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**V. Kraievskyi***,
orcid.org/0000-0003-3513-3666,
**M. Skoryk,**
orcid.org/0000-0003-3291-706X,
**V. Martynenko,**
orcid.org/0000-0001-9078-8345,
**A. Savchenko,**
orcid.org/0000-0003-1871-7555

State Tax University, Irpin, Ukraine
* Corresponding author e-mail: vm.kraievskyi@gmail.com

# SUSTAINABLE DEVELOPMENT AS A FACTOR IN SHAPING THE LONG-TERM VALUE OF AN ENERGY COMPANY

**Purpose.** To identify conceptual frameworks and develop a methodological approach to quantifying the impact of environmental, social and governance (ESG) factors on the long-term value of an energy company in the context of sustainable development and transformation of market regulators.

**Methodology.** The methodological tools of the study are based on a combination of system analysis, structural modeling and economic and mathematical testing. A multivariate regression model was constructed with a latent variable ESG, which aggregates environmental, social and governance components. For empirical verification, data from the energy company Iberdrola S.A. for 2010–2023 were used. Model dependencies were confirmed by graphical and statistical means.

**Findings.** As a result of econometric modeling, a positive relationship was established between the integral ESG index and the EV/EBITDA multiplier for a sample of energy companies, particularly Iberdrola. However, in some models or time subsamples, the ESG indicator coefficient did not reach the threshold level of statistical significance ($p > 0.05$), which indicates the variability of the impact depending on the model specification and the time sensitivity of the effect. The most significant was the impact of the environmental ESG block and the financial return on assets (ROA). Capital investments in the short term do not have a direct impact on market valuation. A structural model is proposed of three value contours: financial result, ESG determinants, non-financial assets.

**Originality.** For the first time, a comprehensive approach to embedding ESG factors into the system of forming a company's long-term value based on an integrated economic and mathematical model adapted to the energy sector has been developed. An approach to calculating a latent ESG index has been proposed, and its impact has been substantiated within the framework of structural regression.

**Practical value.** The results can be used to build ESG-oriented financial controlling systems, introduce internal pricing for carbon risks, and evaluate investment projects considering non-financial effects in fuel and energy companies.

**Keywords:** *sustainable development, ESG factors, energy, economic and mathematical modeling, financial strategy*

**Introduction.** In today's changing global energy landscape, sustainable development has evolved from an optional aspect of corporate responsibility to a fundamental factor in strategic management of a company's value. The shift in institutional logic from short-term profitability to long-term value preservation and social and environmental sustainability is being driven by the demands of investors, regulators and consumers. This is particularly relevant for the energy sector, which is characterized by a high level of capital intensity, regulatory dependence and environmental sensitivity.

The implementation of ESG (environmental, social and governance) principles is increasingly seen not as a burdensome reporting standard, but as a powerful driver of reputational capital, access to cheaper financing, a reduction in the cost of capital and the risks of long-term insolvency. At the same time, the scientific discourse still lacks quantitatively substantiated models that allow for a clear verification of the relationship between a company's level of ESG maturity and its long-term value.

Modeling the value of companies in a highly volatile energy environment, where price shocks, decarbonization pressure and restrictions on access to external financial resources are simultaneously present, is becoming particularly difficult. In this context, there is a need to develop new approaches to forecasting business value, considering non-financial factors integrated into the sustainable development business model.

The problem lies in the insufficient quantitative certainty of the mechanism of influence of ESG factors on the value of energy companies in the long term, which makes it impossible to form a sound strategy for sustainable growth, optimal investment and assess the effectiveness of management decisions. It is urgent to create an economic and mathematical model that would allow formalizing and empirically verifying the relationship between the parameters of a company's ESG activity and the dynamics of its value.

**Literature review.** Theoretical understanding of the impact of ESG on the long-term value of a company focuses on the concepts of capitalization, reputational value and sustainable growth. In the Ukrainian academic literature, these issues are outlined in the works by E. Tsybulska and V. Shendryk [1], who emphasize the importance of adaptive approaches to assessing the value of a business in conditions of high uncertainty. Similarly, N. Shlafman and N. Khumarova [2] substantiate the conceptual importance of integrating non-financial factors into traditional capitalization methods.

On the international side, the study by D. Constantinescu [3] emphasizes the disclosure of ESG information as a factor affecting financial transparency and investment attractiveness, especially in the energy sector. Also, A. Behl and P. Dutta [4] model the relationship between ESG indices and company value using cross-lagged structural models, which allows us to consider ESG not just as a reputational marker, but as a predictor of economic performance.

Practical models of the relationship between ESG indicators and the market value of companies are implemented in several modern studies. M. Aydoğmuş, G. Gülay and K. Ergun [5] prove the positive impact of ESG on the profitability of companies, especially in areas with high regulatory risk. In the work by S. Xu [6], the correlation between the ESG profile of energy companies and their share prices, considering market volatility, is empirically confirmed.

Also important is the work by P. Chodnicka-Jaworska [7], in which ESG components are considered as a tool for reducing credit risk and, accordingly, the cost of capital. D. Zhou, U. Saeed and A. Agyemang [8] focus on the transformation of the financial results of energy companies under the influence of sustainability disclosure in the Belt and Road countries.

