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An integrated green credit governance framework for sustainable finance

Abstract. Green finance has become one of the principal instruments supporting the transition to a low-carbon economy by mobilizing financial resources for environmentally sustainable investments. Within the European Union, green bonds, green loans, and ESG-oriented financial instruments play an increasingly important role in achieving climate neutrality. Poland occupies a distinctive position in this process as the world's first sovereign issuer of green bonds while simultaneously facing significant challenges related to energy transition and sustainable economic development.

Problem Statement. Despite the rapid expansion of sustainable finance, existing green financing mechanisms remain fragmented. Public authorities, international financial institutions, commercial banks, producers of green technologies, and end-users frequently operate independently, reducing the overall efficiency and effectiveness of green credit allocation.

Unresolved aspects of the problem. Previous studies primarily examine green bonds and green loans separately, while limited attention has been devoted to integrated governance mechanisms that coordinate stakeholders within a unified sustainable finance ecosystem. Furthermore, the role of renewable energy technology producers as direct beneficiaries of preferential green financing remains insufficiently investigated.

Purpose of the article. The study aims to analyse the development of green finance in Poland and to develop an integrated green credit governance mechanism that strengthens institutional coordination, improves access to sustainable financing, and supports environmental and economic transformation.

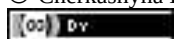
Presentation of the main material. The study employs comparative, statistical, institutional, and system analyses, complemented by conceptual modelling. The empirical analysis is based on descriptive and comparative data from European and Polish financial institutions covering the period 2014–2025, including green bond and green loan markets, ESG-related initiatives, and sustainable finance policies. An econometric framework is proposed for future empirical validation; no econometric coefficients are estimated in the present study.

Conclusions. The findings demonstrate that green finance has become a strategic driver of sustainable development in Poland. The proposed integrated green credit governance mechanism combines government institutions, international financial organizations, commercial banks, green technology producers, and final users within a unified financing ecosystem. The study introduces preferential financing for producers of green technologies, ESG-based assessment, and risk-sharing instruments as key components of sustainable credit governance. The proposed framework may enhance the effectiveness of green finance, improve institutional cooperation, and support the implementation of the European Union Sustainable Finance Framework and long-term climate objectives.

Keywords: *green finance, green bonds, green loans, sustainable development, ESG, green credit governance.*

JEL Classification: G21, G28, O16, Q56, Q58

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Introduction.

The growing intensity of climate change, environmental degradation, and resource depletion has transformed sustainable development from a political aspiration into a strategic necessity for governments, businesses, and financial institutions worldwide. The transition toward a low-carbon economy requires substantial financial resources to support renewable energy deployment, energy efficiency improvements, sustainable transportation systems, and climate adaptation measures. Consequently, the financial sector has become one of the key drivers of sustainable transformation through the development and implementation of green finance instruments.

Green finance represents a system of financial mechanisms, policies, institutions, and instruments designed to mobilize capital for environmentally sustainable projects while simultaneously promoting economic growth and social well-being. Over the past decade, green bonds, green loans, sustainability-linked loans, and ESG-oriented investment products have become increasingly important components of national and international financial systems. Their rapid development has been strongly influenced by the adoption of the Paris Climate Agreement, the United Nations Sustainable Development Goals (SDGs), and the European Green Deal.

Within the European Union, sustainable finance has become a strategic priority aimed at supporting climate neutrality by 2050. According to recent estimates of the European Commission, achieving the objectives of the green transition will require hundreds of billions of euros in additional annual investments. As a result, the development of efficient financing mechanisms capable of directing capital toward environmentally beneficial projects has become one of the central challenges for European economies.

Poland occupies a unique position within the European sustainable finance landscape. As the first sovereign issuer of green bonds in the world, Poland has demonstrated its commitment to supporting environmental transformation through innovative financial instruments. At the same time, the country continues to face significant challenges related to energy transition, greenhouse gas emissions reduction, modernization of residential buildings, and expansion of renewable energy infrastructure. These challenges create an increasing demand for effective green financing mechanisms capable of mobilizing both public and private capital.

Recent years have witnessed substantial growth in green bond issuance and green lending activities across Europe. Nevertheless, existing sustainable finance mechanisms often operate in a fragmented manner. Public institutions, international financial organizations, commercial banks, technology producers, and final users frequently participate in financing processes independently rather than within an integrated governance framework. Such fragmentation may reduce the overall effectiveness of green finance and limit its contribution to sustainable development objectives.

In this context, the development of a comprehensive green credit governance mechanism becomes particularly relevant. A systemic approach capable of coordinating the interests and activities of all stakeholders may significantly enhance the efficiency of green financing, improve access to sustainable investment resources, and accelerate the adoption of environmentally friendly technologies.

Therefore, this study focuses on the development of green finance in Poland and proposes an integrated green credit governance mechanism that combines public institutions, international financial organizations, commercial banks, green technology producers, and end-users within a unified sustainable finance ecosystem. Special attention is devoted to the role of preferential financing conditions, ESG-based assessment mechanisms, and risk-sharing instruments in supporting sustainable economic transformation.

Literature Review

The growing importance of climate change mitigation, environmental protection, and sustainable economic transformation has significantly increased academic and policy interest in green finance. Green finance is generally understood as a system of financial instruments,

institutions, and policies aimed at mobilizing capital for environmentally sustainable projects while simultaneously supporting economic growth and social development.

One of the earliest conceptual contributions was provided by Wang and Zhi (2016), who argued that green finance operates through the interaction of market mechanisms and public policies. According to their approach, environmental objectives cannot be achieved solely through market incentives; government intervention and regulatory support are necessary to correct market failures and stimulate investments in green technologies.

Taghizadeh-Hesary and Yoshino (2019) further developed this perspective by emphasizing the importance of risk-sharing mechanisms in attracting private capital to sustainable investments. Their research demonstrates that public guarantees and financial support schemes can significantly reduce investment risks and increase participation by private investors in green projects.

The role of green bonds as a source of climate finance has been extensively investigated by Banga (2019). The author concludes that green bonds represent a promising instrument for mobilizing long-term capital, particularly in emerging and developing economies. However, their effectiveness depends on transparent reporting systems, investor confidence, and adequate regulatory frameworks.

Recent studies have shifted attention from the quantitative growth of green finance toward its qualitative impact. Maltais and Nykvist (2020), using Sweden as a case study, demonstrate that green bonds influence not only capital allocation but also the sustainability behavior of market participants. Their findings suggest that green bonds contribute to the diffusion of sustainability principles within financial markets and corporate governance structures.

At the same time, Bhandary, Gallagher, and Zhang (2021) identify several limitations of existing climate finance systems. The authors argue that the absence of harmonized international standards and effective enforcement mechanisms may reduce the credibility of green financial instruments and increase the risk of greenwashing. Furthermore, climate finance policies should be integrated with broader regulatory, industrial, fiscal, and environmental policies in order to generate measurable environmental outcomes.

A broader perspective is provided by Mudalige (2023), who conducted a systematic review of 978 publications indexed in Scopus and Web of Science databases. The study identifies seven major research streams in green finance: environmental sustainability, green investments, innovation, green credit policies, economic development, corporate social responsibility, and barriers to green finance implementation. The author concludes that green credit governance and institutional coordination remain underexplored areas requiring further research.

