

THE EVOLUTION OF FINANCIAL INSTRUMENTS USED IN THE GREEN TRANSITION

DANIEL-GEORGE SURDU

PHD STUDENT, ROMANIAN ACADEMY, SCHOOL OF ADVANCED STUDIES OF THE
ROMANIAN ACADEMY, DOCTORAL SCHOOL OF ECONOMIC SCIENCES, NATIONAL
INSTITUTE FOR ECONOMIC RESEARCH “COSTIN C. KIRIȚESCU”, INSTITUTE OF
NATIONAL ECONOMY, BUCHAREST, ROMANIA

e-mail: daniel-george.surdu@ince.ro

Daniel George Surdu (0009-0007-2814-2288) - ORCID

Abstract

This paper examines the evolution of green financial instruments in Central and Eastern Europe, highlighting their role in supporting the transition toward low-carbon economy. The region has experienced a gradual but uneven development of green financial instruments, driven by European Union regulatory frameworks, climate policy commitments, and increasing investor awareness of environmental, social, and governance criteria. Using a mixed-method approach that combines secondary data analysis with case studies, the research reveals that while European Union integration and access to cohesion funds have accelerated green finance development, specific challenges persist (like limited market depth, or regulatory fragmentation).

Keywords: Green Finance, EU Taxonomy, Green Transition.

JEL codes (optional): [e.g., O33; C23; R11]

I. Introduction

1.1. The Context of the Green Transition and the Importance of Financial Instruments

The transition toward a climate-neutral economy represents one of the most profound structural transformations of the contemporary era, requiring major reconfigurations not only at the industrial level but, more importantly, within global financial systems. In this context, green finance ceases to be a niche segment, becoming the central pillar of sustainable development strategies. The relevance of the topic is derived from the increasing pressure exerted by climate change and the need to align capital flows with the objectives of the Paris Agreement and the European Green Deal.

For states in the process of convergence, such as Romania, the challenge is twofold: the need to ensure sustained economic growth and the imperative of decarbonization in emission-intensive sectors. This paper investigates the evolution of green financial instruments, from traditional European funds to complex mechanisms such as green bonds and sustainability-linked loans. The motivation for this research lies in the need to identify those instruments that can accelerate the energy transition in Central and Eastern Europe, providing a comparative perspective between emerging and developed economies within the European Union.

By analyzing financial flows and institutional barriers, this work aims to highlight how the contemporary financial architecture adapts to new sustainability paradigms, ultimately providing a series of recommendations for optimizing the financing mix in the national context. The primary objective is to analyze the evolution of the main financial instruments that support the green transition, emphasizing their role in mobilizing private and public capital for sustainable projects. The research combines a theoretical analysis of the European and international framework with an assessment of the efficiency of these instruments in attracting investments in renewable energy, sustainable infrastructure, and energy efficiency projects in Romania.

1.2. Motivation for the Research Topic

The selection of the topic regarding the evolution of green financial instruments is based on the necessity of identifying sustainable financing mechanisms capable of supporting the transition to a climate-neutral economy. The selection of the six member states—Romania, Bulgaria, Hungary, Croatia, Slovakia, and Poland—is not coincidental but based on criteria of historical, political, and economic homogeneity, essential for a valid comparative analysis.

Firstly, these states share a common past of planned economies, which left a deep mark on their industrial structures, historically characterized by high energy intensity and major dependence on fossil fuels. Their transition from centralized systems to functional market economies forms the backdrop for the second major transformation: decarbonization. Secondly, their status as current EU member states subjects them to the same regulatory and legislative framework, including the European Green Deal, the EU Taxonomy, and the Recovery and Resilience Facility. However, despite following the same directives, these countries start from different economic convergence positions, reflected in variations in GDP per capita.

Consequently, this panel allows for the observation of how green financial instruments are adapted in a geographical area (Central and Eastern Europe) that must bridge major technological gaps compared to the EU core, transforming the socialist industrial legacy into a new type of sustainable infrastructure.

II. Theoretical framework and literature review

2.1. The Evolution of the Concept of Green Finance

The global green transition has emerged as an increasingly emphasized imperative, driven by the climate crisis, biodiversity loss, and the limits of natural resources. The specialized literature highlights that for the Paris Agreement and the Sustainable Development Goals (SDGs) to be achievable, it is necessary to mobilize significant amounts of capital—both public and private—toward low-emission projects, renewable energy, sustainable infrastructure, and innovative technologies. Green financial instruments represent the set of financial products and mechanisms designed to direct capital toward activities and projects with a positive impact on the environment and climate, contributing to decarbonization and sustainable development objectives. This category primarily includes green bonds, green loans, sustainable investment funds, climate-related insurance products, and derivatives used to manage transition and physical risks associated with climate change.

From a functional perspective, green financial instruments aim to internalize environmental risks into investment decisions, reallocate portfolios toward assets aligned with green taxonomies, and mobilize private resources complementary to public financing for projects involving low carbon emissions, energy efficiency, or the circular economy. Simultaneously, they play a significant role in improving transparency and sustainability reporting through specific disclosure requirements regarding the use of funds and environmental performance, thereby strengthening investor confidence and reducing the risk of "greenwashing".

Studies also indicate that regulations such as the EU Taxonomy, mandatory standardized reporting, and ESG criteria are becoming increasingly important in investment decisions, contributing to the credibility and transparency of green finance. From Romania's perspective, the context is unique: the economy still has a significant dependence on fossil fuels, and coal-mining regions are undergoing a difficult reconversion process. Furthermore, research titled "Financial Instruments for Decarbonization: Likely Pathways in Romania" shows that banking instruments, such as green loans or green certificates, have the greatest potential to mobilize the energy transformation in the country, given the structure of the national financial market, which is dominated by the banking sector compared to the relatively small capital markets.

Table 1 – Main publications studied for green financial instruments

No.	Author / Institution	Year	Study Type	Domain / Financial Instrument	Main Results
1	Döbbeling-Hildebrandt et al.	2024	Meta-analysis (Nature Communications)	Carbon pricing (ETS, taxes)	Carbon pricing leads to emission reductions (-5% to -20% in 3–5 years), depending on policy design.
2	Flammer, C.	2024	Empirical study (NBER Working Paper)	Blended finance	Blended finance mobilizes private capital but faces challenges regarding transparency and additionality.
3	Convergence Blended Finance	2024	Portfolio analysis	Blended finance in emerging economies	Every public dollar attracts an average of 4 private dollars; maximum efficiency in clean energy and agriculture.
4	Demski, S. et al. (BIS)	2025	Global economic analysis	Green bonds	Green bond issuance is correlated with emission reductions and strict climate policies.
5	OECD DAC	2025	Methodological guide and evaluation	Public-private green blended funds	Blended finance instruments can multiply private investment by 3–5 times.
6	World Bank / Steckel et al.	2025	Comparative case studies	Carbon taxes	Carbon taxes reduce emissions by 1–2% annually and can be equitable if revenues are redistributed.
7	European Commission	2025	Regulatory analysis	EU Taxonomy	The EU Taxonomy increases transparency and reduces greenwashing risk but is complex for SMEs.
8	IMF	2025	Macroeconomic analysis	Green fiscal policies / subsidies	Green subsidies are effective if fossil fuel subsidies are gradually phased out.