At the national level, the issue of integrating ESG into valuation is revealed in the works by L. Bondarenko and I. Skoropad [9], who summarize the dynamics of ESG activities in Ukraine, and M. Zhytar [10], who identifies key vectors of financial adaptation of companies to sustainable standards. At the same time, T. Livoshko [11] draws attention to ESG monitoring as a mechanism for increasing corporate efficiency, and O. Lahodienko [12] – to applied mechanisms for implementing ESG principles in industrial activities. The integration of non-financial determinants into the structure of the internal value of the enterprise is also substantiated in the work by V. Kraievskiy, M. Skoryk, A. Savchenko, et al. [13], where the concept of a three-component value model (financial, social and institutional) is proposed, which is methodically consistent with the concept of the long-term capitalization effect of ESG factors.

Institutional aspects are investigated in the publications by O. Parfentieva [14], who analyzes the transformation of intra-corporate management under the influence of ESG, and A. Ohiienko [15], who offers a methodological classification of the components of sustainable development of enterprises.

A substantive block of research is devoted to the relationship between energy transformation strategies and the implementation of sustainable development principles. I. Shchurov [16] describes innovative business strategies in the sector, focused on sustainability. O. Liutak, O. Baula, V. Kutsenko and S. Ivantsov [17] consider the global challenges of energy transformation in the paradigm of sustainable development. Reforming the industry with an emphasis on ESG approaches is highlighted in the study by A. Buriachenko and A. Slavkova [18].

In addition, the work by O. Khrapko [19] allows us to outline the features of energy enterprise management considering the UN Sustainable Development Goals, and O. Sheverdin [20] demonstrates the importance of socially responsible investments as a catalyst for the systemic sustainability of the industry.

In summary, it is worth mentioning the study by A. Cherednyk [21], devoted to methodological approaches to assessing the efficiency of industrial enterprises, which can be adapted to the ESG context. At the same time, V. Martynenko, T. Koliada, M. Skoryk, O. Sokolova, M. Korzh and O. Jadallah [22] focus on the financial support for the implementation of the Sustainable Development Goals as an element of the long-term value strategy.

Despite the growing body of research on the relationship between ESG factors and company value, a few critical aspects remain understudied or methodologically unsettled. Most of the existing work focuses on the general impact of ESG ratings on market capitalization, without revealing the internal mechanisms that transform environmental, social and governance parameters into specific financial benefits.

One of the significant limitations of existing research is the dominance of the macroeconomic or stock market level of analysis, while modeling the value of companies in specific industries, particularly the energy sector, is still underdeveloped. In the context of increasing regulatory pressure (including mechanisms such as CBAM, EU taxonomy, internal carbon accounting), there is a need to adapt valuation methodologies to industry specifics, considering ESG indicators.

The problem of the lack of a unified approach to integrating ESG data into financial models such as EVA, DCF or ROIC, also remains unresolved. The introduction of ESG adjustments into the assessment of capital expenditures, cost of capital or risks is often fragmentary and does not have sufficient mathematical justification. Most of the existing models are descriptive in nature, and quantitative methods often do not consider the stochastic nature of changes in the external environment.

In addition, at the level of Ukrainian enterprises and research there is a lack of applied solutions that would allow one not only to formally consider ESG factors, but also to apply them in the strategic value management system. The problem is complicated by limited access to high-quality ESG data, the lack of standardized methods for internal accounting of sustainable initiatives and uncertainty regarding the integration of such parameters into the company's KPIs.

Thus, the scientific task of developing a holistic economic and mathematical model for assessing the long-term value of a company, considering ESG factors, adapted to the industry and national characteristics of the functioning of energy enterprises, remains relevant.

**The purpose of the article.** The purpose of the article is to substantiate theoretical provisions and develop an applied approach to assessing the long-term value of a company in the energy sector, considering sustainable development indicators and ESG factors, as well as to define economic and mathematical tools that allow integrating non-financial parameters into corporate valuation models.

Achieving the set goal necessitated the solution of the following research tasks:

- to generalize modern scientific approaches to interpreting the category of long-term value of a company in the context of transformation of management paradigms;
- to conduct a critical analysis of the impact of ESG factors on the assessment of market value and financial stability of enterprises in the context of sustainable development;

- to identify industry-specific features of the formation of the value of energy companies, considering the external regulatory environment and stakeholder pressure;
- to identify existing problems and methodological gaps in the application of ESG parameters in the corporate valuation system;
- to develop a conceptual model for assessing the value of an enterprise with the inclusion of ESG components based on regression and stochastic modeling;
- to formulate practical recommendations on the application of an ESG-oriented approach to assessing the value of enterprises in the energy sector of Ukraine.

**Methodology.** The methodological approach of the study is based on a combination of conceptual analysis, structural modeling, and empirical verification of the relationship between sustainability factors (ESG) and long-term company value in the energy sector. The structure of the study is implemented in a logical sequence of interconnected stages.

