula (1):

$$\nu_i = \frac{\tilde{\sigma}_{C_i}}{\bar{C}_i} \tag{1}$$

where n is the number of indicators for the assessment state of inclusive social responsibility of the stakeholders of the innovation process;

$\tilde{\sigma}_{C_i}$ is the root mean square deviation, which is calculated according to the following formula:

$$\tilde{\sigma}_{C_i} = \sqrt{\frac{1}{n-1} \sum_{i=1}^m (C_i - \bar{C}_i)^2} \tag{2}$$

where C_i is the average expert assessment of the i -th indicator of the assessment state of ISRSIP at the n -th energy industry enterprise;

\bar{C}_i is the average value of the i -th indicator of the assessment state of ISRSIP (characterizes the general opinion of experts), which is calculated according to the formula:

$$\bar{C}_i = \frac{1}{n} \sum_{i=1}^n C_i \tag{3}$$

And with the help of the concordance coefficient (W), which is calculated according to the formula [Bashynska, 2015]:

$$W = \frac{12S}{m^2(n^3 - n)} \tag{4}$$

where

$$S = \sum_{i=1}^n \left(\sum_{j=1}^m x_{ij} - \frac{1}{2}m(n+1) \right)^2 \tag{5}$$

m is number of experts;

x_{ij} is the i -th element in the x_j sample.

Subtrahend in parentheses shows the average sum of ranks (summed up for each object) received from experts. The concordance coefficient varies in the range from 0 to 1, and its equality of one means that all experts assigned the same ranks to the objects. The closer the value of the coefficient is to zero, the less consistent the experts' assessments are.

At the next evaluation stage, respondents were asked to evaluate the importance of the i -th indicator of each j -th group of the assessment state of ISRSIP. The evaluation was carried out by pairwise comparison method according to the templates developed by the authors (Fig. 1 - Fig. 3).

In this case, the designations in the field of the matrix of pairwise comparisons must be interpreted as follows.

	X_1	X_2	X_3	X_4	X_5	X_6
X_1	0					
X_2		0				
X_3			0			
X_4				0		
X_5					0	
X_6						0

Fig. 1. The matrix of pairwise comparisons of indicators of the economic group of the assessment state of ISRSIP.

- 1 - the importance of the i -th indicator is higher than that of the j -th indicator;
- 0 - indicators are equally important;
- 1 - the importance of the j -th indicator is higher than the i -th indicator.

According to the results of the processing of expert evaluations for each functional unit of the assessment of the effectiveness of the inclusive development of the innovative activity of the enterprise, two matrices of the following type were formed (Medykovskiy and Shuneyvych, 2011):

$$\tilde{R}^k = \left\| \omega_{ij}^k \right\|, \omega_{ij} \in \{-1, 0, 1\}, \tag{6}$$

$$\tilde{R}^{k+} = \left\| \omega_{ij}^{k+} \right\|, \omega_{kij} \in \{0, 1, 2\}, \tag{7}$$

where $\omega_{ij} = -1$ means the superiority of the i -th indicator over the j -th indicator of the k -th group of indicators for assessing the state of ISRSIP;

$\omega_{ij} = 0$ means the equivalence of the i -th and j -th indicator of the evaluation of the effectiveness of the inclusive development of the innovative activity of the enterprise;

$\omega_{ij} = 1$ means the superiority of the i -th indicator over the j -th indicator of the k -th group of indicators for assessing the state of ISRSIP.

\tilde{R}^{k+} is a transformed matrix of the comparative importance of indicators for assessing the state of ISRSIP.

According to the values of the elements of the transported matrices $\tilde{R}^{k+} = \left\| \omega_{ij}^{k+} \right\|$, for each group of indicators of the state of the ISRSIP, a consolidated matrix of coefficients of comparative importance is formed, the elements of which are calculated according to the formula:

$$\omega_{ij} = \frac{1}{k} \times \sum_{t=1}^m R_t \tag{8}$$

where ω_{ij} is the average weighted estimate of the comparative importance of the i -th indicator of the state of ISRSIP;

k is total number of respondents;

R_t is the value of the element of the matrix of comparative importance according to the i -th indicator of the effectiveness of the inclusive development of innovative activity.

