

Green bonds as a financing instrument for environmental projects in Ukraine

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Abstract. The aim of the study was to substantiate the mechanisms underpinning the functioning of the global green bond market and to identify the conditions for their effective utilisation in financing environmental projects in Ukraine. The methodological foundation of the research comprised systemic, structural-functional, comparative, and institutional approaches, alongside content analysis of scholarly sources, analytical reports, and regulatory documents. The study analysed issuance volumes, documenting the global market's growth beyond USD 4 trillion and highlighting the energy sector's dominance in fund allocation. The research findings established that the development of green bonds is determined by the interplay of regulatory requirements, institutional infrastructure, and the level of market transparency, which collectively shape the conditions for capital attraction and the degree of investor confidence. Based on the market dynamics analysis, it was determined that the key parameters of the instrument's effectiveness are the earmarked use of proceeds, the availability of verification procedures, and the capacity to deliver a measurable environmental impact. It was estimated that implementing a programme for developing Ukraine's decentralised energy system based on renewable generation and energy storage systems requires between USD 15.5 billion and USD 23 billion in initial investment, while simultaneously securing a 5.6% reduction in the energy system's annual operating costs. It was established that the adoption of international reporting and certification standards contributes to reducing information asymmetry, whereas their incomplete implementation constrains the market's development opportunities in Ukraine. The analytical synthesis facilitated the identification of the structural peculiarities of the national segment, characterised by a limited number of issuances and dependence on external sources of financing, as substantiated by the implementation of discrete instruments totalling EUR 325 million and EUR 50 million. The study formulated a conceptual model linking regulatory conditions, issuance mechanisms, and fund utilisation efficiency through green bonds

Keywords: sustainable development; energy efficiency; information transparency; institutional conditions; energy security

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Introduction

The evolution of financial instruments oriented towards environmental objectives reflects a transformation in capital mobilisation mechanisms amidst increasingly stringent requirements for the environmental performance of investments. Within this context, green bonds serve as an instrument that combines financial parameters with the targeted allocation of funds towards the implementation of environmentally-focused projects. For Ukraine, this issue acquires particular significance due to the necessity of financing infrastructure restoration, enhancing energy efficiency, and ensuring energy security. Concurrently, the development of the green bond market is accompanied by constraints linked to institutional immaturity, the insufficient level of financial market development, and regulatory environment uncertainty, which necessitates a comprehensive analysis of both the opportunities and barriers associated with the utilisation of this instrument. In the work of O. Cheberyako (2025), green financing is examined as an instrument for ensuring sustainable development and the post-war recovery of Ukraine's economy. The author demonstrated that environmentally-oriented financial mechanisms are capable of mobilising resources for infrastructure modernisation and improving the efficiency of energy resource utilisation. The study analysed the dynamics of green financing development globally and established that over 50 countries actively employ green financing instruments within their national economies. The researcher substantiated the role of green instruments in shaping long-term investment flows, which permits their consideration as an element of restorative economic policy. Within the context of forming the green bond market in Ukraine, it is essential to characterise the barriers to its development, among which key constraints are delineated in the work of A. Dubko (2022). The author identified the insufficient level of regulatory framework, limited awareness among market participants, and the absence of developed infrastructure as factors inhibiting the development of this segment. Simultaneously, the potential of green bonds in financing environmental projects was highlighted, allowing them to be regarded as a promising instrument for capital mobilisation. The global dimension of the green bond market's development was revealed through the prism of crisis phenomena in the work of N.V. Dunas (2021), which demonstrated that even under conditions of economic instability, the market maintains a growth trajectory. The author emphasised that after 2020, the global green bond market surpassed USD 1 trillion in cumulative issuance volume. The author characterised the role of international initiatives in shaping national markets. In the study by B. Lutsiv *et al.* (2023), the banking sector is identified as a key element of green financing, manifested in the transformation of lending and investment approaches by integrating environmental criteria. The authors proved that the integration of such approaches into the activities of financial institutions facilitates the formation of new financial instruments and alters the structure of the financial

market, creating preconditions for the development of green bonds as a component of the sustainable finance system. In particular, a rise in the share of ESG-oriented financial products within the structure of banking services and a strengthening of the role of environmental criteria in risk assessment processes were established. At the level of territorial communities, the utilisation of green bonds is linked to the possibility of financing local environmental projects, notably in the areas of energy efficiency and infrastructure. According to I. Sokoliuk (2024), this instrument can facilitate the mobilisation of resources for modernising communal service facilities; however, its effectiveness depends on access to financial resources and the development of local financial institutions.

The issue of investor confidence in green financing instruments is becoming of decisive importance for the formation of a fully-fledged market, as it fundamentally determines the potential for scaling up issuances and attracting long-term capital. The research by R. Zvarych & O. Masna (2025) demonstrated that the level of trust directly depends on the quality of information disclosure, adherence to reporting standards, and the availability of verified environmental impact evidence for the financed projects. The authors underscore that the global green bond market surpassed USD 4 trillion as of 2025, and that further expansion of the segment directly depends on the quality of verification mechanisms and the transparency of fund utilisation. Such an approach allows transparency and accountability to be regarded not as formal requirements, but as instruments for reducing information asymmetry between issuers and investors. In this context, it is precisely the reliability of data concerning fund utilisation and project implementation outcomes that shapes the investment attractiveness of green bonds, as it enables the assessment not only of financial parameters but also of the environmental performance of investments. In the work of Y. Petlenko (2024), it is substantiated that the development of the energy sector requires the attraction of substantial investment resources directed towards infrastructure modernisation and reducing dependence on fossil energy sources. Under these conditions, green bonds constitute an alternative capital mobilisation mechanism that combines financial viability with the achievement of environmental objectives. The author emphasises that the implementation of energy transition programmes requires multi-billion-dollar investments in the modernisation of energy infrastructure and the development of renewable energy sources. Their utilisation ensures the targeted channelling of resources towards projects related to the advancement of renewable energy sources. The level of development of sustainable finance instruments is determined by the institutional capacity of the financial system, which establishes the conditions for the effective attraction and allocation of investment resources. A study by A. Koldovskyi (2025) emphasises that the quality of financial infrastructure plays a key role, particularly the ability to ensure transparency of