Source: Own processing based on bibliography.

2.2. Analysis of Relevant Contemporary Economic Theories

The evolution of green financial instruments is not an isolated phenomenon but represents a practical application of the evolution of contemporary economic thought, which has shifted from an exclusive focus on GDP growth toward sustainable development and circular economy models.

Theory of Externalities and New Institutional Economics (Pigouvian and Coasian Approach): Green finance is based on the concept of "negative externalities." Contemporary theory, starting with Arthur Pigou, argues that pollution is a market failure where social costs exceed private costs. Green financial instruments (such as carbon taxes or subsidized loans for green technologies) function as mechanisms to internalize these externalities. From the perspective of New Institutional Economics (Ronald Coase), the development of green certificate markets represents the definition of property rights over environmental resources, facilitating their trade for an optimal balance between development and conservation.

Endogenous Growth Theory and Schumpeterian Innovation: Contemporary growth models (Romer, Lucas) emphasize the role of knowledge and technology. In the green transition, financing acts as a catalyst for "creative destruction" (a Schumpeterian concept), directing capital toward R&D sectors and facilitating the technological leap to renewable energy.

Stakeholder Theory and ESG Integration in Modern Finance: A major paradigm shift in contemporary financial theories is the transition from "Shareholder Primacy" (Milton Friedman) to "Stakeholder Capitalism". Sustainable financing is based on the theoretical premise that non-financial risks (ESG) are, in fact, material long-term risks.

Donut Economics (Kate Raworth) and Planetary Boundaries: Contemporary theory proposes moving beyond the linear vision of consumption. "Donut" economics suggests that the financial system must operate in a safe and equitable space: above the social foundation but below the planet's ecological ceiling. Green financial instruments are the mechanisms by which the real economy is forced to remain within these planetary boundaries.

III. Research objectives

The methodological approach of this research is built around the idea of continuity and structural transformation of green finance in Central and Eastern Europe. In order to understand how financial instruments have evolved, the process is not limited to a simple inventory but proposes a longitudinal analysis intersecting two fundamental periods for the European Union's budgetary architecture. The first stage of the analysis focuses on the Multiannual Financial Framework (MFF) 2014-2020, a period marked by the use of cohesion funds as the primary driver of environmental investments, while the second stage explores the dynamics generated by the MFF 2021-2027 and the emergence of the NextGenerationEU instrument.

The central objective guiding this investigation is to evaluate how Romania, in parallel with its regional partners — **Bulgaria, Hungary, Croatia, Slovakia, and Poland** — has managed to navigate the transition from an almost exclusive dependence on non-reimbursable grants toward a more complex and sophisticated financing mix. An essential component of this endeavor is analyzing the extent to which green financial instruments have managed to catalyze progress toward three fundamental targets of the 2030 Agenda: **SDG 7** (Affordable and Clean Energy), **SDG 9** (Industry, Innovation, and Infrastructure), and **SDG 13** (Climate Action).

To provide increased analytical depth, the research correlates the evolution of these instruments with two crucial macroeconomic and performance indicators: **GDP per capita** and the **Share of renewable sources in gross final energy consumption (%)**. The integration of the latter indicator allows for the assessment of the real efficiency of the invested capital; the aim is to identify how income growth (reflected in GDP per capita) and the diversification of financing mechanisms (such as green bonds or sustainable loans) translate into tangible results regarding the decarbonization of the national energy mix. Thus, the proposed methodology tests the hypothesis that states with a more mature financial market and a high standard of living manage not only to attract capital but also to significantly accelerate the share of renewable energy, reducing the gap compared to European averages over the two analyzed financial cycles (2014-2024).

This investigation is based on three working hypotheses that reflect the tensions between the old and the new economic paradigms:

First, it is assumed that the 2014-2020 cycle functioned as a "green financial literacy" stage, paving the way for the current migration toward market-based instruments.

The second hypothesis concerns the essential role of ESG reporting and banking digitalization; states that integrated these standards during the n+3 transition period of the old cycle seem to be better positioned today to meet the strict criteria of the EU Taxonomy.

The research explores the idea that, in the case of Romania, the major obstacle in accelerating the transition is not necessarily the capital deficit, but the **administrative capacity limitations** in aligning projects with the new European technical rigors.

From a methodological point of view, the study adopts a mixed strategy, intertwining the rigor of documentary analysis with the interpretation of quantitative data. The financial evolution is reconstructed by aggregating data from official sources such as Eurostat, OECD Data Explorer, and the European Commission's cohesion monitoring platforms. By comparing absorption indicators and sovereign bond issuances over the ten analyzed years (2014-2024), the paper manages to sketch the portrait of a region in full convergence effort, where financial instruments are not just figures on balance sheets, but essential levers for long-term climate resilience.



Fig. 1 Sustainable development goals.

IV. Methodology

The methodological approach of this research is built around the concept of continuity and the structural transformation of green finance in the Central and Eastern European region. To understand the depth of the changes in how capital supports sustainability, this endeavor is not limited to a simple inventory of instruments. Instead, it proposes a longitudinal analysis that intersects two fundamental periods for the European Union's budgetary architecture.

This analytical narrative is anchored, on one hand, in the Multiannual Financial Framework (MFF) 2014-2020—an era of foundational investments through cohesion funds—and, on the other hand, in the 2021-2027 cycle, marked by standardization through the EU Taxonomy and the urgency of implementing the NextGenerationEU mechanism.

From a methodological standpoint, the study adopts a mixed strategy:

Quantitative reconstruction: Financial evolution is reconstructed by aggregating data from official international sources, such as Eurostat and the OECD Data Explorer.

Comparative analysis: By comparing absorption rates, sovereign bond volumes, and GDP per capita dynamics across the ten analyzed years (2014-2024), the paper manages to sketch the portrait of a region in the midst of a profound economic redefinition.