The formation of vectors of importance coefficients of the i -th indicator of the k -th group of indicators for assessing the state of ISRSIP is carried out according to the formula:

$$\omega_{(1..2)}^{(k)} = \frac{\sum_{j=1}^m \omega_{ij}^+}{\sum_{i=1}^m \sum_{j=1}^m \omega_{ij}^+}, \tag{9}$$

To assess the state of inclusive social responsibility of energy industry enterprises, at the next stage, each group's complex performance indicators were calculated based on the taxonomic method (Benfer, 1972; Christenson and Read, 1977; Vasiutkina et al., 2019). The calculation was carried out according to the following formula:

$$GI_{ICB}^{(X,Y,Z)} = \sum_{i=1}^n \sqrt[n]{\sum_{i=1}^n (SO_{ij})^{\omega_{ij}}} \tag{10}$$

where $GI_{ICB}^{(X,Y,Z)}$ is a complex indicator of the level of priority of the j -th group of indicators of the state of inclusive social responsibility (economic (X), social (Y), and socially responsible attitude (Z));

SO_{ij} is degree of achievement of the i -th indicator of the assessment of the state of inclusive social responsibility of the j -th group of its reference value;

ω_{ij} is the coefficient of the importance of the i -th indicator of the state of inclusive social responsibility of the j -th group of indicators.

The degree of achievement of the i -th indicator of the assessment of the inclusive development of the innovative activity of the j -th group of indicators of its reference value (SO_{ij}) is determined by the formula (Yermak, 2019):

$$SO_{ij} = \frac{S_{ij} - S^s}{\sigma_j} \tag{11}$$

where SO_{ij} is the standardized value of the i -th indicator of the assessment of the state of inclusive social responsibility of the j -th group of indicators for the k -th energy industry enterprise;

S_{ij} is the actual value of the i -th indicator of the assessment of the state of inclusive social responsibility of the j -th group of indicators for the k -th energy industry enterprise;

S^s is the reference (maximum) value of the i -th indicator of the assessment of the state of inclusive social responsibility of the j -th group of indicators for the k -th energy industry enterprise;

σ_j is the root-mean-square deviation of the i -th indicator of the assessment of the state of inclusive social responsibility of the j -th group of indicators for a sample population of energy industry enterprises (2), which is calculated according to the formula:

$$\tilde{\sigma}_{SO_i} = \sqrt{\frac{1}{n-1} \sum_{i=1}^m (S_i - \bar{S})^2} \tag{12}$$

where n is the number of indicators for assessing the state of inclusive social responsibility of the energy industry enterprises;

S_i is the value of the i -th indicator of the assessment of the state of inclusive social responsibility;

\bar{S}_i is the average value of expert evaluations, which characterizes the general opinion of experts, which is calculated according to the formula:

$$\bar{S}_i = \frac{1}{n} \sum_{i=1}^n S_i \tag{13}$$

The general assessment of the state of inclusive social responsibility of the subjects of the innovation process (ISRSIP) in the energy sector is proposed to be carried out using the integral indicator (IIISR):

$$II_{ISR} = \sqrt[3]{\frac{(GI^X \bullet \omega_X) \bullet (GI^Y \bullet \omega_Y) \bullet (GI^Z \bullet \omega_Z)}{\sum \omega_i}} \tag{14}$$

where GI^X , GI^Y , GI^Z are indicators of the assessment state of the ISRSIP by groups (economic indicators (X), social indicators (Y) and indicators of socially responsible attitude (Z));

ω_X , ω_Y , ω_Z are coefficients of the importance of each group of indicators, coef.

4. Research results

To assess the state of inclusive social responsibility of the stakeholders of the innovation process, a sample of innovatively active enterprises in the energy industry of Ukraine was made; the volume of activity of which for 2020 was 250 million euros and more (Table 2).

From the given Selection 1 (25 enterprises), the 10 most profitable enterprises were selected for the analysis of ISRSIP (Selection 2: Ukr-gazvydobuvannya JSC (7), Ukrnafta PJSC (9), Ukrohdroenergo PJSC (20), D.Trading LLC (5), YE Energy LLC (12), Energotrade LLC (16), United Energy LLC (11), Dnipro energy services LLC (25), West Petrol Market LLC (13), ERU Trading LLC (18)), justifying the choice by the

Table 2

A selection of innovative enterprises in the energy sector of Ukraine with a volume of activity in 2020 was 250 million euros and more.