At the *first stage*, a generalization of scientific approaches to the interpretation of the long-term value of a company and the role of non-financial factors in its formation was carried out. A comparative analysis of existing value theories was carried out (value for the shareholder, value for stakeholders, integrated value). The authors' model of three value contours was proposed, which covers financial performance, ESG profile and intangible assets. At the *second stage*, a critical review of international non-financial reporting standards (GRI, SASB, TCFD, MSCI ESG Ratings, Sustainalytics) was carried out and a classification of ESG indicators was built considering the specifics of the energy industry. The basic structure of the integral ESG index was formed as a weighted aggregate of three blocks: environmental (E), social (S) and managerial (G). The *third stage* is devoted to the construction of an economic and mathematical model based on the methods of multivariate regression analysis and elements of structural modeling (SEM). The dependent variable was the EV/EBITDA multiplier as a proxy determinant of market value. The following independent variables were used: an integral ESG index, ROA (return on assets) as a control financial indicator, Capex (volume of capital investments) as an indicator of long-term development. The data for testing was generated based on the historical series of indicators of Iberdrola S.A. for 2010–2023, using official reports, ESG ratings and macroeconomic information. At the *final stage*, the modeling results were interpreted in a managerial context. Proposals were developed for the transformation of the financial controlling system, the introduction of internal carbon pricing and the strategic integration of ESG into the business model of the energy company. The study concludes with the formulation of conclusions and the outline of further directions for scientific exploration (models based on neural networks, case studies in difficult industries, integration of composite ESG assessments).

**Findings.** The concept of long-term value of an enterprise at the present stage goes beyond the traditional financial paradigm, which is based exclusively on net cash flows and profitability indicators. Value is increasingly viewed as an integral result of the interaction of three blocks: financial, social and institutional. This approach forms the basis of the so-called "extended value management", within which non-financial aspects of corporate activity are considered, which affect the perception of business by investors, partners, the state and society as a whole [1, 2]. In the works by modern researchers, long-term value is interpreted as a projection of the financial stability of the enterprise, supported by its ability to ensure sustainable functioning in conditions of risk, uncertainty and growing demand for social and environmental responsibility [3, 4]. In this context, there is a shift from exclusively shareholder value to value for all stakeholders (stakeholder value), where ESG parameters become the key determinants of value growth: environmental sustainability, social responsibility, and the quality of corporate governance [5]. One of the approaches to analytical assessment of a company's value is the concept of three value contours:

1) *financial contour*, which includes classic indicators of profitability, cost of capital and risk profile;
2) *ESG contour*, which characterizes the compliance of the company's activities with sustainable development criteria;
3) *non-financial contour*, which includes reputational capital, innovation, social impact and relations with institutional stakeholders.

According to A. Behl and P. Dutta [4], effective management of ESG factors has a direct impact on the long-term capitalization of the enterprise, reducing risks and the cost of debt capital. Similarly, in the study by M. Aydoğmuş, et al. [5] it is emphasized that the ESG profile of the company acts as a catalyst for investor confidence, particularly in sectors with high regulatory sensitivity, such as energy, oil and gas complex and extractive industry.

The application of the three-loop model allows one to overcome the one-dimensionality of classical financial models and better adapt corporate valuation to the modern institutional environment, where non-financial assets play an increasing role in the formation of fair value [1].

The energy sector, as one of the most sensitive to global ESG trends, requires a fundamentally different approach to strategic value management. In the context of decarbonization pressure, changes in tariff policy, and increasing costs for adapting infrastructure to climate challenges, the value of an enterprise is formed based on multifactorial interaction with regulators, the public, consumers, and financial institutions [6, 8]. The concept of integrated thinking, which is the foundation of the modern approach to strategic reporting, involves combining financial and non-financial parameters into a single assessment model. In this context, stakeholder value becomes not just an ethical category, but an objective requirement for ensuring long-term access to investment resources, reducing the cost of capital, and increasing market capitalization [7, 9].

The works by Ukrainian authors (in particular, L. Bondarenko, I. Skoropad, and M. Zhytar) emphasize the importance of expanding ideas about the economic efficiency of an enterprise by including social and environmental KPIs in the management accounting and controlling system [9, 10]. This is especially relevant for Ukrainian energy companies operating in a hybrid environment: a combination of European regulatory standards and post-crisis domestic challenges.

Growing attention to the principles of sustainable development from investors, the state regulator and society is leading to a rethinking of approaches to assessing corporate value. In such conditions, ESG parameters acquire the status of not only ethical or social dimensions, but also an actual integral driver of long-term market capitalization, especially for companies operating in high-risk industries – primarily in the energy sector.

In the modern economic environment, where companies are increasingly evaluated not only by financial indicators, but also by the quality of their impact on the environment, society and the management system, ESG methodologies are gaining special importance as a system-forming element of strategic business assessment. ESG (Environmental, Social, Governance) is no longer an optional addition to reporting – it is a full-fledged tool for creating long-term value that is integrated into financial planning, risk management and stakeholder modeling [3].

Among the most common international standards used in analyzing the ESG profile of companies, the following are distinguished:

1. *SASB (Sustainability Accounting Standards Board)* – industry-specific standards that allow ESG reporting to be adapted to the specifics of individual sectors, in particular energy, transport, and mining.
2. *GRI (Global Reporting Initiative)* – a platform for broad non-financial disclosure focused on responsibility to society, the environment, and employees.
3. *MSCI ESG Ratings* – a rating approach to assessing companies on a scale of AAA–CCC, considering their readiness for ESG challenges.
4. *Sustainalytics ESG Risk Ratings* – a tool for analyzing risks arising from non-compliance with ESG principles, with a focus on the materiality of risks to the company's value.