operations, accessibility of financial instruments, and stability of capital flows. The author underscores that countries with developed financial infrastructure demonstrate significantly higher volumes of capital attraction in the sustainable finance segment compared to markets where institutional mechanisms remain fragmented. At the same time, institutional constraints associated with the insufficient development of market mechanisms and infrastructure restrain issuer activity and diminish the potential for attracting investment into environmental projects.

Scholarly research has elucidated specific aspects of green finance development, notably the role of financial instruments in ensuring sustainable development, the functioning of the banking system, and the barriers to the formation of the green bond market. However, the works examined predominantly analyse individual elements of this process, whereas the question of systemic interaction between the regulatory environment, institutional infrastructure, and the mechanisms governing the functioning of green bonds remains insufficiently explored. Equally under-researched is the potential for deploying this instrument within the context of Ukraine's economic transformation and the possibilities for its integration into the national financial system based on a holistic model. The aim of the study was to identify the specific features of the green bond market's functioning, to determine the factors driving its development, and to substantiate the possibilities of utilising this instrument to finance environmental projects in Ukraine. To achieve the stated aim, the following objectives were defined: to analyse the emergence and dynamics of the global green bond market; to investigate the specificities of market formation in Ukraine and the parameters of the inaugural issuances, to assess the potential for green bond utilisation; and to develop a model for attracting financing through green bonds within the conditions of the national economy.

Materials and Methods

The study was theoretical and analytical in nature. The methodological foundation of the research was based on the application of systemic, structural-functional, comparative, and institutional approaches, which enabled a comprehensive investigation into the mechanisms of the green bond market's functioning and the interaction among its key participants. During the study, scholarly publications, international reports, and market data were analysed to trace the instrument's evolution, highlight key trends, and summarise project reporting, verification, and certification requirements, such as R. Rodrigues Loiola *et al.* (2025), Climate Bonds Initiative (2025) and Organisation for Economic Co-operation and Development (OECD, 2025). The case study method was employed to investigate the Ukrainian market, including regulatory documents and examples of the initial issuances (IFC, 2025). The temporal scope of the study encompassed the period from 2007 to 2025, from the emergence of the first green bond issuances to the formation of a fully-fledged

segment of the global sustainable finance market. The selection of this period was dictated by the necessity to trace the instrument's evolution from the initial emissions by international financial institutions to the current stage of large-scale capital attraction and market institutionalisation. For analysing contemporary trends, market structure, and institutional investors, data from 2023-2025 were used to characterise the current green bond segment. The global market was examined using a historical-economic approach with time series analysis based on Climate Bonds Initiative (2025). Structural analysis was applied to determine the composition of market participants and their functional roles (Moro & Zaghini, 2025; Kansoy & Stasiulaitis, 2025; Giacometti *et al.*, 2025).

The selection of sources was carried out according to the criteria of scholarly relevance, timeliness, and availability of empirical data. The analysis incorporated scholarly articles, analytical reports from international financial organisations, and regulatory documents, predominantly published between 2019 and 2025. The search was performed using the keywords "green bonds", "sustainable finance", "ESG investing", "green finance", "climate finance", "Ukraine green bonds", "energy transition financing" in international scientometric and analytical databases, including Scopus, Web of Science, OECD iLibrary, Climate Bonds Initiative, International Energy Agency, and the International Capital Market Association (ICMA). The analysis of the emergence of the green bond market in Ukraine was carried out by applying institutional and content analysis through a combination of the normative and practical dimensions of its formation. Analytical materials from the National Bank of Ukraine (2025) and A.A. Olenyuk (2025) were processed. A comparative analysis was used to identify market development specifics, comparing initial green bond issuances with international sustainable finance practices by capital structure, instrument type, sector, financing scale, market integration, and functional role. Based on a comparative case analysis, which involved juxtaposing the parameters of two green finance instruments according to criteria such as instrument type, source of capital, financing sector, project scale, level of integration into the financial market, and functional role, Table 1 was formulated. Investor requirements for green bonds were investigated through the application of content analysis of international standards and a comparative analysis of approaches to assessing instrument quality and conditions for capital access. To this end, research and reports by the ICMA (2025) and Climate Bonds Initiative (2025) were analysed, focusing on instrument structure, use of proceeds, project selection, financial management, and information disclosure. In the process of analysis, these elements were correlated with one another as interconnected components of a single mechanism. A comparative analysis was used to contrast international practice with Ukrainian conditions, assessing the standardisation of green bond requirements, verification and reporting procedures, institutional infrastructure, investor participation, and transparency mechanisms.