Enterprise	Activity	Profit, million euros	Loss, million euros
1. DTEK Skhidenergo JSC	Production of electricity	-	79,37
2. DTEK Zahidenergo JSC	Production of electricity	-	64,55
3. DTEK Dniproenergo JSC	Production of electricity	-	55,56
4. Naftogaz of Ukraine JSC	Import and sale of natural gas	-	531,74
5. D.Trading LLC	Coal, electricity, natural gas	42,06	-
6. TEC Ukrenergo PJSC	Management of main power grids	-	727,51
7. Ukr-gazvydobuvannya JSC	Gas production and production of petroleum products	131,48	-
8. SE "NNEGC "Energoatom"	Production of electricity	-	128,31
9. Ukrnafta PJSC	Oil and gas production	112,96	-
10. TFIOC "Ukrnafta" PJSC	Production of petroleum products	21,96	-
11. United Energy LLC	Resale of state-generated electricity	21,95	-
12. YE Energy LLC	Gas trade	35,71	-
13. West Petrol Market LLC	Import and sale of fuel	17,46	-
14. Centernergo PJSC	Production of electricity	16,13	-
15. VOG Trade Resource LLC	Import and sale of fuel.	1,85	-
16. Energotrade LLC	Import and sale of gas.	22,75	-
17. DTEK Pavlogradvugilya PJSC	Coal mining	-	159,78
18. ERU Trading LLC	Sale of gas, electricity	12,96	-
19. Alliance Energy Trade LLC	Import and sale of oil products	8,99	-
20. Ukrohdroenergo PJSC	Production of electricity at hydroelectric power stations and hydroelectric power stations	109,52	-
21. Naftohimik Prykarpattia PJSC	Storage of oil products.	-	35,19
22. Okko-Business Contract PP	Trading and sale of oil products	40,48	-
23. Kyiv Energy Services LLC	Trade in electricity	83,86	-
24. AV Metal Group LLC	Trade in electricity	7,67	-
25. Dnipro energy services LLC	Trade in electricity	20,11	-

fact that enterprises with working inclusive business models must earn a profit to be able to finance socially responsible areas of their activity.

The average values of indicators of the state of inclusive social responsibility of the energy industry in Ukraine, calculated based on the results of processing questionnaire data, are shown in Table 3.

The calculated value of the coefficient of variation (1) was 9,38%, and the coefficient of concordance (4) was 0,812, which allows us to conclude that a high degree of agreement of opinions among respondents regarding the formation of an integrated system for assessing the state of inclusive social responsibility of the subjects of the innovation process.

The matrices formed according to the algorithm (Figs. 1–3, formulas (6) - (9)) are shown in Fig. 4.

Indicators of the economic group for assessing the state of the ISRSIP.

Taking into account the calculated coefficients of importance (9) and the degree of achievement of the i -th indicator of assessing the state of inclusive social responsibility of the j -th group of indicators of its reference value (CO_{ij}) (11), the complex indicators are calculated the state of inclusive social responsibility, which are given in Table. four.

Table 3

Average values of the indicators of the assessment state of inclusive social responsibility of the energy industry enterprises in Ukraine.