As the central objective guiding this research is to evaluate how Romania—in reflection of its regional partners (Bulgaria, Hungary, Croatia, Slovakia, and Poland)—has managed to navigate the transition from an almost exclusive dependence on non-reimbursable grants to a more complex and sophisticated financing mix, I have introduced an innovative element: the use of **GDP per capita as a control and context variable**.

The selection of this panel of six states is not accidental; they form a homogeneous group in terms of convergence challenges, sharing an emission-intensive industrial past and an acute need for capital to modernize energy infrastructure under the pressure of new European climate rigors. In the context of sustainable development theories, this indicator (GDP per capita) is not viewed

merely as a measure of welfare, but as a determinant of absorption and financial innovation capacity. By correlating GDP per capita with the volume of green investments, the research aims to determine whether the level of economic development directly influences the diversification of the instruments used. It tests whether states with a higher GDP per capita (such as Poland or Hungary) show a greater predisposition toward market-based mechanisms, while states at the lower end of the regional ranking remains focused on the grant-based assistance model.

Complementing the macroeconomic indicators, the research pays special attention to the correlation between GDP per capita and the dynamics of European fund absorption rates across the two financial cycles (2014-2020 and 2021-2027). This approach goes beyond a purely descriptive analysis, providing a perspective on the institutional capacity of the panel states to transform national wealth into sustainable investments. The aim is to verify the hypothesis that an increase in the standard of living, reflected in GDP per capita, acts as a catalyst for the maturation of local financial markets, facilitating the transition from traditional grant mechanisms to complex instruments, such as sovereign and corporate green bonds.

V. Analysis of financial instruments in the green transition

The transition toward a climate-neutral economy in the Central and Eastern European (CEE) region represents not only a technological challenge but a profound reconfiguration of capital allocation mechanisms. In this chapter, we analyze how financial instruments have metamorphosed, evolving from their role as simple subsidy sources to vectors for internalizing environmental externalities, as theorized in the previous chapters. The evolution of these mechanisms is closely correlated with the macroeconomic performance of the states in the analyzed panel, where GDP per capita serves as a predictor of financial market maturity, and the share of renewable energy represents the ultimate indicator of the efficiency of invested capital.

During the first analyzed financial cycle (2014-2020), the financial landscape in states such as Romania, Bulgaria, or Slovakia was almost authoritatively dominated by structural and cohesion funds. At this stage, green instruments functioned as compliance levers, primarily oriented toward public infrastructure projects—waste management, thermal rehabilitation of buildings, and water management. This was a period when green finance was perceived more as a component of social and territorial cohesion policies, with non-reimbursable assistance (grants) being the primary mechanism for reducing negative externalities. However, toward the end of this cycle, we witnessed the first signs of maturation in regional capital markets, with Poland managing to break the ice through the issuance of sovereign green bonds, demonstrating that private investor interest in sustainability can also be activated within emerging economies.

With the launch of the European Green Deal and the start of the new 2021-2027 financial cycle, the paradigm shifted fundamentally through the introduction of the EU Taxonomy. This classification system transformed financing from an option into a matter of strict technical rigor, imposing the "Do No Significant Harm" (DNSH) principle. In this new context, financial instruments have become more diverse and sophisticated. Green Bonds have ceased to be an isolated experiment, becoming a strategic component of public debt for the states in the analyzed panel, with Hungary and, recently, Romania accessing international markets to finance large-scale projects in renewable energy and rail transport.

In parallel with bond issuances, the banking sector in the Central and Eastern European region has begun to internalize climate risks, giving rise to a new generation of green loans. These no longer represent simple loans with subsidized interest rates but are hybrid mechanisms, often correlated with the debtor's sustainability performance. The emergence of the temporary recovery instrument, NextGenerationEU, has acted as an additional catalyst, forcing states in the region to utilize blended finance mechanisms—a fusion of grants and loans designed to de-risk private investments. Thus, the current typology of instruments reflects a much more resilient financial

architecture, where the responsibility for the transition is shared between the European public budget, the monetary policies of central banks, and the risk appetite of institutional investors.

5.1. Typology of Instruments at the European Level (The EU Taxonomy)

While in the 2014-2020 financial cycle the definition of a project as being "green" was often subject to national discretion, the new framework established by the EU Taxonomy introduced a universal technical language that eliminated ambiguity. From a theoretical perspective, the Taxonomy functions as a Coasean institution, reducing information asymmetry between issuers and investors by rigorously defining sustainable economic activities. This standardization serves as the primary driver for achieving SDG 9 (Industry, Innovation, and Infrastructure), providing companies with a clear roadmap for the modernization of assets.

For the selected panel of states (Romania, Bulgaria, Hungary, Croatia, Slovakia, and Poland), the implementation of the Taxonomy represented a necessary regulatory shock. In states with a higher GDP per capita and more dynamic financial markets, such as Poland and Hungary, the Taxonomy facilitated the rapid integration of ESG reporting, attracting international private capital. In contrast, for Romania and Bulgaria, where the share of renewable sources in final consumption necessitates massive capital investments, the Taxonomy imposed the "Do No Significant Harm" (DNSH) principle, fundamentally transforming how banking institutions assess credit risk. Consequently, the typology of European instruments has evolved into an architecture based on climate performance indicators, where access to financing is directly proportional to alignment with SDG 13 (Climate Action) targets.

5.2. Specific Mechanisms: Green Bonds, Cohesion Funds, and Green Loans

The evolution of the financing mix in the CEE region during the 2014-2024 decade highlights a gradual transition from dependence on non-reimbursable assistance toward market-based mechanisms, tailored to the economic profile of each state.

Cohesion Funds: The Foundation of the Transition (2014-2020 Cycle) In the first analyzed stage, Cohesion Funds and the ERDF (European Regional Development Fund) constituted the pillar of stability for environmental protection investments. During this period, states such as Romania and Slovakia utilized these resources for "hard" infrastructure projects, primarily targeting waste and water management. Although essential, these grants demonstrated limits regarding capital multiplication. However, they established the necessary premises for increasing the share of renewables by providing the initial subsidies required in contexts where low GDP per capita did not allow for major private investments.

Green Bonds: The Catalyst for Capital Markets Upon entering the 2021-2027 financial cycle, we observe a maturation of the sovereign green bond market, particularly in panel states that succeeded in diversifying their investor base. Poland and Hungary have established themselves as regional leaders, utilizing these instruments to finance SDG 7 (Clean Energy) objectives. Romania's debut on this market in 2024 marks a paradigm shift: the recognition that accelerating the share of renewables requires significantly larger capital flows than those provided by the state budget. Green bond issuances allow these states to attract long-term financing, directly linking public debt to tangible climate outcomes.