Recent reports from the OECD (2024), the International Energy Agency (2024), and the European Commission emphasize that sustainable finance has become a strategic prerequisite for achieving climate neutrality. The European Commission estimates that the European Union requires approximately €700 billion in additional annual investments to achieve its climate transition objectives by 2030. Consequently, the development of green financial instruments, including green bonds and green lending, has become a central component of the EU Sustainable Finance Framework.

Despite the growing literature, several research gaps remain. First, most studies focus either on green bonds or green loans separately, while limited attention is paid to the interaction between different sustainable finance instruments. Second, the majority of existing research examines financial flows rather than governance structures. Third, relatively little attention has been devoted to the role of producers of renewable energy technologies as direct beneficiaries of preferential green financing mechanisms.

Therefore, this study contributes to the existing literature by proposing an integrated green credit governance mechanism for Poland that combines public institutions, international financial organizations, commercial banks, producers of green technologies, and end-users within a unified financing ecosystem. The proposed framework extends existing approaches by incorporating

preferential financing conditions for green technology producers, ESG-based monitoring systems, and risk-sharing mechanisms designed to accelerate sustainable economic transformation.

Purpose of the Study

The purpose of this study is to analyze the development of green finance in Poland and to develop an integrated green credit governance mechanism that supports sustainable development objectives through coordinated interaction among public institutions, international financial organizations, commercial banks, green technology producers, and end-users.

To achieve this objective, the following research tasks are addressed:

- to analyze recent trends in green bond and green loan development;
- to evaluate Poland's position within the European green finance market;
- to examine the participation of financial institutions in sustainable financing initiatives;
- to develop an integrated green credit governance mechanism;
- to propose an econometric framework for assessing the effectiveness of green finance instruments.

Methodology and Research Methods

The study is based on a combination of qualitative and quantitative research methods aimed at assessing the development of green finance and designing an integrated governance mechanism for green crediting.

The following methods were employed:

- comparative analysis for examining differences in green finance development across European countries;
- statistical analysis for evaluating trends in green bond and green loan markets;
- institutional analysis for assessing the role of public institutions and financial organizations in sustainable finance;
- graphical analysis for visualizing green finance dynamics and market structure;
- system approach for developing the integrated green credit governance mechanism;
- conceptual modelling for identifying relationships among stakeholders within the sustainable finance ecosystem;
- econometric modelling for evaluating the impact of green finance instruments on environmental outcomes.

The empirical basis of the research includes data obtained from:

- European Environment Agency (EEA);
- European Investment Bank (EIB);
- European Bank for Reconstruction and Development (EBRD);
- International Finance Corporation (IFC);
- OECD;
- Ministry of Finance of Poland;
- National Bank of Poland (NBP);
- Climate Bonds Initiative (CBI).

The study covers the period 2014–2025 and focuses on the development of green financial instruments within Poland and selected European countries.

Research results.

Over the past few decades, humanity has come to realize that the relentless exploitation of natural resources can no longer continue. Environmental degradation, depletion of ecosystems, and the intensifying effects of climate change have made it evident that economic progress must be harmonized with ecological balance. At the same time, new global challenges have emerged—geopolitical tensions, energy security issues, and the policies of major oil and gas suppliers—that further accelerate the need for a transformation of the global order. This transformation is

encapsulated in the concept of sustainable development, which seeks to balance economic growth, environmental protection, and social well-being.

The urgency of action has never been greater. Nations must simultaneously neutralize the negative consequences of past and present human activities while developing preventive mechanisms to mitigate future climate and environmental risks—particularly those related to ESG (Environmental, Social, and Governance) factors. Addressing these challenges requires systemic changes across all levels of governance and economic activity.

Every country in the world is moving, at its own pace, toward sustainable development. Among the leaders in this transition are the European countries, where governments and supranational institutions have adopted comprehensive regulatory frameworks defining the strategic directions of sustainability policies. These frameworks are supported by a wide range of financial, legal, and institutional instruments aimed at fostering the green transformation of economies.

A crucial component of this process is the financial dimension. Without an effective financial mechanism, the transition to a low-carbon and sustainable economy would remain merely a theoretical goal. Green finance, encompassing tools such as green loans, green bonds, and other sustainability-linked financial products**, provides the capital foundation for implementing environmentally responsible initiatives, from renewable energy projects to climate resilience and biodiversity conservation programs.

This article focuses specifically on the phenomenon of green finance. The main objective is to analyze and compare the dynamics and development trends of green loans and green bonds in Poland and other European countries, highlighting both progress and existing challenges. The study also aims to offer practical recommendations for improving the governance mechanisms of green finance in Poland, with an emphasis on increasing transparency, efficiency, and integration with EU-wide sustainability goals.

According to the report *Green Loans in Poland, Sweden, Denmark, Norway and Finland* (2020), the action plan sets out a comprehensive strategy to further connect finance with sustainability through the following measures:

1. Establishing a clear and detailed EU classification system – or taxonomy – for sustainable activities. This will create a common language for all actors in the financial system.
2. Establishing EU labels for green financial products. This will help investors to easily identify products that comply with green or low-carbon criteria. It is very important for all participants: customers, producers and government.
3. Introducing measures to clarify asset managers' and institutional investors' duties regarding sustainability.
4. Strengthening the transparency of companies on their environmental, social and governance (ESG) policies. The Commission will evaluate the current reporting requirements for issuers to make sure they provide the right information to investors.
5. Introducing a 'green supporting factor' in the EU prudential rules for banks and insurance companies. This means incorporating climate risks into banks' risk management policies and supporting financial institutions that contribute to fund sustainable projects.

According to the European Environment Agency (2025), green bonds are used to finance activities that support climate and environmental objectives. Green bonds reached 6.9% of all bonds issued by corporations and governments across the European Union in 2024, compared with 5.3% in 2023. This trend reflects increasing demand for financial products that support sustainability objectives. The issuance of green bonds is expected to remain important given the ambitious decarbonisation goals of the Competitiveness Compass and the European Green Deal.