Indicators by groups	United Energy LLC	ERU Trading LLC	Ukrhydroenergo PJSC	Dnipro energy services LLC	West Petrol Market LLC	Energotrade LLC	Ukrnafta PJSC	YE Energy LLC	Ukrkazvydobuvannya JSC	D. Trading LLC	
1. Economic indicators group (X)	X ₁	3,1	2,1	2,4	1,4	1,5	2,2	2,5	3,1	3,3	4,1
	X ₂	1,3	1,1	3,2	2,2	2,6	2,1	3,1	2,4	2,5	2,1
	X ₃	2,1	3,4	2,6	3,7	3,6	4,3	2,1	2,8	3,1	4,4
	X ₄	1,8	1,1	2,2	1,3	1,4	1,1	1,2	1,4	1,3	1,7
	X ₅	3,2	2,5	3,1	2,3	2,5	2,4	1,4	2,7	2,4	4,4
	X ₆	3,4	2,7	3,8	2,4	1,6	3,5	3,7	2,2	2,7	3,5
2. Social indicators group (Y)	Y ₁	3,3	2,3	2,9	1,4	2,6	2,6	2,9	3,1	2,7	3,7
	Y ₂	4,2	3,2	3,3	3,5	2,8	3,8	2,3	2,4	3,7	4,2
	Y ₃	2,3	2,2	2,2	2,4	2,6	2,4	3,2	5,2	3,8	5,0
	Y ₄	1,8	2,2	2,4	3,2	2,6	4,2	2,4	4,1	2,2	5,0
	Y ₅	3,3	2,3	2,5	2,2	2,8	2,9	4,1	2,8	3,3	4,8
	Y ₆	2,3	3,6	3,4	1,5	4,2	4,7	3,2	4,1	3,2	4,8
	Y ₇	3,8	2,4	3,2	3,8	2,7	3,2	4,5	4,4	3,4	3,2
	Y ₈	3,4	3,3	3,5	3,4	2,6	3,7	4,2	2,3	3,3	4,7
3. Socially responsible attitude indicators group (Z)	Z ₁	5,0	3,7	4,1	4,5	4,2	3,6	5,0	4,2	4,7	4,9
	Z ₂	4,3	3,4	3,7	2,1	3,2	2,1	4,2	3,2	4,4	4,2
	Z ₃	4,2	4,5	4,2	2,1	4,3	4,9	4,2	4,1	4,3	4,2
	Z ₄	4,9	4,2	4,7	4,2	4,6	4,9	4,7	4,1	4,1	4,8
	Z ₅	4,6	3,2	4,2	4,1	2,9	5,0	5,0	5,0	4,9	4,8
	Z ₆	4,6	4,2	3,8	3,3	3,1	4,5	4,8	5,0	4,2	4,8

Source: calculated by the authors.

	Y ₁	Y ₂	Y ₃	Y ₄	Y ₅	Y ₆	Y ₇	Y ₈
Y ₁	0							
Y ₂		0						
Y ₃			0					
Y ₄				0				
Y ₅					0			
Y ₆						0		
Y ₇							0	
Y ₈								0

Fig. 2. The matrix of pairwise comparisons of indicators of the social group of the assessment state of ISRSIP.

	Z ₁	Z ₂	Z ₃	Z ₄	Z ₅	Z ₆
Z ₁	0					
Z ₂		0				
Z ₃			0			
Z ₄				0		
Z ₅					0	
Z ₆						0

Fig. 3. The matrix of pairwise comparisons of indicators of the group of socially responsible attitude of the assessment state of ISRSIP.

5. Discussion and conclusions

Analysis of Table 4 data allows us to conclude that the values of group indicators for the economic group of indicators for the assessment state of inclusive social responsibility in the studied selection of energy industry enterprises range from 2,004 to 3,289. The most considerable value in the economic group of indicators is noted in D.Trading LLC, and the smallest is in ERU Trading LLC. According to the social group of indicators for the assessment state of inclusive social responsibility of

enterprises, the values of group indicators in energy industry enterprises range from 2.689 to 4.446. At the same time, the largest value according to the social group of indicators is typical for D.Trading LLC, and the smallest is Dnipro Energy Services LLC. Analyzing the value of group indicators by a group of socially responsible attitude indicators of the assessment state of inclusive social responsibility of enterprises, it should be noted that its maximum value (4,669) is noted in Ukrnafta PJSC, the minimum (3,360) is typical for Dnipro Energy Services LLC.

Thus, according to the results of the calculation of group indicators of the assessment of the state of inclusive social responsibility of enterprises, it was established that D.Trading LLC is the leader in terms of the state of inclusive social responsibility of the subject of the innovation process in the selection of energy industry enterprises.

In Fig. 5 shows the graphical results of the structural analysis of the state of inclusive social responsibility of energy industry enterprises in Ukraine, according to which it is possible to draw a general conclusion about the balance of indicators by assessment groups.

Analysis of the data shown in Fig. 5 allows us to conclude that no energy industry enterprise achieves the maximum possible assessment state of inclusive social responsibility for all groups of indicators.

The graph of dispersion of the integral indicators of the state of inclusive social responsibility (from enterprises in the energy industry, calculated according to formula (14) is shown in Fig. 6. The leader is D.