The potential for utilising green bonds in Ukraine was assessed through the application of structural-functional and comparative analysis. In the study, scholarly approaches to green financing, as presented by M. Babic (2024) and A. Frolov (2024), were compared with the economy's environmental needs to identify key application areas, including renewable energy, energy efficiency, infrastructure, transport, and waste management. In the process of analysis, these areas were examined from the perspective of their investment attractiveness, capital intensity, and the potential for achieving a measurable environmental effect. A structural-functional approach was employed to systematise these interconnections, within which the market was regarded as a system with input parameters, a functioning mechanism, and outcomes. The architecture of the conceptual model (Fig. 3) was formulated based on the structural-functional approach and the operational logic of sustainable finance markets. The delineation of the model's four blocks (input parameters, functioning mechanism, impact moderators, and outcomes) was necessitated by the need to reflect the sequence of formation and implementation of the capital attraction mechanism through green bonds. The input parameters encompass the regulatory and institutional conditions that form the basis for market functioning. The functioning mechanism covered the processes of issuance, verification, placement, and monitoring of the instrument. The impact moderators included risks, the level of investor confidence, and macroeconomic conditions, which determine the efficacy of market functioning. The outcomes block reflected the volumes of attracted financing and the environmental effect of the implemented projects.

Results and Discussion

The emergence of the global green bond market occurred as a response by the financial system to the need to mobilise capital for financing projects aimed at mitigating negative environmental impact. Conceptually, this instrument is grounded in the principle of the earmarked use of proceeds, which distinguishes it from conventional debt instruments and shapes a new logic of interconnection between financial flows and environmental outcomes (Rodrigues Loiola *et al.*, 2025). M. Migliorelli (2021) emphasises that sustainable finance does not constitute a separate market segment but rather represents a transformation of the operating logic of the financial system. Within this logic, investment is assessed not only against financial parameters but also by its capacity to generate a measurable environmental effect. This defines the place of green bonds within the sustainable finance system. Historically, the formation of the global market is linked to the activities of international financial institutions, which undertook the first attempts to integrate environmental objectives into debt financing mechanisms. The inaugural issuances were carried out in 2007-2008 by the European Investment Bank and the World Bank, laying the foundation for the application of the principle of targeted allocation of funds and creating a model that subsequently became the benchmark for the entire market (On

the origin of green bonds, 2023). This stage was characterised by a limited circle of participants and the absence of standardised approaches to assessing environmental effect, which constrained the scaling up of the instrument. The subsequent development of the market in 2009-2015 was accompanied by a sharp increase in issuance volumes and a transition from isolated offerings to the formation of a systemic segment of the financial market. Whereas in 2007 the market volume amounted to less than USD 1 billion, by 2014 it had reached USD 37 billion, and by 2016, USD 80 billion (Climate Bonds Initiative, 2019; Ballester *et al.*, 2024). Such dynamics were driven by the simultaneous growth in demand from investors and the expansion of supply from issuers, including financial institutions, corporations, and government entities. Since 2015, market development has been shaped by the strengthening of climate policy and international agreements that stimulate the mobilisation of private capital to finance environmental transformations. The study by J. Demski *et al.* (2025) underscores that, following the adoption of the Paris Climate Agreement, the market has exhibited exponential growth dynamics, manifested both in increased issuance volumes and in the diversification of participants and financing sectors. The geographical expansion of the market has been accompanied by the emergence of sovereign green bonds, notably the first government issuance in Poland in 2016, signifying the instrument's transition to the level of public financial policy.

Gradually, the market is moving from a phase of quantitative growth towards structural sophistication, manifested in the formation of a system of standards, verification mechanisms, and reporting. In the initial stages, green bond issuance was characterised by a low level of transparency regarding environmental outcomes; however, with the expansion of the market, the role of certification and verification of the use of proceeds has grown, thereby enhancing market transparency, as noted by Z. Zhang (2024) and J. Demski *et al.* (2025). This drives the market's transformation from an instrument based on declarative environmental goals to a mechanism operating on the basis of formalised assessment criteria. Starting from 2017, market development has been characterised by a high level of integration of green bonds into global financial markets (Schoenmaker & Schramade, 2018). As of 2025, the volume of the global market has exceeded USD 4 trillion, reflecting a transition from a niche market instrument to a fully-fledged segment of the global debt market (The evolution of green bonds, 2025; LSEG, 2025; TechSci Research, 2026). This transformation is accompanied by the strengthening of regulation, the growing role of institutional investors, and heightened reporting requirements. Thus, the evolution of the green bond market is determined by the interplay of financial mechanisms, climate policy, and institutional changes, which ensure the systematic channelling of capital towards the environmental transformation of the economy. The initial stage of the global green bond market's development was accompanied by limited placement volumes; however, over the last decade, a significant acceleration in the pace of development has occurred (Fig. 1).

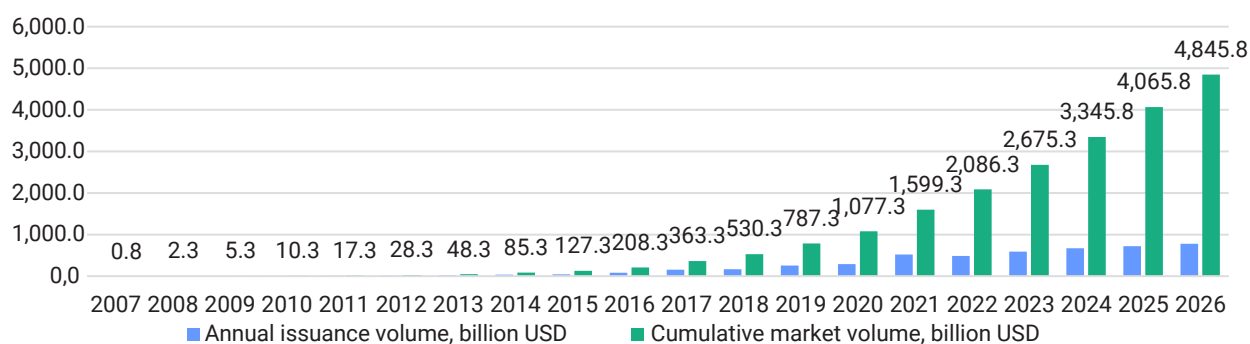


Figure 1. Dynamics of the global green bond market in 2007-2026

Source: compiled by the authors based on D. Schoenmaker & W. Schramade (2018), Climate Bonds Initiative (2025), LSEG (2025), TechSci Research (2026)