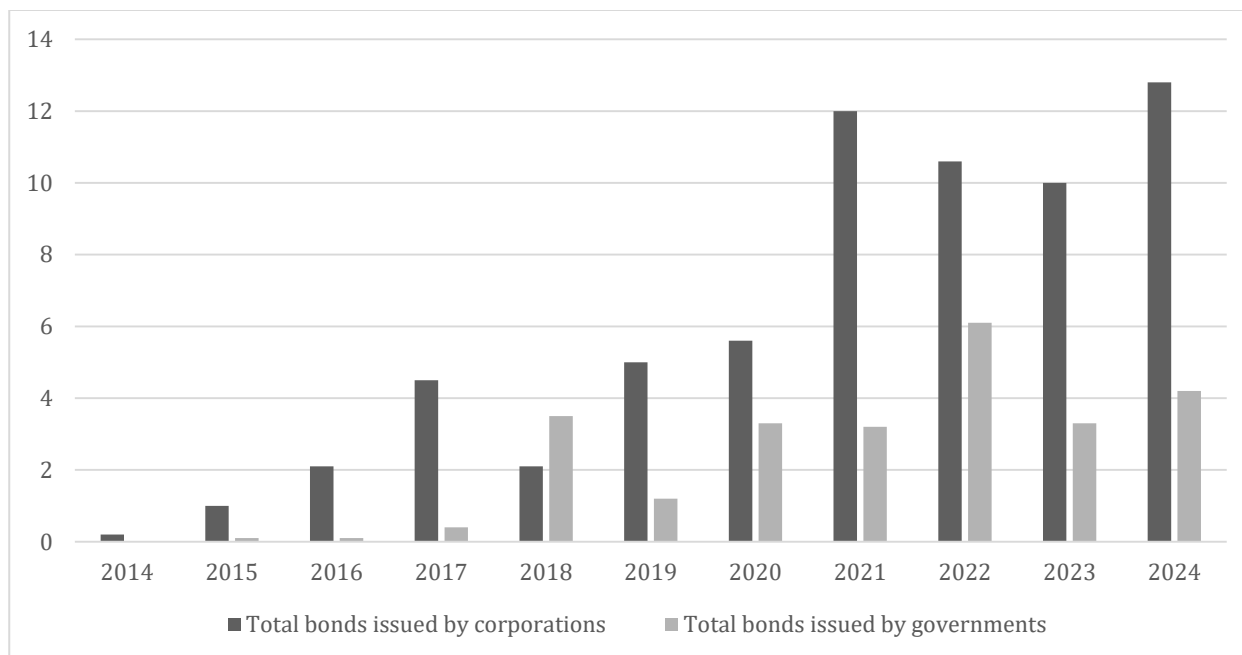


Figure 1. Green bonds as a percentage of total bonds issued by corporations and by governments in the EU-27, 2014–2024.

Source: own elaboration based on data www.eea.europa.eu

The data presented on the figure 1 shows upward trend in the total volume of green bonds issued by both corporations and governments over the past decade. The observed dynamics highlight several key phases in the development of the green bond market in Europe.

1. Initial stage (2014–2016):

The market for green bonds was still in its infancy. Corporate issuance increased slowly from 0.2 % in 2014 to 2.1 % in 2016, while government participation remained marginal. This period was characterized by low investor awareness and the absence of unified EU regulatory frameworks for sustainable finance.

2. Growth and market expansion (2017–2019):

A sharp increase occurred between 2016 and 2017, with corporate issuance more than doubling to 4.5 %, coinciding with the introduction of the EU's early sustainability initiatives. However, in 2018, corporate volumes temporarily dropped to 2.1 %, whereas government issuance rose sharply to 3.5 %, indicating a growing public sector role in promoting climate-related financing. By 2019, both sectors demonstrated renewed confidence, with corporate bonds reaching 5 %.

3. Acceleration during the pandemic period (2020–2021):

The years 2020–2021 marked a significant turning point. Corporations increased issuance from 5.6 to 12 %, reflecting the surge in green recovery programs and the EU's "NextGenerationEU" framework, which emphasized sustainability-linked investments. Governments maintained stable issuance levels around 3.2–3.3 %, focusing primarily on energy efficiency and social infrastructure projects.

4. Maturity and stabilization phase (2022–2024):

Between 2022 and 2024, the green bond market matured, with corporate issuance stabilizing at a high level (10–12.8 %) and government issuance expanding again to 6.1 % in 2022, followed by moderate levels of 3.3–4.2 %. This suggests a diversification of issuers and a transition from experimental to systematic financing of sustainable initiatives.

The following conclusions can be drawn:

1. Corporate dominance. Corporations have become the primary drivers of the green bond market, particularly after 2020, demonstrating stronger adaptability and access to private capital for sustainability projects.

2. Government participation remains essential. Although lower in volume, government-issued bonds play a strategic and stabilizing role, often financing large-scale renewable energy, transport, and infrastructure programs.

3. Post-2020 acceleration. The surge after 2020 correlates with EU-level climate commitments, including the European Green Deal and post-pandemic recovery strategies, which positioned green finance as a key macroeconomic instrument.

4. Market maturity. By 2024, both sectors exhibit institutionalization of green finance, reflecting improved regulatory clarity, investor confidence, and integration of ESG criteria into financial decision-making.

5. Future prospects. The continued growth of green bonds depends on expanding investor incentives, increasing transparency, and aligning national taxonomies with the EU Sustainable Finance Framework to ensure long-term resilience and scalability.

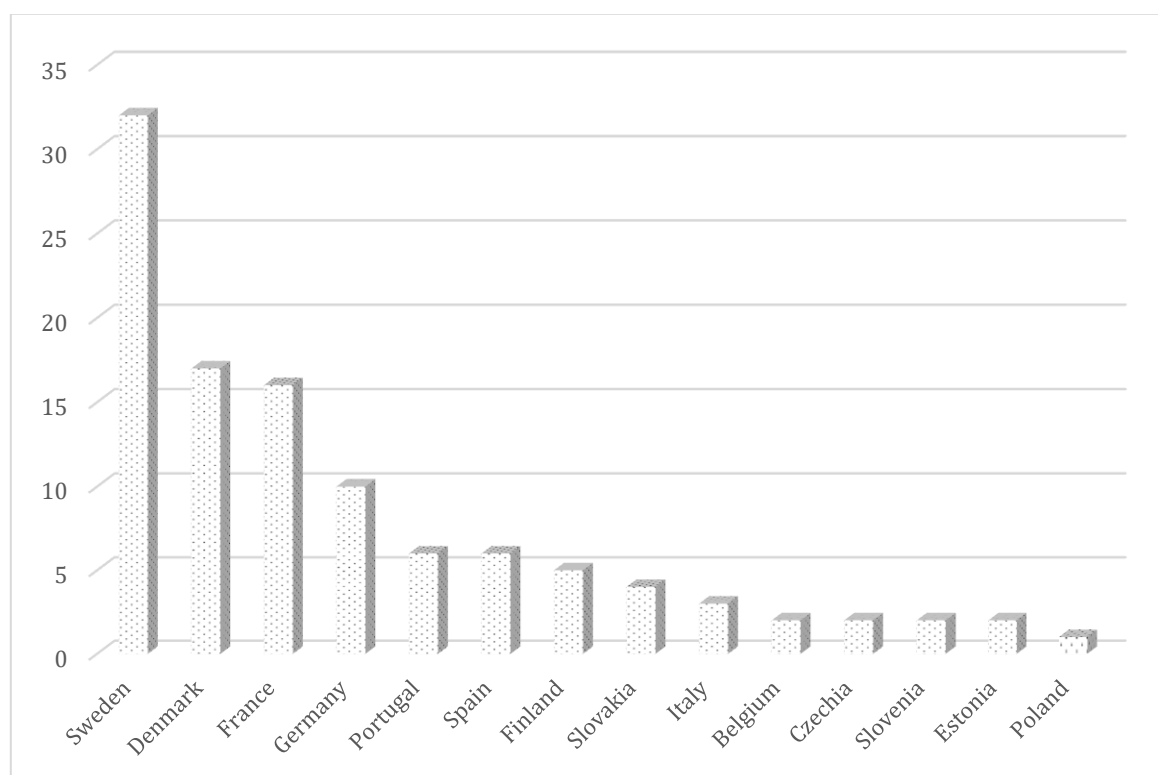


Figure 2. Shares in % of green bonds issued by corporations and by governments in 2024 in different country of Europe.