Indicators of the economic group for assessing the state of the ISRSIP

$$\tilde{R}^X = \|\omega_{ij}^X\| = \begin{vmatrix} 0 & 1 & 1 & 1 & -1 & 1 \\ 1 & 0 & 1 & -1 & -1 & 1 \\ 1 & -1 & 0 & -1 & 0 & 1 \\ -1 & 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & -1 & 0 & -1 \\ -1 & -1 & 1 & -1 & 1 & 0 \end{vmatrix} \quad \tilde{R}^{X+} = \|\omega_{ij}^{X+}\| = \begin{vmatrix} 1 & 2 & 2 & 2 & 0 & 2 \\ 2 & 1 & 2 & 0 & 0 & 2 \\ 2 & 0 & 1 & 0 & 1 & 2 \\ 0 & 2 & 2 & 1 & 2 & 2 \\ 2 & 2 & 1 & 0 & 1 & 0 \\ 0 & 0 & 2 & 0 & 2 & 1 \end{vmatrix} \quad (\omega_i^X) \begin{matrix} \omega_{X1} & 0,234 \\ \omega_{X2} & 0,184 \\ \omega_{X3} & 0,121 \\ \omega_{X4} & 0,237 \\ \omega_{X5} & 0,156 \\ \omega_{X6} & 0,092 \end{matrix}$$

Indicators of the social group for assessing the state of the ISRSIP

$$\tilde{R}^Y = \|\omega_{ij}^Y\| = \begin{vmatrix} 0 & 1 & -1 & -1 & 1 & 1 & 0 & 1 \\ -1 & 0 & -1 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & -1 & 0 & 0 \\ 1 & 0 & -1 & 0 & -1 & 1 & 1 & -1 \\ -1 & -1 & -1 & 1 & 0 & -1 & -1 & 0 \\ -1 & -1 & 1 & -1 & 1 & 0 & 1 & -1 \\ 0 & -1 & 0 & -1 & 1 & -1 & 0 & 0 \\ 1 & -1 & 0 & 1 & 0 & 1 & 0 & 0 \end{vmatrix} \quad \tilde{R}^{Y+} = \|\omega_{ij}^{Y+}\| = \begin{vmatrix} 1 & 2 & 0 & 0 & 2 & 2 & 1 & 2 \\ 0 & 1 & 0 & 1 & 2 & 2 & 2 & 2 \\ 2 & 2 & 1 & 2 & 2 & 0 & 1 & 1 \\ 2 & 1 & 0 & 1 & 0 & 2 & 2 & 0 \\ 0 & 0 & 0 & 2 & 1 & 0 & 0 & 1 \\ 0 & 0 & 2 & 0 & 2 & 1 & 2 & 0 \\ 1 & 0 & 1 & 0 & 2 & 0 & 1 & 1 \\ 2 & 0 & 1 & 2 & 1 & 2 & 1 & 1 \end{vmatrix} \quad (\omega_i^Y) \begin{matrix} \omega_{Y1} & 0,149 \\ \omega_{Y2} & 0,149 \\ \omega_{Y3} & 0,162 \\ \omega_{Y4} & 0,122 \\ \omega_{Y5} & 0,068 \\ \omega_{Y6} & 0,108 \\ \omega_{Y7} & 0,095 \\ \omega_{Y8} & 0,149 \end{matrix}$$

Indicators of the socially responsible attitude group for assessing the state of the ISRSIP

$$\tilde{R}^Z = \|\omega_{ij}^Z\| = \begin{vmatrix} 0 & -1 & 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & -1 & 0 \\ 0 & -1 & 0 & -1 & 1 & 1 \\ -1 & -1 & 1 & 0 & -1 & -1 \\ -1 & 1 & -1 & 1 & 0 & 1 \\ -1 & 0 & -1 & 1 & -1 & 0 \end{vmatrix} \quad \tilde{R}^{Z+} = \|\omega_{ij}^{Z+}\| = \begin{vmatrix} 1 & 1 & 0 & 1 & 2 & 2 \\ 1 & 2 & 1 & 2 & 2 & 0 \\ 1 & 1 & 0 & 1 & 0 & 2 \\ 1 & 0 & 0 & 2 & 1 & 0 \\ 1 & 0 & 2 & 0 & 2 & 1 \\ 1 & 0 & 1 & 0 & 2 & 0 \end{vmatrix} \quad (\omega_i^Z) \begin{matrix} \omega_{Z1} & 0,127 \\ \omega_{Z2} & 0,145 \\ \omega_{Z3} & 0,091 \\ \omega_{Z4} & 0,073 \\ \omega_{Z5} & 0,109 \\ \omega_{Z6} & 0,073 \end{matrix}$$