The volume of green bond issuance in 2023 amounted to USD 589.5 billion, while in 2024 it exceeded USD 670 billion, reflecting the growing demand for instruments financing environmental projects. The cumulative market volume surpassed USD 4 trillion in 2025, indicating its integration into global financial flows. The further expansion of the market is accompanied by an increase in the share of institutional investors and a strengthening of the role of regulatory mechanisms. According to OECD (2025), over 70% of global investments in the sustainable debt instrument segment are formed with the participation of institutional investors, including pension funds, insurance companies, and investment funds, which attests to the high level of integration of green bonds into the structure of professional asset management. The growth in issuance volumes is accompanied by an increase in market liquidity and an expansion of the toolkit, enabling capital to be raised for a broad spectrum of projects. At the same time, growth rates demonstrate a dependence on macroeconomic conditions and the regulatory environment, which is manifested in fluctuations in annual issuance volumes. Moreover, the regional structure of the market is characterised by the concentration of issuance in developed financial centres with a high level of institutional development. Leading positions are held by the USA and China, which account for more than half of the global placement volume, a situation driven by the active implementation of climate policy and the development of the regulatory framework (Ibrić *et al.*, 2024; Yue & Nedopil, 2025). This is supported by Sustainable bond market reaches new highs (2025),

which highlights the USA as one of the largest market segments owing to a substantial volume of corporate issuances. Concurrently, the work of Y. Xia *et al.* (2024) characterises the Chinese market, where a specific development model exists, within which green bonds occupy a relatively small share of the domestic debt market but play a role in financing infrastructure projects. The share of green bonds in the total issuance volume of debt instruments in EU countries reaches 7%, while the aggregate volume of the European green debt market segment has already exceeded USD 1 trillion, reflecting the high level of integration of this instrument into the financial system (Green bonds in Europe, n.d.; LSEG, 2025).

The sectoral structure of the market is determined by the direction of financing towards projects linked to the environmental transformation of the economy. The largest share falls on the energy sector, including the development of renewable energy sources and the enhancement of energy efficiency, which aligns with the strategic objectives of decarbonisation. Financing is also directed towards transport infrastructure, particularly the development of electric transport and the modernisation of logistics systems. A distinct segment is formed by financing the construction and renovation of buildings with enhanced energy efficiency standards, reflecting a change in approaches to infrastructure development (OECD, 2025). The formalisation of project selection criteria is carried out in accordance with international standards, ensuring the alignment of financial and environmental parameters. The sectoral structure of the use of proceeds from green bonds is clearly presented in Figure 2.

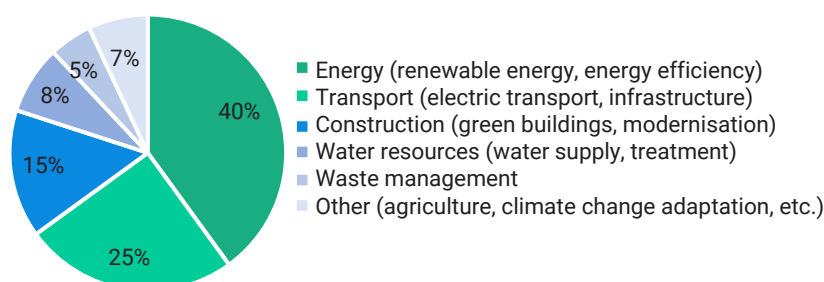


Figure 2. Sectoral structure of green bond proceeds utilisation as of 2025

Source: compiled by the authors based on OECD (2025), Climate Bonds Initiative (2025)

Analysis of the sectoral structure indicates the predominance of energy projects, which is attributable to their high capital intensity and direct impact on emissions reduction. At the same time, the transport and construction sectors account for a significant share, reflecting the expanding scope of green bond application. The functioning of the green bond market is determined by the interaction of three groups of participants, each of which performs a specific role in the process of mobilising and allocating financial resources for environmentally oriented projects (Moro & Zaghini, 2025; Rodrigues Loiola *et al.*, 2025). The category of issuers comprises sovereign states, corporate structures, and development finance institutions, whose activities ensure the formation of supply in this market segment. Sovereign issuers establish the normative foundation and set the operational parameters of the market through the issuance of sovereign bonds, thereby enabling the integration of environmental priorities into financial policy. The corporate sector employs this instrument as a mechanism for attracting long-term capital to modernise production and reduce environmental impact, which signals a shift in companies' strategic orientations.