Green Loans: The Engine of the Private Sector and Innovation The final pillar, green loans, has experienced significant expansion, particularly in Croatia and Poland, where the banking system replicated Western models for financing energy efficiency. These instruments are vital for achieving SDG 9 targets, enabling SMEs to invest in new technologies. However, comparative analysis shows a close correlation with GDP per capita: states with higher income levels exhibit a much higher penetration rate of green loans. For Romania, the challenge remains facilitating access to these loans for small-scale renewable energy projects, ensuring that the transition is not merely driven by large state actors, but is a widespread effort across the entire economy.

In conclusion, the analysis of these mechanisms confirms that the CEE region has moved beyond the stage of passive assistance. The analyzed decade (2014-2024) has demonstrated that, as GDP per capita increases, financial instruments become more sophisticated, transforming sustainable development goals from simple political desiderata into measurable economic realities evidenced by the share of renewable sources and industrial resilience.

VI. Research, results, and discussions

This chapter presents the empirical results of the research, focusing on how the evolution of green financial instruments has impacted the transition toward sustainable development in the six analyzed states (**Romania, Bulgaria, Hungary, Croatia, Slovakia, and Poland**) during the period 2014-2024..

Table 2: Data collected for the 6 analyzed states (2014-2024)

Country	Year	Population (thousands)	DP per capita (EUR)	EU Funds (EUR million)	Green Bonds (EUR million)	Green Loans (EUR million)	Share of renewables in consumption (%)	Share of Green Investments (%)
România	2014	19.909	7.600	~ 2.750	-	-	24,80%	< 1,0%
	2017	19.587	9.600	~ 2.800	-	-	24,50%	< 1,0%
	2020	19.269	11.500	~ 3.200	-	~ 600	24,50%	~ 3,0%
	2022	19.043	14.800	~ 5.400	247	~ 1.500	23,60%	~ 4,0%
	2024	18.900	18.000	~ 6.500	2.180	~ 5.240	25,10%	~ 5,2%
Polonia	2014	38.012	10.700	~ 14.200	-	< 500	11,50%	< 1,0%
	2017	37.974	12.200	~ 11.500	~ 1.200	~ 1.500	11,00%	~ 1,5%
	2020	37.899	13.800	~ 13.000	~ 3.500	~ 3.800	16,10%	~ 3,5%
	2022	37.654	17.400	~ 12.000	~ 5.500	~ 7.500	16,90%	~ 8,0%
	2024	36.600	20.500	~ 16.500	> 9.000	~ 14.500	17,50%	~ 10,0%
Ungaria	2014	9.877	10.700	~ 4.500	-	< 100	14,60%	< 1,0%
	2017	9.797	13.100	~ 3.000	-	~ 300	13,50%	~ 1,0%
	2020	9.769	14.100	~ 4.800	~ 1.500	~ 800	13,90%	~ 2,0%
	2022	9.683	17.500	~ 5.500	~ 3.500	~ 2.500	15,20%	~ 5,0%
	2024	9.580	20.000	~ 4.000	~ 5.000	~ 4.500	16,00%	~ 7,5%
Bulgaria	2014	7.202	6.000	~ 1.500	-	< 50	18,00%	< 0,5%
	2017	7.050	7.400	~ 1.200	-	~ 100	18,70%	~ 0,5%
	2020	6.916	8.800	~ 2.000	~ 50	~ 300	23,30%	~ 1,0%
	2022	6.465	13.200	~ 2.500	~ 200	~ 800	19,10%	~ 2,0%
	2024	6.440	15.500	~ 3.000	~ 500	~ 1.500	20,00%	~ 3,5%
Croatia	2014	4.238	10.400	~ 550	-	< 50	27,80%	< 0,5%
	2017	4.124	12.100	~ 1.000	-	~ 150	27,30%	~ 1,0%
	2020	4.047	12.400	~ 2.200	~ 50	~ 450	31,00%	~ 2,0%
	2022	3.862	17.500	~ 2.800	~ 300	~ 1.100	29,30%	~ 4,0%
	2024	3.850	21.000	~ 3.500	~ 850	~ 2.200	30,00%	~ 6,5%
Slovakia	2014	5.415	14.000	~ 1.300	-	< 50	11,70%	< 0,5%
	2017	5.435	15.500	~ 1.200	-	~ 100	11,50%	~ 0,5%
	2020	5.459	17.100	~ 1.800	~ 150	~ 300	17,30%	~ 1,5%
	2022	5.430	20.000	~ 2.100	~ 500	~ 850	17,50%	~ 3,0%
	2024	5.420	23.000	~ 2.600	~ 1.200	~ 1.800	~ 17,5%	~ 4,5%

Source: Own processing based on data aggregated from: Eurostat (macroeconomic indicators and the *nrg_ind_ren* indicator for the share of renewable energy); World Bank (demographic data); Cohesion Open Data Platform - European Commission (for EU fund absorption volumes); annual and financial stability reports issued by National Central Banks (National Bank of Romania, NBP Poland, MNB Hungary, BNB Bulgaria, HNB Croatia, NBS Slovakia); Ministries of Finance (for sovereign green bond issuances); and the annual reports of the Climate Bonds Initiative (CBI) for Central and Eastern European markets (2014-2024). Regarding the Population column, the collected data are from Eurostat/World Bank sources for the resident population as of January 1st of each year. For GDP per capita (expressed in current prices, EUR), the 2024 values are projections/estimates.

Classic macroeconomic data (Population, GDP, Renewable Energy) are sourced from Eurostat, while niche financial data (Green Bonds, Green Loans, precisely annualized EU Funds) are retrieved from specific reports of National Banks or financial databases (such as Bloomberg or World Bank reports) and synthesized in Table 3.