Source: own elaboration based on data www.eea.europa.eu.

The data presented in Figure 2 illustrate the shares of green bonds in the total volume of bonds issued in 2024 by corporations and governments in selected European countries. The figures clearly demonstrate significant differences in the degree of integration of sustainable finance into national capital markets.

1. Nordic leadership in green integration. The highest concentration of green bonds is observed in Sweden (32%), followed by Denmark (17%) and Finland (5%). This confirms that the Nordic financial systems have achieved an advanced stage of green market development. The widespread adoption of environmental standards, green taxonomies, and ESG disclosure practices has encouraged both corporate and public issuers to align financing activities with sustainability

objectives. In these countries, one-third or more of all issued bonds already meet green or sustainability-linked criteria.

2. Strong progress in Western Europe. France (16%) and Germany (10%) occupy leading positions among continental economies. Their green bond shares demonstrate that sustainable finance is becoming a structural component of national capital markets. The presence of large institutional investors, state development banks, and regulatory incentives—particularly under the EU Green Bond Standard—supports the consistent growth of environmentally oriented instruments.

3. Moderate participation of Southern Europe. Countries such as Portugal (6%), Spain (6%) and Italy (3%) show moderate but steady integration of green instruments. This reflects both increased participation in EU-level sustainability initiatives and domestic efforts to channel investment into energy efficiency, transport decarbonization, and climate adaptation projects. However, the share of green bonds in these countries remains below the EU average, indicating that sustainability-oriented financing is still evolving.

4. Limited penetration in Central and Eastern Europe. The lowest shares are found in Poland (1%), Slovenia, Czechia, Estonia (2% each), and Slovakia (4%). Despite recent regulatory improvements and rising awareness, green bonds still represent only a marginal part of the total bond market in these countries. Barriers include lower investor demand for ESG products, underdeveloped secondary markets, and limited access to verification mechanisms ensuring the environmental credibility of bond projects.

5. General tendencies. The overall pattern highlights a north–south and west–east divide in the European green finance landscape. Advanced economies with mature capital markets and long-standing sustainability traditions have achieved high integration of green instruments, while transition and emerging markets are still building the institutional and financial infrastructure needed to expand green financing.

Poland was the first sovereign issuer of green bonds and has four green bond tranches outstanding from the issuance events presented in Table 1.

The Ministry of Finance has issued green bonds on EUR market three times so far (Green Poland 2020):

1. December 20, 2016 - 5-year green bonds maturing on 20 of December 2021.

2. February 7, 2018 - 8-year green bonds maturing on 7 of August 2026.

3. March 7, 2019 two tranche issuance: 10-year green bonds maturing on 7 of March 2029, 30-year green bonds maturing on 8 of March 2049 the longest ever green bonds issued by Sovereign issuer. Poland's Green bond has been successfully approved by LuxSE and listed on the Luxembourg Green Exchange platform. Poland's Green bonds were assessed by Moody's rating agency which assigned GB2 note. It is the second highest grade („VeryGood”) in 5-notch scale. In the table 1 there are key characteristics of main issued green bonds.

Table 1. Key characteristics of Poland's sovereign green bond issues, 2016–2019

Main data	1st issuance (2016)	2nd issuance (2018)	3rd issuance (2019), 30-year tranche	
Term (years)	5	8	10	30
Date of maturity	20 of December 2021	7 August 2026	7 of March 2029	8 of March 2049
Yield	0.634%	1.153%	1.057%	2.07%
Amount	0.75bn	1.0bn	1.5bn	0.5bn
Allocation to green investors	61%	41%	47%	43%

Source: own elaboration based on data www.financeministersforclimate.org

The table 1 summarizes four consecutive green bond issues conducted between 2016 and 2019, presenting information on maturity terms, yields, amounts issued, and allocation to green investors. The data demonstrate both the evolution of Poland's sovereign green bond program and the general market dynamics of sustainable debt instruments during the period of their initial expansion in Europe.

1. Temporal and structural evolution. The first issue in 2016 marked the beginning of Poland's green bond market, with a 5-year term and total amount of €0.75 billion. Subsequent issues gradually extended maturity, culminating in a 30-year bond in 2019, which signifies increasing market confidence and investor trust in the long-term stability of green financial instruments. The extension of maturities from 5 to 30 years indicates that investors were increasingly willing to commit capital to long-term sustainable projects, aligning with the objectives of climate-neutral economic transformation.

2. Yield trends. Yields remained relatively low, ranging from 0.63% in 2016 to 2.07% in 2019, reflecting strong investor demand and low risk perception associated with green bonds. The gradual increase in yields over time is primarily linked to longer maturities rather than declining confidence. It also corresponds with broader market interest rate movements within the eurozone and Poland's monetary environment during that period. The yields suggest that green bonds were competitive with conventional government bonds, confirming their attractiveness as secure and socially responsible investment instruments.

3. Amounts issued and market expansion. The volume of each issuance expanded from €0.75 billion in 2016 to €1.5 billion in 2019, except for the 30-year bond (€0.5 billion), which targeted a narrower investor group due to its longer duration and risk sensitivity. This growth pattern demonstrates increasing market appetite for green financial instruments and progressive institutionalization of green finance within Poland's public debt strategy.

4. Allocation to green investors. The share of allocations to dedicated green investors ranged between 41% and 61%. The first issuance (61%) attracted the highest proportion of sustainability-focused investors, reflecting strong initial enthusiasm and limited supply in early years. Later issues show slight diversification of the investor base, with growing participation of traditional institutional investors (e.g., pension funds, insurance companies) incorporating ESG criteria into their portfolios. The consistent allocation above 40% across all issues underscores a stable and expanding segment of environmentally conscious investors.

The structure of buyers Poland's green bonds was diversified. Investors domiciled in the UK & Ireland represented 44% of the demand for the green bonds, followed by investors from the Nordics (15%). The rest of the bonds were purchased by investors from Germany and Austria (15%), Southern Europe (7%), Benelux (6%), France (2%), Switzerland (2%), Poland (2%) and the rest of the world (8%). Investment funds were dominant, representing 62% of the demand for this bond. The rest was purchased by Hedge funds (12%), banks (11%), insurance companies and pension funds (7%), central banks and public institutions (6%) and other institutions (2%) (Poland Goes Green with New Bond 2025). Dedicated green investors acquired 65% of 12-year Green Bonds tranche.

The issue was executed under the Republic of Poland's European Medium-Term Note (EMTN) Program. The lead managers on the transactions were Citigroup, Commerzbank, ING Bank and Santander.

According to the Sovereign Green Bond Framework of the Republic of Poland (June 2025), funds raised through green bonds can be used for renewable power, green buildings, green infrastructure, clean transportation, the environmentally sustainable management of living natural resources and land use, climate change adaptation, and sustainable water and wastewater management.