The formation of demand in the market is primarily linked to the activities of institutional investors, for whom the integration of environmental, social, and governance (ESG) criteria into the investment decision-making process is becoming an integral component of portfolio policy. This transformation alters traditional approaches to asset valuation, as, alongside financial indicators, the quality of non-financial characteristics reflecting the degree of issuers' alignment with sustainable development principles is taken into account, according to F. Kansoy & D. Stasiulaitis (2025). As a result, capital is gradually being reallocated in favour of those instruments capable of delivering a combination of financial returns and a verified environmental impact. According to Climate bonds released provisional... (2025), the volume of assets managed under ESG criteria has exceeded USD 30 trillion globally, indicating the strengthening role of institutional investors in the development of the sustainable finance market. This drives the growing role of specialised investment funds focused on sustainable development and shapes a new demand structure in which transparency and the reliability of information concerning the use of proceeds occupy a central position (Giacometti *et al.*, 2025). A distinct function in ensuring market efficiency is performed by intermediaries, notably rating agencies, independent verifiers, and auditors, who assess the alignment of financed projects with established environmental criteria. Their involvement helps to reduce information asymmetry between issuers and investors by verifying the reliability of reporting and monitoring the earmarked use of funds. The presence of external verification formalises the environmental parameters of investments and ensures their comparability, which enhances confidence in the instrument and creates preconditions for market expansion. At the same time, S. Yiqun & Y. Hao (2025) are convinced that, within such

a system, intermediaries perform not only a control function but also an institutional one, since it is through their activities that a mechanism for reconciling the interests of all market participants is formed. The development of the green bond market is accompanied by the progressive institutionalisation of financing approaches grounded in the consideration of environmental, social, and governance criteria. The integration of such approaches into the financial system signifies a transition from the episodic use of environmental instruments to their systematic application in capital-raising processes (Rodrigues Loiola *et al.*, 2025; Walker & Gramlich, 2026).

Further transformation of the market is associated with the strengthening role of the regulatory environment, which defines the rules for classifying environmentally oriented activities and establishes the criteria for their compliance. In this context, the European Union Taxonomy occupies a prominent position, representing a unified system for identifying economic activities that align with environmental objectives (Chalavon *et al.*, 2025; Treglia, 2026). Its implementation ensures consistency in approaches to project assessment and reduces the risk of ambiguous interpretation of their environmental orientation, thereby influencing the conditions of market functioning and the level of trust in it. In parallel, the standardisation of issuance procedures and reporting is underway, envisaging the establishment of uniform requirements for the use of proceeds, their monitoring, and information disclosure. The introduction of the European Green Bond Standard (n.d.) is aimed at unifying the rules governing market operation and enhancing the transparency of investment processes, which ensures the comparability of financial instruments and reduces the costs associated with assessing their quality. Simultaneously, the problem persists of a discrepancy between the declared environmental characteristics of projects and the actual outcomes of their implementation, which manifests in practices of so-called "greenwashing". The use of environmental rhetoric without adequate substantiation of real impact creates risks of information distortion and reduces market confidence. The findings obtained regarding the risks of non-compliance and greenwashing practices align with the critical approaches to assessing the green bond market presented in the research of S. Bracking (2024). Within this approach, the existence of a contradiction between the financial returns and the environmental value of the instruments is emphasised, which creates preconditions for formal compliance with standards without ensuring a genuine environmental effect. In this regard, the significance of verification, control, and information disclosure procedures is amplified, as they allow for ensuring that financing corresponds to the declared environmental objectives and for increasing the reliability of information on the market (Yiqun & Hao, 2025; Treglia, 2026).

When examining the problem of green bond market formation in the context of Ukraine, it is expedient to proceed from the combination of normative consolidation of the instrument and limited practice of its use, which

determines the specific features of this financial market segment's emergence. The introduction of a legislative definition of green bonds in 2021 established the basic conditions for their use as an instrument for financing environmental projects, setting out the requirement for the earmarked direction of proceeds and the necessity of disclosing information on the results of their utilisation (National Bank of Ukraine, 2025). This regulatory model is oriented towards ensuring the transparency of financial flows and creates preconditions for aligning the national approach with international practice, which gradually influences the market structure (Olenyuk, 2025). The practice of using green bonds in Ukraine is characterised by a limited number of issuances and concentration within the corporate sector, reflecting the early stage of market development (National Bank of Ukraine, 2025). The placement parameters, notably the currency denomination and orientation towards international investors, indicate the limited capacity of the domestic capital market to provide the necessary volumes of financing and constrain the participation of local financial institutions in the development of this segment. At the same time, the normative environment is being shaped

under the influence of harmonisation processes with European approaches to regulating sustainable finance, which is manifested in the consideration of the provisions of the Taxonomy for Sustainable Activities, the International ICMA (2025) recommendations regarding the Green Bond Principles, and the European Green Bond Standard (n.d.), aimed at unifying approaches to structuring issuances, project selection, and information disclosure. The development of financing practices for Ukrainian environmental projects is also taking place through the use of adjacent instruments, which form the institutional foundation for the expansion of the green bond market. The attraction of financing in the amount of EUR 50 million in 2025 within the framework of sustainable development support programmes aimed at implementing projects in the sphere of energy efficiency and renewable energy demonstrates the gradual formation of demand for green finance instruments and creates preconditions for their further dissemination (IFC, 2025). Given the limited number of practical cases, it is appropriate to systematise the parameters of the first green finance instruments in Ukraine and their functional characteristics (Table 1).