Table 3: Comparative Analysis of Indicators by Financial Cycles (2014-2024)

State	Period / Cycle	GDP per Capita (EUR)	Share of renewable energy consumption (%)	Dominant Financial Instrument	Share of Green Investments (%)
România	2014-2020	7.600 - 11.500	24.8% - 24.5%	Cohesion Funds (ERDF)	~3%
	2021-2024	13.800 - 18.500	24.5% - 25.1%	NRRP / Green Bonds (2024)	~5,20%
Polonia	2014-2020	10.700 - 13.800	11.5% - 16.1%	Cohesion / Green Bonds (Sovereign)	~3,5%
	2021-2024	14.800 - 20.500	16.1% - 17.5%	NRRP / Green Bonds (Corp.)	~10,0%
Ungaria	2014-2020	10.700 - 14.100	14.6% - 13.9%	EU Funds / Subsidy schemes	~2,0%
	2021-2024	14.100 - 20.000	13.9% - 16.0%	Green Bonds / Green Loans / NRRP	~7,5%
Bulgaria	2014-2020	6.000 - 8.800	18.0% - 23.3%	Cohesion Grants	~1,0%
	2021-2024	8.800 - 15.500	23.3% - 20.0%	NRRP / Modernisation Funds	~3,5%
Croația	2014-2020	10.400 - 12.400	27.8% - 31.0%	Cohesion Funds (Environment)	~2,0%
	2021-2024	12.400 - 21.000	31.0% - 30.0%	NRRP (Green Pillar)	~6,5%
Slovacia	2014-2020	14.000 - 17.100	12.0% - 17.3%	Cohesion Funds / Banking sector	~1,5%
	2021-2024	17.100 - 23.000	17.3% - 17.5%	NRRP / Green Loans	~4,5%

Source: Own processing based on Eurostat comparative data, National Recovery and Resilience Plans (NRRPs) submitted to the European Commission, and national scores extracted from the Sustainable Development Report / SDG Index (Sachs, J., et al., 2024).

This table serves as the bedrock of the quantitative research, enabling the observation of the correlation between economic growth (GDP per capita) and the outcomes of sustainability policies.

The dynamics captured between 2014 and 2024 are not merely statistical; they reflect a paradigm shift in how macroeconomic variables, such as GDP per capita, and financing instruments have directly influenced the attainment of Sustainable Development Goals (SDGs 7, 9, and 13) and the share of renewable energy within the national energy mix.

Macro Data Aggregation: GDP per capita data were sourced from Eurostat time series (indicator nama_10_pc), utilizing current prices to reflect each state's nominal investment capacity. Period averages were calculated to smooth out annual fluctuations.

Energy Performance Monitoring: The "Share of Renewables" indicator was extracted from the European Union's SHARES (Renewable Energy Shares) reports. Its evolution was tracked to assess whether the capital infusion during Cycle I (2014-2020) generated the momentum required for the ambitious targets of Cycle II.

Analysis of NRRP Allocations: The figures in the final column represent the official commitments undertaken by governments through National Recovery and Resilience Plans (NRRP), validated by the Council of the EU. These were correlated with SDG 13 (Climate Action) to demonstrate the shift from voluntary investments to regulated, mandatory investments (with a minimum 37% green allocation).

Identification of Instruments: The classification of the "Dominant Instrument" was performed via a qualitative analysis of the financing gap structure, noting the timing of Green Bond market entry (e.g., Poland in 2016 vs. Romania in 2024).

Analytical Conclusion: The data confirm that GDP per capita growth in the CEE region was accompanied by a refinement of financial instruments. While during the 2014-2020 period the bulk of the transition effort was sustained by cohesion funds (grants), the 2021-2024 period shows an unprecedented mobilization of resources through the NRRP, with states like Hungary and Slovakia allocating record-breaking shares (exceeding 43%) to bridge industrial innovation gaps (SDG 9).

Table 4. Key Indicators and Regional Performance (2014-2024)

State	GDP per Capita Evolution (Trend)	Renewable Share (%) (2024 Est.)	NRRP Green Allocation (%)	SDG 7 Score (Energy)	SDG 9 Score (Industry)	SDG 13 Score (Climate)	Dominant Financial Instrument
Romania	Increasing	24.2%	41.0%	Medium	Moderate	High	Cohesion Funds / NRRP
Poland	High (Leader)	16.5%	42.7%	High	Advanced	Medium	Green Bonds & Cohesion
Hungary	Moderate-High	17.2%	48.1%	High	Moderate	Medium	Green Bonds & Green Loans
Bulgaria	Low-Moderate	23.0%	37.0%	Moderate	Low	High	EU Funds (Grants)
Croatia	Moderate	29.5%	40.3%	High	Medium	High	EU Funds & Green Tourism
Slovakia	Moderate	17.5%	43.0%	Medium	Advanced	Medium	EU Funds & Banking Sector

Source: Own processing based on Eurostat, OECD, and SDG Index (2024) data.

6.1. Analysis of Correlations Between Macroeconomic Indicators and Environmental Performance

The data analysis highlights the existence of a complex link between the level of economic development and the capacity to implement green projects. During the first stage of the analysis (corresponding to the MFF 2014-2020), it was observed that states with a GDP per capita in the phase of accelerated convergence, such as Poland and Hungary, exhibited a superior absorption capacity of cohesion funds, strategically directing them toward the SDG 9 pillar (Industry, Innovation, and Infrastructure). This early investment in modernizing industrial assets established the foundation for a more efficient subsequent growth in the share of renewable energy.

Conversely, for Romania and Bulgaria, the 2014-2020 period was characterized by "basic infrastructure recovery." Although these states show high scores for SDG 13 (Climate Action)—often a residual effect of post-1989 industrial restructuring—the actual efficiency in increasing consumption from renewable sources was limited by administrative capacity barriers. The data indicate that, despite massive flows of European grants, the lack of private financial instruments (green loans) slowed the pace of decarbonization compared to the regional average.

It is noteworthy that in Romania, although GDP grew significantly, the share of renewables experienced more temperate growth, suggesting that the capital infusion from the first cycle was directed more toward basic infrastructure rather than new production capacities—a barrier that the NRRP aims to eliminate.

6.2. The Transition of Instruments: From Grants to Market Mechanisms (2021-2024)

With the commencement of the new financial cycle and the launch of the NextGenerationEU mechanism, data indicate an "explosion" in the diversification of instruments. The analysis of green bond evolution confirms the hypothesis: states that have surpassed a specific GDP per capita threshold have succeeded in "greening" their public debt. Hungary and Poland have utilized these instruments to finance SDG 7 (Clean Energy) targets, successfully mobilizing private capital to supplement NRRP (National Recovery and Resilience Plan) allocations.

The case of Romania is particularly compelling at this stage. While the share of renewables remained relatively stagnant during the first part of the decade, the issuance of the first green bonds in 2024 and the substantial allocation of 41% of the NRRP toward climate objectives signal a significant acceleration. The research indicates that Romania is striving to bridge the industrial innovation gap (SDG 9) by utilizing recovery funds as a guarantee mechanism for the banking sector, thereby incentivizing the provision of green loans.

6.3. Discussions on Regional Efficiency and Achieving the SDGs

Analyzing the structured data for the six Central and Eastern European (CEE) states between 2014 and 2024, we can derive a series of valuable conclusions and themes for critical debate regarding regional efficiency and the progress toward achieving the UN Sustainable Development Goals (SDGs).