Fig. 4. Matrices and vectors of coefficients of the significance of indicators for assessing the state of inclusive social responsibility of the subjects of the innovation process of fuel and energy enterprises (source: calculated by the authors)

$\tilde{R} = \|\omega_{ij}^k\|$ – a summary matrix of the comparative significance of the k-th group of indicators for assessing the state of the ISRSIP; $\tilde{R}^+ = \|\omega_{ij}^{k+}\|$ – transported matrix of the comparative importance of the k-th group of indicators for assessing the state of the ISRSIP; (ω_i^k) – vector of coefficients of the comparative significance of the k-th group of indicators for assessing the state of the ISRSIP.

Table 4

The value of complex group indicators for assessing the state of inclusive social responsibility of enterprises in the fuel and energy complex of Ukraine, coefficients.

Enterprises	Group		
	economic	social	socially responsible
1. United Energy LLC	2457	3050	4622
2. ERU Trading LLC	2004	2709	3805
3. Ukrhydroenergo PJSC	2819	2936	4104
4. Dnipro energy services LLC	2068	2689	3360
5. West Petrol Market LLC	2134	2831	3695
6. Energotrade LLC	2378	3415	3975
7. Ukrnafta PJSC	2253	3263	4669
8. YE Energy LLC	2461	3556	4205
9. Ukrgazvydobuvannya JSC	2538	3222	4509
10. D.Trading LLC	3289	4446	4625
minimum value	2004	2689	3360
average cost	2440	3212	4157
maximum value	3289	4446	4669

Trading LLC, the outsider in this rating is Dnipro Energy Services LLC. At the same time, the integral indicator of the state of inclusive social responsibility of an outsider is above the average, which generally indicates a significant inclusive social responsibility of all enterprises in selection 2.

The value of inclusive social responsibility for innovative enterprises, especially energy enterprises, is significant in the period of military operations in Ukraine and in the period of its post-war recovery,

revitalization of the affected territories and further development of Ukraine-EU relations.

The main directions of inclusive social responsibility are manifested in the significant impact on the ecology of the territories of presence as a result of the production cycles of industrial enterprises of the SCM Group (which includes D.Trading LLC). Development of management systems for environmental protection and implementation of long-term investment programs to reduce the level of pollution and ecological rehabilitation of territories. Cooperation and consultation with local communities in regions where the enterprise affects the environment, health and safety of residents. The right of everyone to actively participate in the formation of civil society and to support various public initiatives. Encouraging employees to participate in corporate volunteering improves the quality of life of vulnerable population categories. Support charitable initiatives by implementing joint projects with the "Development of Ukraine" Foundation in the fields of education, national health, cultural heritage, targeted assistance, etc.

And although inclusive social responsibility at enterprises begins with awareness of the need for general inclusion in the innovation process on the one hand and understanding of the possible negative impact of innovation on society and the environment on the other, it is very convenient to assess the state of inclusive social responsibility of the stakeholders of the innovation process and obtain a single quantitative result to determine the competitiveness of the energy enterprise on the market.