Table 1. Comparative characteristics of the parameters of the first green financing instruments in Ukraine

Parameter	DTEK renewables green Eurobonds	Sustainable financing programmes (IFC and partners)
Year of launch	2019	2025
Financing volume	EUR 325 million	EUR 50 million
Type of instrument	Debt instrument (Eurobonds)	Credit and investment mechanism
Source of capital	International investors	International financial institutions
Currency	EUR	EUR
Financing sector	Renewable energy	Energy efficiency, sustainable energy
Scale of projects	Large infrastructure facilities	Small and medium-sized enterprises
Level of market integration	Full integration into the international capital market	Indirect integration through financial intermediaries
Functional role	Formation of the green bond market segment	Formation of demand for green financing
Limitations	Dependence on external investors	Absence of a direct debt instrument

Source: compiled by the authors based on IFC (2025), National Bank of Ukraine (2025)

The generalisation has enabled the delineation of the structural configuration of market formation, within which isolated corporate issues and mechanisms of international financial support are combined. The existence of a single, fully-fledged debt instrument with a volume of EUR 325 million indicates a high level of market concentration and its dependence on individual issuers. Concurrently, financing within the framework of programmes amounting to EUR 50 million generates demand for environmental projects, yet it does not translate into the development of a domestic debt instrument market. Such a structure reflects an asymmetry between institutional support and issuance practice, which constrains market depth and determines its reliance on external sources of capital. Expanding the spectrum of financial instruments in the field of sustainable finance establishes the preconditions for a gradual transition from isolated issuances to a more systematic use of green bonds (Kidwell *et al.*, 2025). The combination

of international financial resources with national support mechanisms produces an institutional multiplier effect, within which the development of adjacent instruments stimulates the formation of a market for environmentally-oriented debt instruments. This makes it possible to compensate for limitations associated with the insufficient level of development of the domestic capital market and ensures a gradual expansion of financing opportunities for environmental projects. The emergence of the green bond market in Ukraine is characterised by a gap between the regulatory formalisation of the instrument and the limited practice of its use. The selection of projects for financing through green bonds involves the application of specialised assessment procedures that ensure coherence between environmental objectives and the financial parameters of investments. Such procedures are oriented towards determining the environmental impact of projects, the efficiency of resource use, and compliance with established

sustainable development criteria, forming the basis for investment decision-making (Frolov, 2024). At the same time, the absence of established assessment methodologies and the limited experience of their application restrain the activity of issuers and reduce the instrument's attractiveness for investors. The shaping of investor requirements for green bonds occurs within a gradual shift from evaluating exclusively financial parameters towards a comprehensive consideration of transparency, accountability, and environmental performance characteristics.

Access to capital is determined not only by the issuer's creditworthiness but also by the ability to ensure project compliance with established sustainable finance standards, which alters the structure of the investment process and elevates the role of non-financial information (Rodrigues Loiola *et al.*, 2025; OECD, 2025). The institutional basis for shaping such requirements is provided by international standards, which ensure the unification of approaches to green bond issuance and define the criteria for project assessment. The Green Bond Principles, developed by the ICMA (2025), establish general requirements for the use of proceeds, project selection procedures, resource management, and disclosure, shaping the fundamental architecture of market functioning. In parallel, a system of sector-specific criteria is emerging, developed within the framework of the Climate Bonds Initiative (2025), which specifies the requirements for the environmental orientation of projects and ensures their comparability across different sectors of the economy. The evolution of the European Green Bond Standard is aimed at further detailing these requirements and integrating them into the regulatory environment, thereby increasing the level of market formalisation and creating conditions for reducing information uncertainty (Treglia, 2026; European Green Bond Standard, n.d.). Investor requirements are structured around four interconnected components that determine the quality of the instrument and the level of trust in it (Frolov, 2024). The first component relates to the targeted use of proceeds, envisaging their allocation exclusively to financing projects with a clearly defined environmental effect. The second component encompasses project selection procedures, which ensure investment compliance with established criteria and involve the assessment of their environmental impact. The third component includes mechanisms for the management of proceeds, which guarantee their targeted use and control over the flow of financial resources. The fourth component pertains to reporting, which ensures the disclosure of information on project implementation results and enables investors to assess the efficiency of the capital raised (ICMA, 2025; OECD, 2025). The aggregate of these elements forms a systemic model for evaluating green bonds, within which financial and environmental parameters are integrated into a single investment decision-making process. Ensuring the instrument's compliance with established requirements presupposes the use of verification and certification mechanisms, which allow for the confirmation of the credibility of declared characteristics (Yiqun

& Hao, 2025; Demski *et al.*, 2025). A prominent place is occupied by external audit, which ensures the verification of information regarding the use of proceeds and the compliance of projects with established criteria. It is also common practice to engage independent expert assessments, which form an additional layer of quality confirmation for the instrument and reduce the risks of information uncertainty. Within this cycle, trust is built through a sequence of stages that include defining the targeted use of proceeds, selecting projects, ensuring control over their implementation, and disclosing results. Each of these stages is linked to corresponding verification mechanisms, which allows for the minimisation of information asymmetry and ensures that financing corresponds to the stated environmental objectives. The presence of information asymmetry between issuers and investors complicates the project assessment process and increases uncertainty regarding their environmental effectiveness, which may lead to a decrease in the investment attractiveness of green bonds (Ballester *et al.*, 2024; Zhang, 2024).

A comparison of international practice with the Ukrainian market demonstrates the existence of gaps in the level of compliance with established requirements. In the global context, the functioning of the market is based on a developed system of standards, verification, and reporting, which ensures a high level of transparency and investor confidence. In Ukraine, these mechanisms are at the formative stage, which is manifested in the limited experience of applying standards and the insufficient development of institutional infrastructure (Cheng, 2022; Piskunov *et al.*, 2025). This situation necessitates the further improvement of the regulatory environment and the adaptation of international practices to national conditions. Investor requirements for green bonds form a comprehensive system of criteria that covers all stages of the instrument's life cycle – from project selection to the assessment of their results. The level of compliance with these requirements determines the degree of trust in the market and directly influences the possibilities for attracting financial resources, which confirms the dependence of access to capital on the level of transparency and the effectiveness of control mechanisms. The areas of application of green bonds in Ukraine are shaped with consideration for the structure of environmental challenges and the specificities of the economy. The most influential area remains renewable energy, which requires significant investment in the modernisation of energy infrastructure and allows for the direct reduction of emissions. According to estimates by the International Energy Agency, implementing a scenario for the development of Ukraine's decentralised energy system based on renewable generation and energy storage systems requires between USD 15.5 and 23 billion in initial investment, depending on the structure of the energy balance (IEA, 2024). At the same time, such a scenario is viewed as more economically efficient in the long term, as it allows for a reduction in the annual costs of the energy system by approximately 5.6% owing to decreased fuel costs and electricity imports. Alongside this,