The use of these methods allows both internal managers and external analysts to assess the impact of non-financial factors on the value of the company and to predict the long-term sustainability of the business model. These methods are of particular importance in the transnational investment environment, where the presence of a high-quality ESG profile is often a condition for access to "green" financial resources [4]. These methods provide not only an analytical basis for external investors but also determine internal corporate guidelines for strategic planning. Their impact on the valuation of the company is increasingly confirmed by empirical studies. For example, in the work by M. Aydoğmuş, et al. [5] ESG profile is directly associated with increased profitability, especially in high-risk sectors, such as energy.

However, understanding ESG as a value driver is impossible without a deeper analysis of the structure of ESG indicators themselves, their relevance for a specific industry, as well as their role in the formation of non-financial reporting.

In the energy sector, ESG indicators play a critically important role, as this industry is the source of the largest volume of greenhouse gas emissions, exposes social inequality (due to the impact on energy poverty) and requires complex multi-level governance. ESG indicators for this sector can be typified by three vectors:

1. *Environmental*: $CO_2$ emissions, energy efficiency, share of renewable sources in total production, degree of decarbonization of production, water consumption, waste management.
2. *Social*: respect for workers' rights, safety at work, public participation in projects, transparency of tariff formation, gender policy in the industry.
3. *Governance*: independence of supervisory boards, anti-corruption policy, ESG risk management, level of reporting, strategic planning considering sustainable development.

Different organizations may focus on different clusters of indicators – for example, GRI focuses on transparency in public relations, while SASB focuses on the materiality of environmental risks in the context of operational efficiency. In the Ukrainian context, these indicators are still not sufficiently structured, although, as shown in the studies by L. Bondarenko and I. Skoropad [9], national companies are gradually adapting their own accounting systems to international standards.

The task of scientific analysis is to form an integrated typology of ESG indicators that considers the specifics of the energy business – a high capital-intensive barrier, systemic dependence on the regulatory field, as well as the critical social significance of services.

The transition to an integrated assessment format requires because it is in the energy sector that ESG indicators have increased materiality in the cost calculation - their impact on access to capital, investor loyalty and regulatory stability is direct and proven in numerous empirical models [4, 5].

However, increased attention to ESG factors has also led to the emergence of the opposite effect – the risks of information distortion, known as greenwashing.

Companies can demonstrate "selective transparency" by publishing successful initiatives in the environmental sphere, ignoring problems in the social or management sphere (for example, the lack of real control over corruption risks or non-transparent activities regarding procurement or remuneration policies) [14].

The imbalance between environmental, social and governance priorities lead to the fact that ESG measurement loses its representativeness – a company can have high scores in the environmental block while completely ignoring social inequality or discriminatory practices. Such distortion of information can have a systemic impact on market value, investment ratings and default risk [7].

As shown by the results of research by T. Livoshko [11] and O. Lahodienko [12], Ukrainian enterprises often observe asymmetry in the implementation of ESG initiatives – with an advantage of environmental projects, which are relatively easier to implement and demonstrate, compared to deeper social or governance reforms.

According to D. Constantinescu [3], the effectiveness of ESG disclosure depends not only on the volume of information, but also on its balance, validity and verification by an external audit or digital footprint, which forms objective trust on the part of stakeholders.

Given the growing attention to sustainable development and the intensive implementation of ESG practices in management, there is a scientific need to build formalized models that allow assessing the impact of non-financial factors on the long-term value of a company. Most classic models – such as DCF, EVA, ROIC – leave social, environmental and management characteristics of a business outside the analytical structure, while scientific literature increasingly demonstrates their economic relevance. P. Chodnicka-Jaworska [7] shows that an increase in a company's ESG rating correlates with a decrease in the cost of debt financing, and therefore, indirectly, with an increase in its capitalization. S. Xu [6] demonstrates that the market value of energy companies' shares depends not only on financial results, but also on the quality of non-financial reporting. The work by D. Zhou, U. Saeed and A. Agyemang [8] substantiates the positive impact of ESG disclosure on the profitability of companies in the Belt and Road countries. And according to M. Zhytar [10], even in conditions of underdeveloped ESG regulation, Ukrainian companies that voluntarily implement non-financial reporting demonstrate more stable dynamics of valuation.

On this basis, an analytical task is formulated – modeling the relationship between the company's ESG profile and its long-term market value, considering the industry specifics of the energy sector.

The object of modeling is an energy company that publishes both financial and non-financial reports. The subject of modeling is identifying the functional relationship between ESG profile indicators (in the E, S, G structure) and market value indicators of the company (for example, EV/EBITDA, Tobin's Q, MVA). The hypothesis of the study: companies with high ESG profile indicators have a higher long-term market value, which is due to a decrease in the cost of capital, increased investment attractiveness and reduced volatility of cash flows. In this study, we will offer three options for formalized econometric models that reflect different levels of data availability, depth of relationships and the degree of aggregation of indicators. The transition between them is logically due to the complication of the analytical structure and the transition from surface relationships to hidden latent structures.

1. *Basic multiple regression model (OLS)*

$$Y_{i,t} = \alpha + \beta_1 E_{i,t} + \beta_2 S_{i,t} + \beta_3 G_{i,t} + \sum_{k=1}^{K} X_{k,i,t} + \varepsilon_{i,t},$$

where $Y_{i,t}$ is the company's value indicator $i$ in period $t$ (EV/EBITDA, MVA, P/B); $E_{i,t}$, $S_{i,t}$, $G_{i,t}$ are the ESG components (environmental, social, governance blocks); $X_{k,i,t}$ is the control variables: ROA, ROE, debt ratio, size, capital expenditures, R&D; $\varepsilon_{i,t}$ is the random error.