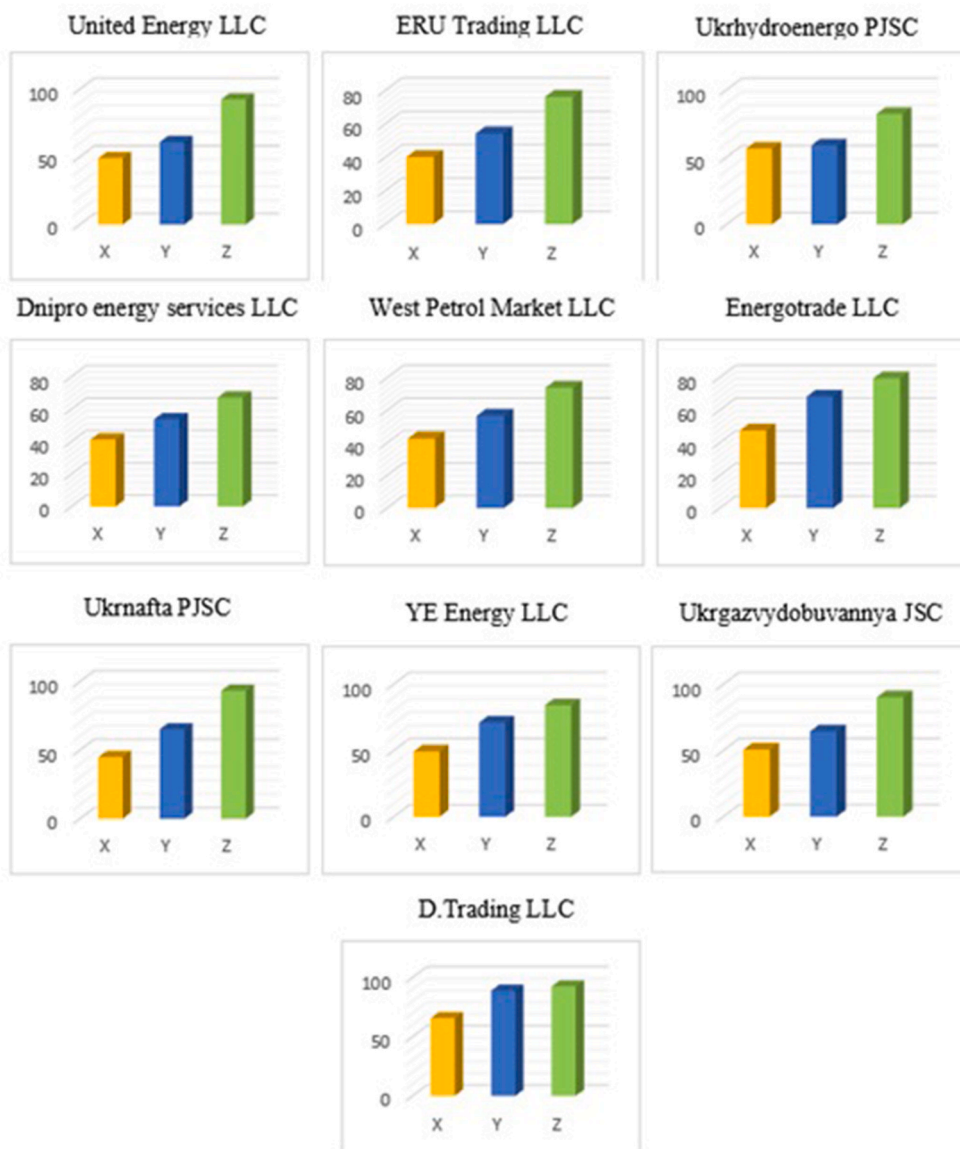


Fig. 5. Results of the structural analysis of group indicators of the assessment state of inclusive social responsibility of the energy industry enterprises in Ukraine (source: developed by the authors).

6. Final considerations

Implications for theory and practice on cleaner production/sustainability. The proposed aggregated system of indicators for assessing the state of ISVSIP is defined by the authors as a contribution to the theory and methodology of the development of inclusive social responsibility of the stakeholders of the innovation process, as well as in the theory of clean production and sustainable development.

The offered method of assessment of inclusive social responsibility, unlike the existing ones, includes in its focus the following components (most of the indicators of which correspond to almost 60% of the Sustainable Development Goals (2015–2030), namely Goals 1, 6–13, 17): social (taking into account vulnerable categories of the population), socially responsible attitude (definition of the central values, law-abiding enterprise, thrifty attitude to ecology, reduction of negative impact on the environment, reduction of emissions of harmful substances into the atmosphere, soil and water. etc.) and economic (cost savings due to the use of energy-saving technologies, decrease in the cost of production), emphasizing the importance of the company's profit-making to ensure its sustainable and inclusive development and

eliminating some limitations of previous studies, so, in contrast to (Urusova and Lepokhin, 2022; Parlińska and Stawicka, 2018; Dinçer et al., 2019), each of the proposed indicators has a universal character; unlike (Smachilo and Balyaba, 2015; Nawrocki and Szwajca, 2021) helps the energy company to examine its internal business processes and find bottlenecks in its operations, and using them as an aggregated system has a synergistic effect unlike (Celis, 2015; Fatenok-Tkachuk & Voronko, R. 2021).