The Key Pillars Poland's EPP2040

1) Just Transition. Through the EPP2040, Poland commits to providing new development opportunities for the regions and communities most negatively affected by the low-emission energy transition, while creating new jobs and including new industries to participate in the energy sector. This transition will leverage national competitive advantages, create new development opportunities, and initiate modernization actions.

2) Zero-Emission Energy System. The EPP2040 recognizes that the long-term direction of the energy transition is zero-emission. Decarbonization of the energy sector will only be possible

through increased investments in renewable technologies, the expansion of distributed and community-based energy generation, and the involvement of industrial energy stakeholders.

3) Good Air Quality. Improvement in air quality is one of the most noticeable outcomes in shifting away from fossil fuels. Investments in the district heating sector transition, electrification of transport and promotion of passive and zero-emission houses using local energy sources, will improve environmental health and ensure clean air in Poland.

The successful implementation of sustainable development strategies depends on coordinated cooperation among state institutions, the private sector, and civil society (European Commission, 2020). Sustainable transformation therefore requires a systemic approach in which public governance, financial mechanisms, and societal engagement operate in synergy toward achieving the United Nations Sustainable Development Goals (UN, 2015).

From this perspective, the creation of an integrated mechanism for the implementation of sustainable development becomes an essential prerequisite. Such a mechanism should ensure the participation of all stakeholders in decision-making, financing, and monitoring processes (OECD, 2021). The government's role in establishing a stable institutional and regulatory framework is of particular importance, as it creates the enabling environment for green investment and sustainable growth.

In the case of Poland, the state demonstrates an active and comprehensive involvement in promoting sustainability-oriented financial instruments. In recent years, the Polish government has undertaken the issuance of sovereign green bonds, directing the raised capital toward projects that support environmental protection, renewable energy, and sustainable infrastructure (Ministry of Finance of Poland, 2022). These initiatives reflect a growing commitment to aligning national financial policies with the objectives of the European Green Deal.

Furthermore, the state actively encourages the participation of commercial banks in financing sustainable initiatives. Polish banks are increasingly integrating ESG (Environmental, Social, and Governance) criteria into their lending policies and investment portfolios, thereby enhancing the resilience and sustainability of the national financial system (Narodowy Bank Polski, 2023). Through targeted incentives, regulatory guidance, and collaboration with international institutions, Poland is developing a financial ecosystem that supports both economic growth and environmental responsibility.

The subsequent section will provide a detailed analysis of the participation of Polish banks in the realization of sustainable development programs. Particular attention will be given to the structure of green credit portfolios, ESG-based financial products, and the banks' contributions to achieving Poland's long-term sustainability targets in line with EU directives and global standards.

Warsaw, Poland, September 9, 2025—International Finance Corporation (IFC), a member of the World Bank Group, and Bank Pekao S.A. (Bank Pekao), Poland's second-largest bank, have launched the first step in a long-term partnership, under which IFC is considering investing up to \$250 million in a series of bonds to be issued by Bank Pekao. The potential investments, subject to commercial terms, relevant corporate approvals and market conditions, would strengthen the bank's financing capacity and contribute to the resilience of Poland's banking sector, while supporting sustainability objectives. [<https://www.ifc.org/en/pressroom/2025/ifc-partners-with-bank-pekao-to-boost-financing-for-green-and-blue-projects-in-poland>].

Polish businesses will get a green financing boost as a result of a €50 million (European Investment Bank 2025) loan to Credit Agricole. The French lender's Polish subsidiary, Credit Agricole Bank Polska, will use the EIB credit to generate up to €100 million in new loans for Mid-Caps across Poland. At least 30% of the financing will go to Polish Mid-Cap investments that fight climate change and promote environment sustainability – the first such EIB arrangement with Credit Agricole Bank Polska. Most of the funds will be made available in Poland's cohesion regions, where per capita income is below the European Union average.

A significant example of green financial cooperation in Poland is the initiative between the European Bank for Reconstruction and Development (EBRD) and BNP Paribas Bank Polska

(BNPPBP). Within this framework, the EBRD has extended a portfolio risk-sharing guarantee of €80 million to BNPPBP, aimed at enhancing the availability and accessibility of green financing instruments in the Polish market.

The guarantee mechanism enables BNPPBP to issue approximately €100 million in sub-loans to private individuals, primarily directed toward residential energy-efficiency improvements, renewable energy installations and sustainable transport investments. Through this instrument, the bank facilitates the implementation of environmentally responsible projects at the household level, contributing to the broader decarbonization goals set under the European Green Deal and the EBRD's Green Economy Transition (GET) framework.

The program particularly targets the modernization of single-family homes, which constitute nearly 40% of Poland's residential building stock. By providing financial incentives for the replacement of outdated heating systems and the implementation of comprehensive thermal modernization measures, the initiative seeks to mitigate one of Poland's most pressing environmental issues — the high energy intensity and carbon footprint of its residential housing sector.

Moreover, the project directly addresses Poland's air pollution challenge, much of which originates from residential heating reliant on coal-based systems that account for approximately 40% of the country's total energy consumption. By promoting the transition to low-emission and energy-efficient solutions, the program supports Poland's progression toward a low-carbon and climate-resilient economy.

The EBRD's guarantee benefits from partial first-loss risk coverage provided by the European Union and is supplemented by technical assistance within the framework of the InvestEU Programme (EBRD and BNP Paribas Bank Polska 2025). This integrated approach reflects the European model of leveraging blended finance instruments to accelerate the green transition, reduce financing barriers for end-users, and promote sustainable economic growth.

In essence, this cooperation exemplifies a multi-level financial intervention that links international financial institutions, commercial banks, and private households in a shared effort to advance sustainable development objectives. It also illustrates how risk-sharing mechanisms can effectively catalyze private investment in environmentally significant sectors, thereby reinforcing both the environmental and socio-economic pillars of sustainability.

Table 2 presents the main conditions of green loan products supported by the European Investment Bank (EIB). The comparison illustrates how preferential financing conditions can reduce barriers to household investment in renewable energy and energy-efficiency technologies.