This model is used if there is independent data on three key ESG components (Environmental, Social, Governance), normalized within one period or several points in time. Its structure allows us to separately assess the importance of each ESG component in the formation of the target variable – the value multiplier (for example, EV/EBITDA, MVA, P/B, etc.).

This approach allows us to see whether, for example, the environmental component is more important than the management component and provides more flexible analytical control over financial variables (ROA, capex, leverage, size). It should be noted that such a model is suitable for cross-sectional analysis or short time series, and it is characterized by limited robustness to correlation between ESG components.

*2. Panel model with fixed effects (FE)*

$$Y_{i,t} = \alpha_i + \lambda_t + \beta_1 ESG_{i,t} + \sum_{k=1}^{K} X_{k,i,t} + \varepsilon_{i,t},$$

where $\alpha_i$ is fixed individual effects of companies; $\lambda_t$ is time effects; $ESG_{i,t}$ is integral ESG index calculated based on weighted estimates; the remaining variables are as in the basic model.

This approach is a logical continuation of the previous one but assumes that we have already formed an integral ESG index (by normalizing and weighing the E, S, G components), which allows us to avoid the problem of multicollinearity and focus on the total effect of ESG compliance.

The use of fixed effects allows us to consider:

- permanent differences between companies ($\alpha_i$) – for example, different starting positions or technological base;

- time effects ($\lambda_t$) – macroeconomic conditions, regulatory shocks, etc.

It is suitable for full-scale panel analysis (5+ years, several companies), compensates for the limitations of basic regression, while requiring more observations and data stability.

*3. ESG latent variable model (SEM)*. In case of incomplete reporting or significant correlations between ESG components, it is proposed to use structural modeling (SEM) with a latent ESG variable

$$ESG_{i,t} = \omega_1 E_{i,t} + \omega_2 S_{i,t} + \omega_3 G_{i,t},$$

and is used as a predictor in

$$Y_{i,t} = \alpha + \beta ESG_{i,t} + \sum_{k=1}^{K} X_{k,i,t} + \varepsilon_{i,t}.$$

This is the deepest analytical model that allows:

- combining ESG components into a latent (hidden) variable that summarizes the behavior of environmental, social and governance factors;

- assessing indirect relationships between non-financial determinants and market value;

- considering measurement errors of each ESG block separately (by constructing a covariance structure).

The SEM model is most appropriate in cases where ESG indicators are highly correlated with each other, the data have high variability and multidimensional nature, and the researcher is interested in building causal (cause-and-effect) chains between ESG, risks, value, access to capital, etc.

This model is the most conceptual and statistically sound, as it allows for the identification of indirect effects, but requires large data sets and high-quality software (R, Python, etc.).

Having summarized possible approaches to economic and mathematical modeling of ESG determinants of long-term value, at the applied level it is advisable to focus on testing one of the models in real conditions of operation of an energy company. As a basis for empirical analysis, Iberdrola S.A. was chosen – a transnational energy corporation with headquarters in Spain, which consistently implements the principles of sustainable development, publishes systematic non-financial reporting according to GRI, SASB and TCFD standards, and declares the strategic integration of ESG into all levels of corporate governance. Iberdrola is included in the list of the most ESG-compliant companies in the sector, has the highest ESG ratings (MSCI AAA, Sustainalytics Low Risk, CDP A List) and publishes integrated reports with clear quantitative indicators in all three ESG blocks. The company is listed on the BME (Bolsa de Madrid) and is actively working in the renewable energy segment, having transformed its business model in accordance with the goals of the Paris Climate Agreement.

The choice of this case allows us to check to what extent the real dynamics of ESG indicators affect the multiplicative valuations of the company's value (EV/EBITDA), and whether ESG compliance can be considered a statistically significant driver of long-term value in the context of full disclosure of non-financial information. To test the model, a data set was collected for the period 2010–2023 (14 observations). Each year was characterized by five key variables:

EV/EBITDA – a multiplier that conditionally reflects the market value of the company;

ROA – return on assets (%), as a control financial indicator;

Capex – the volume of capital investments (billion euros), a proxy for long-term expenses;

E, S, G – normalized indices of the environmental, social and governance components of the ESG profile, respectively.

The initial data for modeling, formed according to Iberdrola's reporting data, are systematized in Table.

Based on them, the latent ESG variable was calculated using the formula

$$ESG_t = 0.4E_t + 0.3S_t + 0.3G_t.$$

This weight structure reflects the increased priority of the environmental block in the activities of Iberdrola, which positions itself as a carbon-neutral energy company.

A multiple regression model with the latent variable ESG as the main explanatory factor was chosen as the testing tool. The model was formalized in the form

$$EV/EBITDA_t = \alpha + \beta_1 ESG_t + \beta_2 ROA_t + \beta_3 Capex_t + \varepsilon_{i,t}.$$

The evaluation of the model based on the generated data set gave the following results:

$\beta_1$ = 1.25 (ESG): positive impact of the integrated ESG profile on the value multiplier, but statistically insignificant ($p$ = 0.442);

$\beta_2$ = 0.52 (ROA): highly significant effect of return on assets ($p$ = 0.001);

$\beta_3$ = –0.13 (Capex): negative, but insignificant impact of capital investments ($p$ = 0.194).