Although the region has recorded sustained economic growth (evidenced by the doubling or even tripling of GDP per capita), the ecological transformation of these economies displays mixed efficiency.

The research synthesis reveals a "convergence paradox": states such as Croatia, despite not possessing the highest GDP per capita in the panel, have achieved the largest percentage increase in the share of renewables, reaching scores of excellence for SDG 7 and SDG 13. This success is explained by the concentration of financial instruments on strategic niches (sustainable tourism and wind energy), demonstrating that the efficiency of green capital depends more on public policy design than on the gross volume of funds.

For **Romania**, we observed that the Green Bond market was non-existent at the national level until 2020. In 2022, the first notable issuances from commercial banks appeared (e.g., Raiffeisen, BCR), totaling 247 million euros (Source: NBR Report – Climate Risk Monitoring Dashboard, 2023). Subsequently, in February 2024, the Ministry of Finance launched the first sovereign green bonds of the Romanian state, attracting 1.98 billion euros from European markets and an additional 201 million euros (1 billion RON) from the Japanese market (Samurai Green), totaling 2.18 billion euros exclusively dedicated to environmental and non-polluting transport projects.

In the Green Loan market, the NBR estimated the green credit portfolio in 2020 (particularly for green buildings and energy efficiency) at approximately 3 billion RON (~600 million EUR). By 2024, according to the latest NBR data (Autumn 2024), the stock reached over 10.2 billion RON for companies and 16 billion RON for the population (green mortgage loans). The total stands at approximately 26.2 billion RON, equivalent to ~5.24 billion EUR.

To determine the Share of Green Investment Financing (%), given that "green investments" at a macroeconomic level are difficult to isolate within a single annual indicator, the most reliable metric is the share of green loans in total credit granted. According to the NBR, this represented barely 3% in 2020. By 2024, the share rose to 4.8% for companies and 5.7% for the retail sector (a weighted average of approximately 5.24% at the banking system level).

Regarding EU Funds, the listed values represent an estimate of the funds actually absorbed (entered into the country) during those specific years, rather than the allocation for the entire 7-year cycle. The amounts in 2022 and 2024 are significantly higher compared to 2014 because, since 2022, Romania has begun simultaneously receiving funds from both the Cohesion Policy and substantial tranches from the NRRP (Recovery and Resilience Facility); a major portion of the NRRP is mandatory "green-tagged" (climate transition).

Although Romania attracted tens of billions of euros in EU funds and began issuing massive green bonds in 2024, the share of renewable energy has paradoxically stagnated (24.8% in 2014 vs. ~24.0% in 2024). A similar trend is partially observed in Croatia. This occurred because the efficiency of the funds was diluted: capital was often directed toward road infrastructure or traditional projects, while the country's total energy consumption increased alongside GDP growth, offsetting the percentage of newly added renewable capacities.

Poland is the largest net beneficiary of EU cohesion funds. Regarding green finance, Poland was the first country in the world to issue a sovereign green bond (in December 2016), surpassing much larger economic powers. Consequently, its financial market in this segment is significantly more developed compared to the rest of the region.

The Green Bond Market: In 2016/2017, Poland pioneered the history of the global sovereign green bond market with a 750-million-euro issuance in late 2016, with the funds allocated exclusively to renewable energy and clean transport projects. In 2017, following several corporate issuances, the total volume exceeded the 1-billion-euro mark. Between 2020 and 2022, both the state and major corporations (such as PKN Orlen or large banks) became recurrent issuers. By 2022, the market had reached a consolidated level of approximately 5.5 billion euros. In 2024, the dynamics accelerated significantly; commercial banks alone (e.g., mBank) have set issuance targets in the billions for 2025. The total stock (sovereign and corporate) now exceeds the 9-billion-euro threshold.

The Polish banking sector is among the most aggressive in the region regarding the climate transition, despite Poland still facing major challenges with its coal-based industry. A 2022 specialized study showed that Polish bank portfolios contained approximately 8% green loans (particularly real estate meeting NZEB – Nearly Zero-Energy Building standards and industrial energy efficiency) and 9% loans to carbon-intensive industries. In 2024, the growth of green lending for companies and households, supported by state subsidies, brought the estimated cumulative stock to over 14.5 billion euros (exceeding 60 billion PLN).

In the sector of EU Funds, where figures represent an approximate annual average of actual payments from the EU budget to Poland, and unlike smaller countries, Poland absorbs very large sums annually. In 2024, the amount is higher as it includes both classic Cohesion Policy payments and the first massive releases (tens of billions allocated) from the Polish NRRP (which the European Commission released only in early 2024, following the resolution of rule-of-law disputes).

This refers to the proportion of green loans within the total corporate and retail loan portfolios of the Polish banking sector. The progress from ~1% in 2014 to nearly 10% in 2024 clearly reflects the pressure from European regulatory authorities (via the EU Taxonomy) to force banks to "green" their balance sheets.

Conclusion on Poland: Poland is the absolute regional champion in financial innovation (pioneering sovereign green bonds and holding the largest stock of green loans). Nevertheless, it has the lowest percentage of renewable energy within the group (~17.5% in 2024). Here, efficiency is hindered by historical legacy: the massive financial effort barely manages to offset the heavy structural dependence on coal.

The case of **Hungary** is particularly interesting for two opposing reasons: on one hand, the Central Bank of Hungary (MNB) has been among the European pioneers in stimulating green finance, offering capital facilities to banks that grant green loans; on the other hand, the absorption of EU funds has recently been marked by political blockages related to the rule-of-law conditionality mechanism.

The Green Bond Market, until 2020, this market was practically non-existent. In 2020, Hungary made a robust market entry by issuing its first sovereign green bonds worth 1.5 billion euros at debut, with a 15-year maturity. These bonds targeted clean transport infrastructure and energy efficiency. Between 2022 and 2024, the Hungarian state massively diversified its issuances, launching including “Samurai Green Bonds” (in Japanese yen) and “Panda Green Bonds” (in Chinese renminbi). Along with corporate issuances incentivized by the Central Bank (MNB), the stock rapidly climbed toward the 5-billion-euro threshold.

The primary driver for green loans was the MNB (Magyar Nemzeti Bank). In 2021, the MNB launched the Green Home Programme, a massive initiative providing 0% interest refinancing to commercial banks, on the condition that they granted mortgage loans with a maximum interest rate of 2.5% to clients purchasing or building highly energy-efficient homes. This program led to an explosion in green lending between 2021 and 2024, with the green loan stock (corporate and retail) exceeding an estimated 4.5 billion euros.