significant potential is concentrated in the sphere of energy efficiency, where financing is directed towards the modernisation of the housing stock, industrial enterprises, and communal infrastructure. The transport sector constitutes a separate segment for the instrument's application, linked

to the development of electric transport and the renewal of logistics systems, while waste management opens opportunities for financing recycling and resource recovery projects. Potential directions for financing environmental projects through green bonds in Ukraine are presented in Table 2.

Table 2. Potential directions for financing environmental projects through green bonds in Ukraine

Direction of financing	Content of financing	Environmental effect	Implementation specifics
Renewable energy	Financing the construction and modernisation of solar, wind, and bioenergy facilities	Ensures a direct reduction in greenhouse gas emissions and decreased dependence on fossil fuels	Requires significant capital expenditure and long-term investment, which stipulates dependence on international financing
Energy efficiency	Modernisation of the housing stock, industrial enterprises, and communal infrastructure	Contributes to reduced energy consumption and enhanced resource use efficiency	Implemented through a combination of state support programmes and private investment
Transport infrastructure	Development of electric transport, modernisation of logistics systems, and urban mobility	Reduces air pollution levels and emissions within the transport sector	Requires a comprehensive approach to infrastructure renewal and substantial investment in technologies
Construction and real estate	Financing the construction and reconstruction of buildings with enhanced energy efficiency standards	Reduces energy consumption and emission levels in the construction sector	Necessitates compliance with international certification standards and heightened requirements for design quality
Waste management	Creation and modernisation of systems for recycling, utilisation, and reuse of resources	Reduces waste volumes and negative environmental impact	Characterised by an insufficient level of infrastructure development and requires institutional support
Water resources	Financing water purification projects and the modernisation of water supply and drainage systems	Ensures the conservation of water resources and improvement of water quality	Requires significant investment and a lengthy implementation period
Climate change adaptation	Implementation of projects aimed at increasing infrastructure resilience to climate risks	Reduces the economy's vulnerability to the adverse consequences of climate change	Demands the integration of state policy and long-term strategic planning

Source: compiled by the authors

The generalisation made it possible to identify that the potential for using green bonds is concentrated in sectors with high capital intensity and a clearly measurable environmental effect, which ensures their attractiveness to investors. At the same time, the implementation of such projects is associated with the necessity of combining private and public financing, which determines the complexity of their scaling. The results related to determining the potential of green bonds for financing environmental projects correlate with the conclusions of M. Babic (2024), in which the green finance market is regarded as a key instrument for transforming the energy sector and infrastructure. The development of the green bond market in Ukraine is determined by a set of factors that shape the conditions for its functioning and influence its ability to attract financial resources. Institutional factors are linked to the level of development of the financial infrastructure and the capacity to ensure the transparency and accountability of financing processes. Financial factors reflect the availability of capital and the cost of resources, which characterises the instrument's attractiveness for issuers. Regulatory factors shape the rules of market functioning and influence the level of investor confidence, while investment factors are associated with investors' willingness to incorporate environmental criteria into their decision-making process. Alongside the development factors, there exists a set of barriers that limit the use of green bonds as a financing instrument.

Macroeconomic instability reduces the predictability of financial flows and complicates long-term investment planning. War-related risks heighten the level of uncertainty and deter investor participation, while the weakness of the environmental infrastructure and the limited development of the environmental effect assessment system reduce the potential for project implementation. The restricted participation of institutional investors and the insufficient development of the domestic financial market further constrain the scaling of the instrument, which creates structural limitations for its use. The formation of a model for attracting financing through green bonds involves a generalisation of the interconnections between the key elements of market functioning. Within the framework of the structural-functional approach, the market is viewed as a system encompassing input parameters, a functioning mechanism, moderators of influence, and outcomes. The input parameters are determined by the quality of the regulatory environment, the level of development of environmental standards, and the institutional capacity of market participants. The functioning mechanism includes a sequence of stages of issuance, verification, placement, and monitoring that ensure the implementation of the financial instrument. Moderators reflect the influence of risks, investor confidence, and macroeconomic conditions, which can either amplify or attenuate the mechanism's effectiveness. The outcome of the model's functioning is the volume of attracted financing

and the achieved environmental effect, which influences the efficiency of the instrument's use (Fig. 3).