Considering the fact that all indicators of the presented system are characterized by percentages or certain levels and are evaluated in points, a competitive evaluation can be carried out among enterprises that have different sizes and different scopes of activity, also without reference to their location.

The practical result should be evaluated based on the set goal (assessment of the company's competitive position in the energy market, evaluation of the company's internal business processes and their improvement, establishment of the company's compliance with specific criteria of inclusive development and sustainable development) and the customer (company representatives, external auditors, competitors, investors). Thus, the assessment may be limited to the calculation of

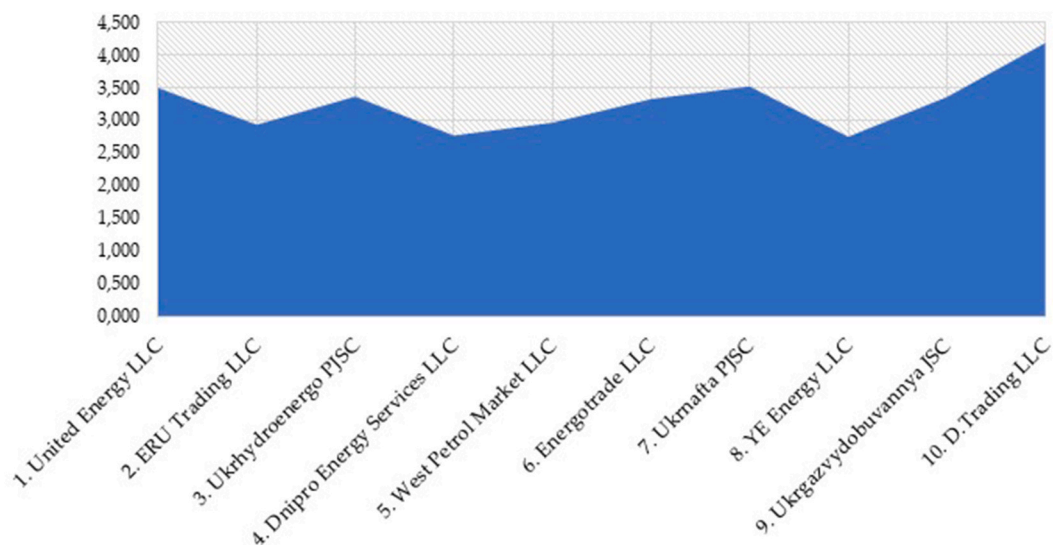


Fig. 6. The graph of dispersion of integral indicators of the state of inclusive social responsibility of energy industry enterprises in Ukraine (source: developed by the authors).

complex performance indicators of energy industry enterprises or the measure of only a separate group of indicators (separate determination of economic, social indicators and indicators of socially responsible attitude).

Despite the existing advantages and importance of conducting such an assessment in a competitive market, the proposed assessment method has its shortcomings and certain limitations.

- the results of the conducted assessment will be relevant only if it is conducted and information is collected during the same period;
- there is a possibility of a certain subjectivity because most of the indicators are found by experts, and employees of the evaluated enterprises can act as experts. That is, there is a risk of receiving unreliable, "slightly exaggerated" information.

Also, during the evaluation, it was found that some indicators of the proposed system need correction and improvement. So, for example, as the survey showed, the Z4 indicator - the level of corporate social responsibility is ambiguous and can be perceived differently for individual enterprises. Therefore, for the purposes of internal evaluation, the indicators can be reviewed and supplemented by the enterprise itself, and for conducting a comprehensive competitive evaluation, it is advisable to improve the proposed system, which requires further research in this area.

Institutional review board statement

Not applicable.

Informed consent statement

Not applicable.

CRedit authorship contribution statement

Marek Dudek: Conceptualization, Validation, Writing – review & editing, Supervision, Funding acquisition. **Iryna Bashynska:** Conceptualization, Validation, Formal analysis, writing—, Writing – review & editing, Visualization, Supervision, Project administration. **Svitlana Filyppova:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – review & editing, Supervision. **Svitlana Yermak:** Methodology, Investigation, Resources, Data curation,

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The study analyzed publicly available datasets. The data can be found here: <https://databank.worldbank.org>, <http://www.ukrstat.gov.ua>, <https://ua.energy>, <https://sae.gov.ua>.

Acknowledgments

AGH University of Science and Technology. Grant numbers: 16.16.200.396.

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