In the EU Funds sector, where figures reflect the average annual payments from cohesion and agricultural funds, and unlike Romania and Poland, the year 2024 does not show a massive jump for Hungary due to disputes with the European Commission. A large portion of the cohesion funds and the Hungarian NRRP (Recovery and Resilience Plan) were frozen, being only partially released (e.g., REPowerEU funds) toward the end of 2023 and the beginning of 2024.

This metric reflects the weight of green instruments in banks' balance sheets. The MNB operates an innovative “capital discount program”: if a bank grants a green loan (e.g., financing a solar farm), the bank is required to set aside less equity as a risk reserve. This policy rapidly doubled the share of green financing within the Hungarian banking system, reaching approximately 7.5% in 2024.

Bulgaria's situation is distinct from the previously analyzed countries. While it possesses a robust share of renewable energy, historically bolstered by hydropower and more recently by a solar panel boom, its financial market is considerably smaller, and the adoption of green financial instruments has been more gradual. Additionally, political instability in recent years has hindered both the absorption of NRRP funds and the issuance of sovereign green bonds.

In contrast to Poland, Hungary, or Romania, the Bulgarian state had not issued sovereign green bonds on international markets until recently, relying on traditional financing methods. The

figures for 2020-2024 in the table exclusively represent corporate issuances, primarily from commercial banks in Bulgaria—many of which are subsidiaries of European groups like KBC or UniCredit. These entities have begun issuing green bonds to meet European capital requirements and ESG regulations.

The green credit market is still in its infancy. Financing has been directed mainly toward large-scale photovoltaic projects, which have surged in Bulgaria over the last 2-3 years, and to a lesser extent, toward industrial energy efficiency. Green mortgage loans for the retail sector have only recently been actively promoted (post-2022), leading to an estimated total stock of approximately 1.5 billion euros in 2024. The Bulgarian banking sector is stable but relatively conservative. The share of green loans in total portfolios remains below the regional average, estimated at about 3.5% in 2024. However, growth has accelerated under pressure from European Central Bank regulations.

In the EU Funds sector, the values reflect estimates of actual disbursements. Absorption has been recently hampered by a series of political crises, as Bulgaria has undergone several rounds of early elections. Bulgaria's National Recovery and Resilience Plan (NRRP) faced late approval, and payments were blocked or deferred due to unmet milestones specifically related to the energy transition, with the phase-out of coal mines remaining a highly sensitive issue.

Despite lagging in green finance, Bulgaria performs very well in renewable energy consumption. This is attributed to its historical energy mix, grounded in a significant hydropower base, complemented by a massive capacity of privately and commercially installed solar panels in recent years. In 2020, a peak of 23.3% was recorded, though it was somewhat artificial, resulting from the sharp decline in total energy consumption (particularly fossil fuels) during the pandemic.

The case of **Croatia** is unique within this group. Having acceded to the EU most recently, in July 2013, and recently adopted the Euro in 2023, its economy remains heavily dependent on tourism. These factors profoundly influence the structure of its green financing, which is largely centered on hotel infrastructure and energy efficiency.

Similarly to Bulgaria, the Croatian state did not rush into issuing sovereign green bonds, as it benefited from relatively low-cost traditional financing, particularly following market anticipation of its Eurozone entry. The data in the table is derived from the corporate and banking sectors. The national electricity company (HEP) and major banks such as Zagrebačka Banka or Erste&Steiermärkische Bank began issuing green bonds, especially after 2021, to finance coastal wind farms and energy efficiency projects.

A defining characteristic of Croatia is the prominence of tourism as the primary destination for green loans. A significant portion of bank financing labeled as "green" is directed toward renovating hotel complexes to NZEB (Nearly Zero-Energy Building) standards, installing solar panels on hotels, and developing sustainable tourism infrastructure. The adoption of the Euro in 2023 eliminated currency risk, triggering an accelerated growth in lending during 2023-2024, with the green loan stock exceeding 2 billion euros.

In 2014, only one year after accession, Croatia's administrative capacity for absorbing EU funds was still limited. These amounts have increased substantially in recent years. The funds attracted between 2022 and 2024 include not only cohesion funds and the NRRP (Recovery and Resilience Facility) but also billions of euros from the EU Solidarity Fund. These were specifically allocated for post-earthquake reconstruction following the devastating events in Zagreb and Petrinja in 2020. Much of this reconstruction was mandated to comply with new green and energy efficiency standards.

Croatia boasts the highest percentage in the group, at nearly 30%. This is not the result of recent massive innovations but rather its favorable geographical framework: Croatia possesses a very strong historical network of hydroelectric plants, supplemented by biomass energy. The year 2020 saw a peak of 31%, similar to Bulgaria, driven by the collapse of energy consumption during

the COVID-19 pandemic, as the cessation of economic and tourism activities drastically reduced fossil fuel usage.

Slovakia is distinguished in this region by its extremely strong automotive industry, being the world's largest car producer per capita. This characteristic also leaves its mark on green financing, which is heavily directed toward the retooling of factories as well as transport infrastructure. However, regarding green financial innovation, the Slovak market is relatively conservative compared to its neighbors.

The Slovak financial market is heavily dominated by banks, which hold approximately 70% of the financial system's assets, while the domestic capital market is quite small. Until recently, green bond issuances were exclusively private sector initiatives from banks such as Tatra Banka or subsidiaries of UniCredit and Erste Bank, which began issuing green, mortgage, or corporate bonds, particularly after 2021. The Slovak state has long hesitated to enter the sovereign green bond market, relying primarily on non-reimbursable European funds to cover its climate transition needs. The stock of approximately 1.2 billion euros in 2024 belongs almost entirely to banks and large energy/industrial corporations.

Green loan financing in Slovakia is mainly directed toward the commercial real estate sector (office buildings with LEED/BREEAM certifications in Bratislava), as well as toward adapting industrial production lines to energy efficiency standards. In 2024, the stock is estimated at 1.8 billion euros, with the pace dictated strictly by commercial banks' compliance with the European Taxonomy.

The values for EU fund absorption represent the annual averages attracted from the Cohesion Policy. For the years 2022-2024, these amounts also include the tranches received from the National Recovery and Resilience Plan (NRRP). Slovakia has programmed a large portion of these European funds specifically to supplement the lack of private green financial instruments.

Although the share of renewable consumption increased from 11.7% (2014) to over 17% in the 2020-2024 period, Slovakia continues to have an energy mix heavily dependent on nuclear energy, which is not counted as renewable energy under the strict Eurostat `nrg_ind_ren` indicator, despite having zero carbon and fossil fuel emissions in the industrial sector. The percentage increase is primarily due to biomass and the installation of new solar parks.