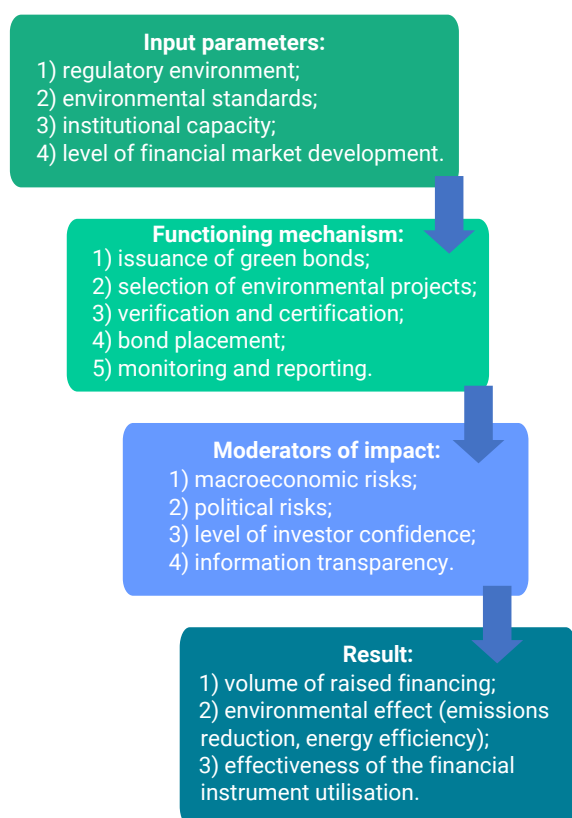


Figure 3. Conceptual model for attracting financing through green bonds

Source: developed by the authors

The interpretation of the model indicates that the efficiency of market functioning depends on the coherence among its components. Improving the quality of the regulatory environment and developing institutional infrastructure contribute to increased investor confidence and larger volumes of financing. At the same time, the negative influence of risk factors can neutralise positive effects, which necessitates a comprehensive approach to market development. Thus, the potential of green bonds as an instrument for financing environmental projects in Ukraine is determined not only by the availability of relevant areas of application but also by the capacity to ensure coherence among the institutional, financial, and regulatory conditions of their use. The developed model allows for the systematisation of these interconnections and the identification of key directions for enhancing the efficiency of market functioning.

Conclusions

The study has substantiated that the use of green bonds forms a distinct segment of the financial market, within which the

financial and environmental parameters of investment are combined. Its economic essence lies in the targeted attraction of capital for the implementation of projects with a measurable environmental effect, which alters the traditional logic of debt instrument functioning. The total market volume exceeded USD 4 trillion as of 2025. This indicates the transition of green bonds from a niche instrument to a fully developed segment of the global debt market. The dominance of the energy sector is driven by its capital intensity and direct effect on emission reductions, while the increasing role of the transport and construction sectors reflects the broader application of the instrument. The study found that the development of this financial market segment in Ukraine is marked by a gap between regulatory consolidation of the instrument and its limited practical use. The existence of DTEK renewables' green Eurobonds in the amount of EUR 325 million and sustainable financing programmes worth EUR 50 million attests to the market's dependence on external sources of capital and the insufficient level of development of the domestic debt instrument market. It has been established that the potential for using green bonds in Ukraine is most significant in the sectors of renewable energy, energy efficiency, transport, construction, and waste management. It has been revealed that market functioning is based on the interaction of issuers, investors, and intermediaries, who ensure the formation of supply, demand, and quality control of financing. It has been substantiated that the key factor in attracting investment is the level of transparency and reliability of information. The significance of this factor is reinforced by the fact that over 70% of global investments in the sustainable debt instrument segment are formed with the participation of institutional investors, and the volume of assets managed under ESG criteria exceeds USD 30 trillion. A cause-and-effect relationship has been identified: compliance with reporting standards, the presence of verification procedures, and confirmation of environmental impact directly influence the investment attractiveness of green bonds. A structural-functional model for financing has been proposed, reflecting the interconnection between input parameters, the implementation mechanism, and the outcomes of the instrument's use. The model's efficiency depends on regulatory coherence, investor confidence, institutional quality, and macroeconomic factors, enabling systematisation of capital attraction and optimisation of environmental project financing.

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Conflict of Interest

None.

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Зелені облігації як інструмент фінансування екологічних проєктів в Україні

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Анотація. Мета дослідження полягала в обґрунтуванні механізмів функціонування глобального ринку «зелених» облігацій та визначенні умов їх ефективного використання для фінансування екологічних проєктів в Україні. Методологічною основою дослідження стали системний, структурно-функціональний, порівняльний та інституційний підходи, а також контент-аналіз наукових джерел, аналітичних звітів і нормативних документів. У роботі проаналізовано обсяги емісії, зафіксовано зростання світового ринку понад 4 трлн дол. та підкреслено домінування енергетичного сектору у розподілі коштів. Результати дослідження показали, що розвиток «зелених» облігацій визначається взаємодією нормативних вимог, інституційної інфраструктури та рівня прозорості ринку, що в сукупності формує умови для залучення капіталу та ступінь довіри інвесторів. На основі аналізу динаміки ринку встановлено, що ключовими параметрами ефективності цього фінансового інструменту є цільове використання залучених коштів, наявність процедур верифікації та здатність забезпечити вимірюваний екологічний ефект. Оцінено, що реалізація програми розвитку децентралізованої енергетичної системи України на базі відновлюваних джерел і систем накопичення енергії потребує від 15,5 до 23 млрд дол. початкових інвестицій та водночас забезпечує зниження річних експлуатаційних витрат енергосистеми на 5,6 %. Встановлено, що запровадження міжнародних стандартів звітності та сертифікації сприяє зменшенню інформаційної асиметрії, тоді як їх неповне впровадження обмежує можливості розвитку ринку в Україні. Аналітичний синтез дозволив виявити структурні особливості національного сегмента, що характеризується обмеженою кількістю емісій та залежністю від зовнішніх джерел фінансування, що підтверджується реалізацією окремих інструментів на суму 325 млн євро та 50 млн євро. Дослідження сформулювало концептуальну модель, яка пов'язує нормативні умови, механізми емісії та ефективність використання коштів через «зелені» облігації

Ключові слова: сталий розвиток; енергоефективність; інформаційна прозорість; інституційні умови; енергетична безпека