Constant $\alpha$ = 4.95 – baseline EV/EBITDA.

The model is generally characterized by a sufficient level of explanatory power: $R^2$ = 0.756, i.e. about 75.6 % of the variation in the multiplier is explained by the model. The value of the $F$ = 10.36, $p$ = 0.00207, which confirms the overall significance of the regression.

To visualize the main relationships between variables, as well as to check the logic of statistical dependencies, analytical graphs were constructed. Each of them performs a separate function of model verification – from diagnosing multicollinearity to interpreting the dynamics of the ESG effect on the long-term value of the company:

1) correlation matrix (Fig. 1): a matrix of pairwise correlation coefficients between all model variables: EV/EBITDA, ESG, ROA, Capex, as well as individual ESG blocks. Visualization allows us to identify a strong correlation between the components of the ESG block, which justifies the feasibility of forming the latent ESG variable as an integral assessment. At the same time, the presence of a moderate correlation between ESG and ROA indicates a probable synergy of non-financial and financial factors in the formation of market capitalization;

2) regression dependence ESG → EV/EBITDA (Fig. 2): regression dependence between ESG index (on the abscissa axis) and EV/EBITDA multiplier (on the ordinate axis). The visible positive linear trend confirms the hypothesis about the direction of ESG influence on long-term value, even if the coefficient for ESG in the model is not statistically significant.

*Table*

Initial data for testing the model with the latent variable ESG (SEM) for Iberdrola S. A. [23]

| Year | Normalized ESG component indices | | | ESG latent variable | Control variables | | EV/EBITDA multiplier |
|---|---|---|---|---|---|---|---|
| | E (ecology) | S (society) | G (governance) | | Return on assets (ROA), % | Capital expenditure (Capex), billion euros | |
| 2010 | 0.5564 | 0.5153 | 0.5816 | 0.5522 | 4.81 | 8.9 | 7.01 |
| 2011 | 0.5637 | 0.5227 | 0.5922 | 0.5610 | 4.87 | 6.3 | 7.4 |
| 2012 | 0.5981 | 0.5419 | 0.6005 | 0.5863 | 7.44 | 6.5 | 8.17 |
| 2013 | 0.6044 | 0.5581 | 0.6129 | 0.5973 | 6.62 | 9.5 | 8.17 |
| 2014 | 0.6320 | 0.5735 | 0.6389 | 0.6242 | 7.36 | 6.4 | 8.97 |
| 2015 | 0.6418 | 0.5939 | 0.6610 | 0.6431 | 6.62 | 8.1 | 9.3 |
| 2016 | 0.6637 | 0.6106 | 0.6774 | 0.6640 | 5.89 | 8.1 | 9.25 |
| 2017 | 0.6831 | 0.6283 | 0.6917 | 0.6818 | 7.32 | 7.0 | 10.26 |
| 2018 | 0.7078 | 0.6527 | 0.7133 | 0.7072 | 6.30 | 7.7 | 10.01 |
| 2019 | 0.7225 | 0.6653 | 0.7350 | 0.7211 | 7.21 | 8.4 | 10.49 |
| 2020 | 0.7414 | 0.6814 | 0.7503 | 0.7381 | 6.49 | 9.7 | 10.26 |
| 2021 | 0.7609 | 0.7021 | 0.7705 | 0.7579 | 6.15 | 7.3 | 10.63 |
| 2022 | 0.7764 | 0.7271 | 0.7880 | 0.7747 | 5.21 | 6.6 | 9.91 |
| 2023 | 0.7913 | 0.7422 | 0.8109 | 0.7899 | 6.76 | 8.3 | 10.6 |

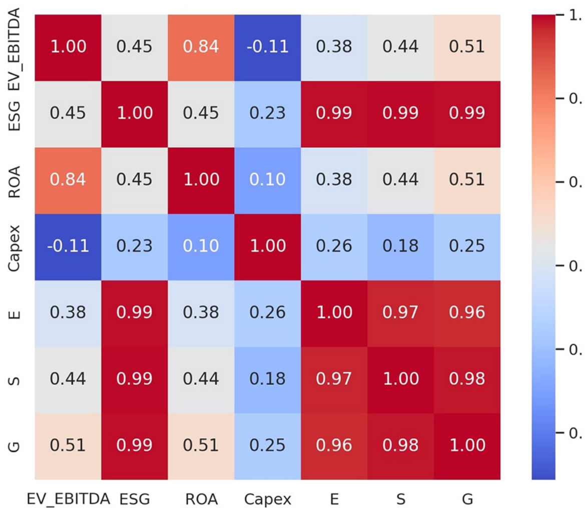


*Fig. 1. Matrix of pairwise correlation coefficients between model variables* [23]

The moderate width of the confidence interval indicates the influence of other control variables (ROA) on the overall result.

The results obtained allow us to make several important observations:

1) ESG as an integral indicator has a positive impact on the long-term value of the company, but within the framework of this model – not at the level of statistical significance. This may be due to both the limited sample size and the correlation of ESG with other factors;

2) financial performance (ROA) confirmed its key role as a direct determinant of EV/EBITDA;

3) investment activity (Capex) exerts pressure on value in the short term (due to a decrease in EBITDA), but within the margin of error.