Table 2. Green financing supported by the European Investment Bank

	Green financing supported by EIB	Green energy loan
Terms and conditions	Available for solar panels, heat pumps, energy storage	Available for solar panels, wind generators, heat pumps, EV charging stations
Amount	4 000 zł - 100 000 zł	4 000 zł - 100 000 zł
Interest rate	Fixed or variable, at least 0.25% lower	Fixed or variable
Agreement fee	0 zł	0 zł
RRSO	11.73%	12.86%
Period	Up to 120 months (fixed interest), up to 150 months (variable interest)	Up to 120 months (fixed interest), up to 150 months (variable interest)

Source: <https://inbank.pl/en/loan/green-energy>

The presented data compare two primary instruments supporting the development of sustainable energy solutions in Poland: the Green Financing with the European Investment Bank (EIB) and the Green Energy Loan. Both programs are designed to facilitate private investments in renewable energy technologies and energy efficiency improvements; however, they differ slightly in scope and financial terms. Both instruments target environmentally friendly household and small-scale energy projects, such as the installation of solar panels and heat pumps. The Green Energy Loan, however, offers a broader application range, additionally covering wind generators and

electric vehicle (EV) charging stations, reflecting a stronger alignment with transport electrification and distributed renewable energy generation. The credit limits for both programs are identical, ranging from 4,000 PLN to 100,000 PLN, with no agreement fee (0 PLN). This parity ensures equal accessibility for individual borrowers regardless of the chosen scheme. The EIB-supported financing provides a significant advantage in terms of cost efficiency, offering an interest rate at least 0.25% lower than that of the standard Green Energy Loan. This preferential rate directly contributes to the program's attractiveness for households aiming to minimize the long-term financial burden of green investments. Correspondingly, the Annual Percentage Rate of Charge (RRSO) is lower for the EIB instrument (11.73%) compared to the Green Energy Loan (12.86%), confirming its greater financial competitiveness. Both programs allow a repayment period of up to 120 months for fixed-interest loans and up to 150 months for variable-interest ones. This flexibility provides borrowers with opportunities to adjust repayment schedules based on their income stability and interest rate expectations. The analysis suggests that the Green Financing with EIB offers slightly more favorable financial conditions and aligns closely with the EU's objective of making green finance more affordable. In contrast, the Green Energy Loan provides broader technological coverage, making it particularly relevant for diversified sustainable energy investments, including in the emerging EV infrastructure sector.

Mechanism of Green Credit Management.

The effective governance of green crediting requires a structured and multi-level mechanism that ensures the coherence of financial, institutional, and environmental objectives. In the context of Poland and the European Union, such a mechanism should integrate the efforts of public authorities, financial institutions, enterprises, and producers of sustainable technologies. Its main goal is to provide targeted, affordable, and transparent financial support for projects that contribute to the green transition.

Goal.

The main goal of the green credit management mechanism is to stimulate sustainable economic transformation through the provision of accessible and preferential financial resources for environmentally oriented projects, thereby accelerating progress toward climate neutrality and resource efficiency.

Objectives.

1. To expand access to financial instruments supporting renewable energy, energy efficiency, and sustainable transport.
2. To ensure the inclusion of enterprises engaged in the production of green technologies, components, and materials as priority beneficiaries of preferential lending.
3. To enhance the transparency, monitoring, and accountability of credit allocation processes.
4. To align national credit policies with EU-level taxonomies and sustainable finance frameworks.

Therefore, this study contributes to the literature by proposing an integrated green credit governance mechanism for Poland that coordinates established sustainable-finance instruments within a single governance architecture. The distinctive contribution is the explicit inclusion of green technology producers as direct beneficiaries of preferential financing and the coordination of ESG-based monitoring, risk-sharing, and institutional cooperation. The econometric component is presented as a framework for future empirical validation rather than as an estimated model.

Principles.

1. Sustainability: all financed projects must contribute to long-term environmental benefits.
2. Transparency: credit decisions and performance must be based on clear, verifiable criteria.
3. Inclusiveness: support extends to both end-users (households) and producers of green technologies.

4. Preferential conditions: lower interest rates and extended repayment terms are applied to entities engaged in sustainable production.
5. Synergy: integration of financial, regulatory, and technological instruments to achieve systemic impact.

Methods.

1. Application of ESG-based assessment for borrowers to ensure environmental and social responsibility.
2. Implementation of risk-sharing mechanisms involving international financial institutions (e.g., EIB, EBRD, IFC).
3. Use of credit guarantees and interest subsidies for green technology producers and SMEs.
4. Establishment of digital monitoring platforms for tracking credit use and project outcomes.

Instruments.

1. Green loans and leasing programs for renewable energy installations, sustainable infrastructure, and clean technologies.
2. Preferential refinancing lines provided by supranational and national development banks.
3. Public–private partnership (PPP) models for financing large-scale decarbonization projects.
4. Fiscal incentives and tax reliefs for enterprises that invest in sustainable equipment production.

Subjects of Financing.

1. Public institutions: ministries, development banks, and local governments defining regulatory and incentive frameworks.
2. To propose an econometric framework for future empirical validation of the effectiveness of green finance instruments.
3. Private sector entities: enterprises manufacturing renewable energy components, energy-efficient equipment, and sustainable materials.
4. End-users: households and communities adopting green technologies.

Objects of Financing.

1. Renewable energy generation (solar, wind, bioenergy).
2. Energy efficiency and modernization of buildings.
3. Sustainable mobility infrastructure (EV charging networks, low-emission transport).
4. Production of green technologies and equipment supporting the circular economy.
5. Environmental protection and adaptation to climate change.
6. Preferential Lending for Green Producers.

To ensure the sustainability of the green credit ecosystem, it is essential to include producers of environmentally friendly technologies and components—such as manufacturers of photovoltaic panels, heat pumps, and electric vehicles—as direct participants in preferential financing schemes. For such enterprises, interest rates should be reduced by at least 0.25–0.5 percentage points compared to standard corporate loans, accompanied by longer repayment periods and reduced collateral requirements. This approach creates a multiplier effect: by supporting production, the mechanism indirectly expands access to affordable green technologies for consumers, fostering a self-reinforcing cycle of sustainable growth.

The figure 3 illustrates the integrated mechanism of green credit management in Poland. The mechanism is based on cooperation between public authorities, international financial institutions, commercial banks, green technology producers and final users. Public institutions establish regulatory frameworks and incentive systems, while international financial institutions provide guarantees, refinancing facilities and risk-sharing instruments. Commercial banks act as financial intermediaries, channeling capital to producers of sustainable technologies and households

implementing green projects. The interaction of all participants generates a multiplier effect that accelerates renewable energy deployment, improves energy efficiency and contributes to sustainable economic growth and CO₂ emission reduction.

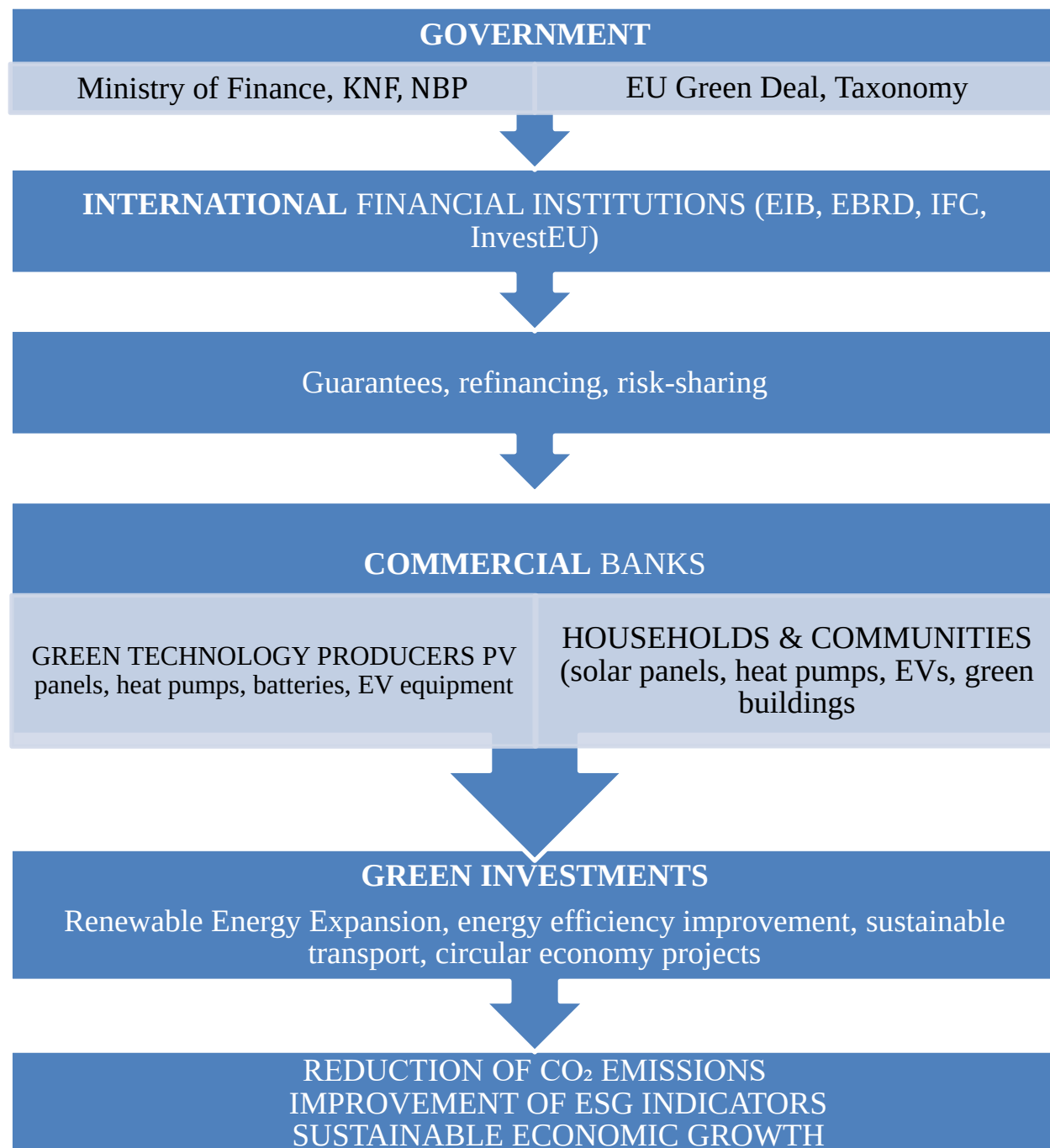


Figure 3. Integrated Green Credit Governance Mechanism for Sustainable Development
Source: prepared by the authors

Proposed econometric framework for future empirical validation of the relationship between green finance instruments and environmental outcomes.

Research Hypotheses

To assess the effectiveness of green finance instruments, the following hypotheses are proposed:

H1: Growth in green lending contributes to a reduction in carbon dioxide emissions.

H2: Growth in green bond financing contributes to a reduction in carbon dioxide emissions.

H3: An increase in the share of renewable energy sources contributes to a reduction in carbon dioxide emissions.

H4: Preferential financing of green technology producers creates a multiplier effect that accelerates sustainable economic transformation.

To assess the effectiveness of the proposed green credit management mechanism, an econometric model is proposed as a framework for future empirical testing of the relationship between green finance instruments and environmental outcomes.

The proposed regression model is:

$$CO2_t = \beta_0 + \beta_1 \text{GreenLoans}_t + \beta_2 \text{GreenBonds}_t + \beta_3 \text{RES}_t + \varepsilon_t$$

where:

$CO2_t$ – carbon dioxide emissions in Poland in year t (million tonnes);

GreenLoans_t – total volume of green loans issued in year t (EUR million);

GreenBonds_t – total value of green bonds issued in year t (EUR million);

RES_t – share of renewable energy sources in total final energy consumption (%);

β_0 – intercept term;

$\beta_1, \beta_2, \beta_3$ – regression coefficients;

ε_t – random error term.

Expected Signs of the Coefficients

$\beta_1 < 0$. An increase in green lending is expected to contribute to lower CO₂ emissions through investments in renewable energy, energy efficiency and sustainable technologies.

$\beta_2 < 0$. Growth in green bond financing should support environmentally beneficial projects and therefore reduce emissions.

$\beta_3 < 0$. A higher share of renewable energy sources is expected to decrease dependence on fossil fuels and lower greenhouse gas emissions.

Data Sources.

The proposed model can be estimated using annual data for Poland for the period 2014–2025, subject to the availability and consistency of the underlying series.

Potential data sources include:

Eurostat – renewable energy indicators and environmental statistics;

European Environment Agency (EEA) – greenhouse gas emissions and climate indicators;

World Bank DataBank – macroeconomic and environmental indicators;

National Bank of Poland (NBP) – banking sector statistics;

Polish Financial Supervision Authority (KNF) – green finance and banking reports;

Climate Bonds Initiative (CBI) – green bond issuance statistics.

The proposed model has not been empirically estimated in the present study. Future empirical verification could use Ordinary Least Squares (OLS) regression, subject to appropriate diagnostic tests for multicollinearity, heteroskedasticity, autocorrelation, and model specification. Estimated coefficients would then provide evidence on the relationship between green finance instruments and environmental performance; however, causal interpretation would require additional identification strategies.

Future research may expand the model by including additional explanatory variables such as GDP growth, energy prices, ESG investment indicators, or climate policy measures. Given the

limited number of annual observations in the 2014–2025 period, a panel-data design covering several European countries would provide a more robust basis for empirical comparison and statistical inference.

Discussion

The results indicate that the effectiveness of green finance depends not only on the volume of financial resources but also on the institutional architecture through which these resources are allocated, monitored, and shared among stakeholders. The analysis of European and Polish green bond and green loan markets supports the need to connect public policy, financial intermediation, technology supply, and end-user demand within a coherent governance framework.

The proposed mechanism extends existing approaches by treating producers of green technologies as a direct financing group alongside households and other end-users. This creates a supply-side channel through which preferential credit may support production capacity, reduce barriers to technology adoption, and strengthen the transmission of sustainable finance into the real economy. ESG assessment, guarantees, refinancing, and risk-sharing are not presented as individually novel instruments; rather, their coordinated use within the proposed architecture constitutes the principal conceptual contribution.

The proposed econometric framework provides a basis for future empirical validation of the mechanism, but the present study does not estimate the regression coefficients. Therefore, the expected negative relationships between green finance variables, renewable energy development, and CO₂ emissions remain hypotheses rather than empirically confirmed effects. In addition, the multiplier effect is currently a conceptual proposition and requires separate empirical measurement.

The main limitation of the study is the absence of econometric estimation and the relatively short annual observation period considered for Poland. These constraints limit causal inference and make a multi-country panel design, with additional macroeconomic and policy controls, a more appropriate direction for subsequent research. Nevertheless, the descriptive evidence and institutional analysis provide a basis for refining the governance mechanism and specifying variables for future empirical testing.