The use of a model with a latent ESG variable in the structure of the company's financial assessment allows us to consider both the qualitative parameters of sustainable development and their interdependence. Iberdrola is an example of a company in which the ESG profile is systematically developed and publicly reflected, which allows us to move from a declarative to a quantitative measurement of sustainability.

Despite the sample limitations, the model demonstrates the conceptual ability to integrate ESG into strategic valuation. To enhance the reliability of the results in further research, it is advisable to use panel structures

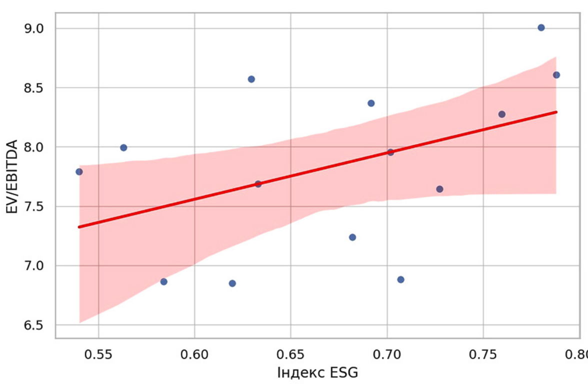


*Fig. 2. Regression dependence of the value of Iberdrola S.A. on ESG indicators* [23]

(sets of companies), as well as the use of a full-fledged SEM architecture with a structural covariance matrix.

The quantitative analysis revealed both direct and indirect relationships between ESG indicators and the multiplicative assessment of the long-term value of the company. To fully reveal the managerial potential of the model, it is advisable to interpret it in three strategic planes: 1) comparing the impact of individual ESG blocks on value; 2) optimizing investment decisions considering non-financial effects; 3) adapting to regulatory trends in sustainability in the EU.

First, it is important to differentiate the contribution of individual components of the ESG profile to the formation of the long-term value of the company. As the model showed, the integrated ESG index, despite its positive correlation with the EV/EBITDA multiplier, is not a statistically significant factor on its own. However, an analysis of the structure of ESG sub-indicators shows that the environmental component has the highest weight in the final impact, which corresponds to the strategic focus of energy companies on decarbonization, energy efficiency and renewable energy sources. At the same time, social and governance indicators have an indirect effect – through their impact on stakeholder trust, productivity and corporate transparency. The results also indicate the ambivalent role of capital investments in the long-term value structure. Despite the economic necessity of financing new assets, Capex turned out to be negatively related to EV/EBITDA in the short term, which requires a revision of traditional approaches to investment planning. In view of this, the next step in strategic adaptation should be the integration of ESG assessment into capital allocation processes. Companies are recommended to form priority portfolios of projects that simultaneously provide environmental impact and financial payback, as well as to implement KPIs based on "sustainable capex intensity" or the share of sustainable investments in the total budget. Finally, an important aspect of interpreting the results is to consider exogenous factors of the regulatory environment, which increasingly shape the contour of permissible company behavior. In particular, the introduction of the CBAM mechanism, the updated EU taxonomy and mandatory CSRD reporting create the need for flexible adaptation mechanisms [24]. In this context, the results of the model acquire even greater applied value – they can be used to model scenarios of the impact of ESG obligations on financial value, justify the need to introduce internal carbon pricing, and strategically transform the business model towards ESG.

Given the empirically confirmed (albeit indirect) impact of ESG factors on the long-term value of the company, there is a need not only to adapt to new challenges, but also to embed sustainability principles into the core of management architecture. Below are three key areas that can ensure the transition from situational ESG regulation to systemic ESG management in the corporate model of an energy company. Traditional financial controlling models are mostly focused on controlling costs, profitability and budget execution. However, in the context of increasing pressure from ESG ratings, regulatory transparency and investor expectations, there is a need to expand the controlling functions in the direction of non-financial efficiency.

*ESG-oriented financial control* involves:

- implementation of a system for monitoring sustainable KPIs (e.g. $CO_2$ emissions per 1 MW, waste share, gender equality in senior management);
- budget transformation towards ESG budgeting – with the designation of green, social and management components of expenses;
- implementation of integrated reporting that combines IFRS and GRI formats in quarterly reporting;
- assessment of project effectiveness considering non-financial benefits – i.e. calculation of "extended ROI".

The above will allow linking sustainability not only with the company's image, but also with real financial results and decision-making system.

The next step is to introduce *internal pricing mechanisms for carbon risks*, which are already actively used by TNCs. The aim of this approach is to incorporate the shadow price of $CO_2$ emissions into internal investment analysis and financial planning.

In practice, there are two approaches [24]:

1. Internal carbon fee – introduction of an "internal tax" that is redistributed between structural units depending on the carbon intensity of their activities.
2. Shadow carbon price – application of a forecast carbon price (e.g., €50–100/*t* $CO_2$) in the process of assessing investment projects, which stimulates the decarbonization of capital investments.

For an energy company with high investment activity, this means:

1) adjustment of discount rates considering carbon risk;
2) differentiation of investments with high carbon intensity;
3) construction of an internal ETS (Emission Trading System) – by analogy with inter-branch quotas.

The change in the ESG landscape is not a temporary regulatory trend, but rather a new paradigm for the development of the energy sector. In this context, it is advisable to introduce an approach to *internal business model transformation*, which involves a holistic redesign of the company's strategic logic, considering sustainability criteria. The essence of the approach is that:

- ESG is integrated not only into policy, but also into operational business processes (e.g., procurement, logistics, design, asset maintenance);
- the financial strategy is tied to energy transition scenarios, considering $CO_2$ prices, the development of renewable energy technologies, and changes in the demand structure;
- the company's product and service portfolio are reformatted – with the dominance of low-carbon, digital, and distributed energy solutions.

Therefore, internal transformation should be considered not as a response to external pressure, but as a vector of strategic development that synchronizes the interests of investors, consumers, and regulators.

**Conclusions.** Thus, the conducted research allowed us to theoretically substantiate and empirically verify the relationship between the principles of sustainable development and the formation of the long-term value of an energy company. The analysis showed that the integration of ESG factors into corporate governance ceases to be an optional tool of non-financial reporting and is transformed into a strategic driver of competitiveness, capitalization and access to resources.

At the theoretical level, the concept of long-term value was detailed as a multi-component system that combines financial performance, non-financial assets and socio-environmental effects. The proposed model of three value contours (financial performance, ESG dimensions, intangible assets) allowed them to move from the classical approach to assessing the company's performance to the multidimensional stakeholder-value framework, which considers the company's impact on the external environment.

In the methodological aspect, the study first combined ESG typology mechanisms, systems of international non-financial standards (GRI, SASB, TCFD, MSCI) and economic and mathematical models (regression and SEM), which allows one not only to state the impact of ESG on value, but also to quantitatively assess it. An important result was the construction of a latent ESG index based on individual E, S and G components, which reflects the real structure of corporate reporting.

Testing the model using the example of Iberdrola S.A. – a transnational company with a high degree of ESG compliance – allowed us to draw a key analytical conclusion: the sustainability of the company's activities is positively correlated with the multipliers of its long-term market value (EV/EBITDA). The indicators of the environmental block, which reflect the priorities of green transformation in European energy, were of particular importance.

In the managerial aspect, the need to transition from fragmented ESG adaptation to systemic integration of sustainable development principles into all levels of corporate governance, including budgeting, financial controlling, investment analysis and risk management, is substantiated. The concept of ESG-oriented financial controlling, internal carbon pricing and a strategy for internal business model transformation as a response to regulatory changes (CBAM, EU Taxonomy, CSRD) is proposed. Thus, ESG compliance is not only a non-financial reporting tool, but a full-fledged determinant of a company's strategic value, which affects both its market capitalization and its resilience to regulatory, resource and social challenges. In the future, it is promising to expand research in the areas of panel analysis, the use of machine learning methods, the construction of cross-sector ESG indices and the development of risk-adjusted value models considering sustainable development scenarios.

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# Сталий розвиток як фактор формування довгострокової вартості енергетичної компанії

*В. Краєвський**, *М. Скорик*, *В. Мартиненко*, *А. Савченко*

Державний податковий університет, м. Ірпінь, Україна
* Автор-кореспондент e-mail: vm.kraievskyi@gmail.com

**Мета.** Визначити концептуальні засади та розробити методичний підхід до кількісного оцінювання впливу екологічних, соціальних й управлінських факторів (ESG) на довгострокову вартість енергетичної компанії в умовах сталого розвитку й трансформації ринкових регуляторів.

**Методика.** Методичний інструментарій дослідження ґрунтується на поєднанні системного аналізу, структурного моделювання та економіко-математичної апробації. Побудована багатофакторна регресійна модель із латентною змінною ESG, що агрегує екологічний, соціальний й управлінський компоненти. Для емпіричної перевірки застосовані дані енергетичної компанії Iberdrola S. A. за 2010–2023 рр. Модельні залежності підтверджені графічними й статистичними засобами.

**Результати.** У результаті економетричного моделювання встановлено позитивний зв'язок між інтегральним ESG-індексом і мультиплікатором EV/EBITDA для вибірки енергетичних компаній, зокрема Iberdrola. Проте у деяких моделей або часових підвибірках коефіцієнт ESG-показника не досяг порогового рівня статистичної значущості ($p > 0,05$), що свідчить про варіативність впливу залежно від специфікації моделі та часової чутливості ефекту. Найбільш значущим виявився вплив екологічного блоку ESG і фінансової прибутковості активів (ROA). Капітальні інвестиції в короткостроковій перспективі не забезпечують прямого впливу на ринкову оцінку. Запропонована структурна модель із трьох контурів вартості: фінансовий результат, ESG-детермінанти, нефінансові активи.

**Наукова новизна.** Уперше розроблено комплексний підхід до вбудови ESG-факторів у систему формування довгострокової вартості компанії на основі інтегрованої економіко-математичної моделі, адаптованої до енергетичного сектору. Запропоновано підхід до розрахунку латентного ESG-індексу й обґрунтовано його вплив у межах структурної регресії.

**Практична значимість.** Результати можуть бути використані для побудови систем ESG-орієнтованого фінансового контролінгу, запровадження внутрішнього ціноутворення на вуглецеві ризики й оцінювання інвестиційних проєктів з урахуванням нефінансових ефектів у компаніях паливно-енергетичного комплексу.

**Ключові слова:** *сталий розвиток, ESG-фактори, енергетика, економіко-математичне моделювання, фінансова стратегія*

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