Scientific Novelty

The scientific novelty of the study consists in the following:

- development of an integrated green credit governance mechanism for Poland that explicitly coordinates public institutions, international financial organizations, commercial banks, green technology producers, and end-users;
- inclusion of green technology producers as direct beneficiaries of preferential green financing, extending the proposed governance architecture beyond end-user financing;
- integration of ESG assessment, risk-sharing instruments, and institutional cooperation into a single governance framework, while recognizing that these instruments are established practices whose novelty here lies in their coordinated integration;
- proposal of a clearly specified econometric framework for future empirical validation of the relationship between green finance instruments and environmental outcomes, rather than presentation of an already estimated econometric result;
- conceptualization of a multiplier effect in which financing green technology producers is expected to facilitate both the supply and adoption of sustainable technologies.

The distinctive contribution of the study is therefore not the invention of individual instruments such as ESG assessment, guarantees, refinancing, or risk-sharing, which are already established in sustainable finance, but their integration into a coordinated green credit governance architecture with green technology producers as a direct financing group.

Practical Significance

The proposed mechanism may be applied by:

- government authorities responsible for sustainable development policies;

- commercial banks developing green lending products;
- international financial organizations supporting climate-related investments;
- enterprises producing renewable energy technologies;
- local governments implementing green transition projects.

The mechanism contributes to increasing access to sustainable finance, improving ESG performance indicators, stimulating renewable energy deployment, and supporting Poland's transition toward a climate-neutral economy.

Conclusions

The study demonstrates that green finance has become an increasingly important component of sustainable development policy in Poland and across the European Union. The descriptive and comparative analysis shows the expansion and diversification of green bonds and green lending and highlights the institutional conditions that shape their development.

Poland occupies a distinctive position within the European green finance landscape because it was the first sovereign issuer of green bonds. At the same time, the relatively low share of green bonds in the national bond market indicates substantial potential for further development. The analysis of green bonds and green loans provides the empirical and institutional basis for the proposed governance mechanism.

The study identifies several challenges that may constrain the effectiveness of green finance, including the lack of universally enforceable standards, risks associated with greenwashing, unequal regional development, and the need for stronger institutional coordination. These challenges reinforce the rationale for a governance mechanism that combines transparent eligibility criteria, ESG monitoring, risk-sharing, and coordinated participation of key stakeholders.

The principal scientific contribution is the development of an integrated green credit governance mechanism that combines public institutions, international financial organizations, commercial banks, green technology producers, and final users within a unified financing ecosystem. The mechanism places particular emphasis on preferential financing for producers of renewable energy technologies, thereby linking the supply side of green technologies with their adoption by end-users.

From a policy perspective, the proposed mechanism suggests strengthening ESG-based monitoring systems, expanding risk-sharing arrangements, increasing access to preferential financing, and improving alignment with the EU Sustainable Finance Framework and Green Deal objectives. These recommendations are intended to improve coordination and transparency rather than to imply that the proposed mechanism has already been causally validated.

A key limitation is that the econometric model proposed in the study has not yet been estimated. Consequently, the hypotheses concerning the effects of green loans, green bonds, and renewable energy on CO₂ emissions, as well as the multiplier-effect hypothesis, should be regarded as propositions for future empirical testing. Future research should use longer time series and, preferably, panel data from European countries, together with additional control variables and appropriate identification strategies, to evaluate the long-term effectiveness of green credit instruments.

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Інтегрована модель управління зеленим кредитуванням для сталого фінансування

Анотація. Зелене фінансування стало одним із основних інструментів підтримки переходу до низьковуглецевої економіки шляхом мобілізації фінансових ресурсів для екологічно сталих інвестицій. У межах Європейського Союзу зелені облігації, зелені кредити та фінансові інструменти, орієнтовані на ESG, відіграють дедалі важливішу роль у досягненні кліматичної нейтральності. Польща посідає особливе місце в цьому процесі як перший у світі суверенний емітент зелених облігацій, водночас стикаючись із суттєвими викликами, пов'язаними з енергетичним переходом та сталим економічним розвитком.

Постановка проблеми. Незважаючи на стрімке розширення сфери сталого фінансування, наявні механізми зеленого фінансування залишаються фрагментарними. Державні органи, міжнародні фінансові установи, комерційні банки, виробники зелених технологій та кінцеві користувачі часто діють незалежно один від одного, що знижує загальну ефективність та результативність розподілу зелених кредитних ресурсів.

Нерозв'язані аспекти. Попередні дослідження переважно розглядають зелені облігації та зелені кредити окремо, тоді як інтегрованим механізмам управління, які координують діяльність зацікавлених сторін у межах єдиної екосистеми сталого фінансування, приділяється недостатньо уваги. Крім того, роль виробників технологій відновлюваної енергетики як безпосередніх отримувачів пільгового зеленого фінансування залишається недостатньо дослідженою.

Мета статті. Метою дослідження є аналіз розвитку зеленого фінансування в Польщі та розроблення інтегрованого механізму управління зеленим кредитуванням, спрямованого на посилення інституційної координації, покращення доступу до сталого фінансування та підтримку екологічної й економічної трансформації.

Основний матеріал. У дослідженні використано порівняльний, статистичний, інституційний та системний аналізи, доповнені концептуальним моделюванням. Емпіричний аналіз ґрунтується на описових та порівняльних даних європейських і польських фінансових установ за період 2014–2025 років, зокрема щодо ринків зелених облігацій і зелених кредитів, ESG-орієнтованих ініціатив та політики сталого фінансування. Запропоновано економетричну модель для подальшої емпіричної перевірки; у межах цього дослідження економетричні коефіцієнти не оцінювалися.

Висновки. Результати дослідження демонструють, що зелене фінансування стало стратегічним рушієм сталого розвитку Польщі. Запропонований інтегрований механізм управління зеленим кредитуванням об'єднує державні установи, міжнародні фінансові організації, комерційні банки, виробників зелених технологій та кінцевих користувачів у межах єдиної фінансової екосистеми. Ключовими складовими запропонованої моделі управління сталим кредитуванням є пільгове фінансування виробників зелених технологій, оцінювання на основі ESG-критеріїв та інструменти розподілу ризиків. Запропонована модель може підвищити ефективність зеленого фінансування, покращити інституційну взаємодію та сприяти реалізації Рамкової програми Європейського Союзу зі сталого фінансування і досягненню довгострокових кліматичних цілей.

Ключові слова: зелене фінансування, зелені облігації, зелені кредити, сталий розвиток, ESG, управління зеленим кредитуванням.

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Конфлікт інтересів: автори повідомляють про відсутність конфлікту інтересів

Декларація про використання штучного інтелекту

Під час підготовки цієї статті було використано інструменти штучного інтелекту для пошуку й виявлення статистичних даних і відповідної інформації, а також для мовного редагування, виправлення граматичних помилок і стилістичного вдосконалення тексту.

Автори критично переглянули та перевірили матеріали й зміни, отримані за допомогою інструментів ШІ. Автори несуть повну відповідальність за зміст рукопису, зокрема за точність даних, аналіз, інтерпретацію результатів, наукові висновки та остаточну версію статті.