Regarding **SDG 7** (Affordable and Clean Energy), the region has relied heavily on zero-emission sources that are not strictly classified as "renewable" under certain methodologies (specifically nuclear energy in Romania, Slovakia, and Hungary). Regional efficiency is considered sub-optimal; the transition from fossil fuels to renewable production (wind, solar) was performed chaotically, often relying on subsidy schemes that were unsustainable in the long term—such as the green certificates in Romania in the early 2010s, which halted investments for years once they were phased out.

For **SDG 8 & SDG 9** (Economic Growth, Industry, and Innovation), the region excels. GDP per capita has surged (e.g., Romania increasing from €7,600 to €18,000). Simultaneously, commercial banks in the region have innovated rapidly, establishing dedicated sustainability departments. Regional efficiency is particularly high in terms of institutional innovation. Hungary is frequently cited as a global case study for how its Central Bank (MNB) reduced capital requirements for green loans, effectively mandating innovation within the banking sector. This demonstrates that monetary policies can serve as a powerful catalyst for the SDGs.

The results confirm that the green transition in the CEE region is a multidimensional process. While the 2014–2024 decade began characterized by grant dependency, it concludes with a region beginning to utilize sophisticated financial instruments. However, the debate remains open regarding SDG 9; without profound industrial innovation, the increasing share of renewables may remain an isolated objective, unsupported by a resilient economic structure. The collected data suggests that as the panel states approach the EU average for GDP per capita, the role of European

funds must evolve from direct subsidies toward de-risking mechanisms for long-term private investments.

In terms of **SDG 13** (Climate Action), private climate action was nearly non-existent until 2020, as evidenced by the absence of green bond issuances between 2014 and 2017 for almost all countries except Poland. The "wake-up call" was exclusively administrative: the imposition of the EU Taxonomy and the conditioning of NRRP (Recovery and Resilience Facility) funds on environmental targets. Consequently, regional efficiency in this area remains dependent on external stimuli. Without the pressure of European directives from Brussels, CEE financial markets would not have organically generated the billions of euros in green loans and bonds observed in 2022 and 2024.

Beyond the figures, three major risks for these six states are being discussed at the European level. The most significant is the Risk of Greenwashing. Given the abrupt increase in green loans from under 1% to 5–10% in just a few years, there are serious debates regarding whether these funds are financing a genuine transition or if banks have merely "re-labeled" standard loans (e.g., standard mortgages) as "green" to enhance their ESG reporting.

The second vulnerability is the EU Fund Dependency Syndrome. Unlike Western Europe, where private capital carries the bulk of the transition, CEE states still rely heavily on the European Commission. The domestic capital market is currently too weak to independently sustain the climate SDGs without the infusion of capital from Brussels.

The third risk pertains to the Just Transition. Poland, Romania, and Bulgaria possess massive mining regions. The efficiency of achieving the SDGs is hindered by the social costs (unemployment) generated by the closure of these polluting industries, occurring within the context of the continuous depopulation of these states.

VII. Conclusions and recommendations

The comparative analysis of green financial instruments across the six Central and Eastern European states reveals an accelerated, yet asymmetric, development of the capacity to finance the ecological transition. Although the volume of capital allocated to sustainability has grown exponentially after 2020, the aggregate efficiency of these funds in the structural transformation of the energy mix remains sub-optimal. To accelerate the region's convergence with internationally assumed Sustainable Development Goals (SDGs), an integrated approach focused on several key directions is required.

Firstly, governments must demonstrate greater involvement in fiscal policies and state-funded strategies. A crucial aspect is the institutionalization of sovereign green bond issuances. It is recommended to move away from the sporadic nature of sovereign green issuances and establish predictable issuance calendars. This measure is essential for building a benchmark yield curve, which is necessary for the corporate sector to accurately price risk and attract private capital.

At the same time, democratizing access to green financial instruments is another essential component. States should consider issuing green government bonds dedicated exclusively to the retail sector (the general population). This initiative directly supports SDG 13 (Climate Action) by stimulating civic participation in the decarbonization effort, directing household savings toward public utility projects (e.g., clean transport infrastructure, energy efficiency in public buildings).

Government guarantee schemes to mitigate perceived credit risk represent another aspect that can reduce information asymmetry. The implementation of partial state guarantees for green loans contracted by Small and Medium-sized Enterprises (SMEs) can be proposed, thereby facilitating their access to the capital required for the transition.

The role of Central Banks is major in the implementation of a Green Supporting Factor. Following the model of the Central Bank of Hungary (MNB), macroprudential authorities in the region should analyze the feasibility of reducing risk weights (and consequently capital

requirements) for green exposures on commercial banks' balance sheets. This targeted prudential easing can act as a powerful catalyst for the expansion of sustainable lending.

Finally, the rapid expansion of green portfolios raises risks of misreporting; therefore, it is necessary to strengthen auditing mechanisms and prevent "Greenwashing." It is recommended to impose strict non-financial external audit standards, rigorously anchored in the EU Taxonomy, to ensure that funds classified as "green" generate real and verifiable ecological additionality.

The Expansion of "Sustainability-Linked Loans" (SLLs) – Portfolio Innovation in the Commercial Banking Sector. To support SDG 9 (Industry, Innovation, and Infrastructure), commercial banks must move beyond the exclusive model of financing "green-only" projects and offer lending solutions with a variable interest margin. This margin should be contingent upon the achievement of specific Key Performance Indicators (KPIs) related to greenhouse gas emission reductions by companies in heavy industries.

The banking system requires a diversification of products addressed to individuals, through financing packages with subsidized interest rates or zero commissions for the acquisition of green technologies (e.g., photovoltaic panels, heat pumps, zero-emission vehicles), aiming for a standardization of green retail products.

Redirecting capital flows toward Smart Grids is essential for a Just Transition and the Modernization of Critical Infrastructure. The data reveal an increase in production capacities from renewable sources that is not adequately supported by the current transport infrastructure. Future financing must be prioritized toward the modernization of power grids to facilitate the efficient integration of fluctuating energy and to secure the national energy system (SDG 7).

Last but not least, in the context of the gradual phase-out of fossil fuels (e.g., the coal sector in Poland, Romania, and Bulgaria), it is imperative that a quota of the funds raised through green bonds be allocated to professional retraining programs and local entrepreneurial development in disadvantaged regions. This approach guarantees a "Just Transition" that does not jeopardize the achievement of SDG 8 (Decent Work and Economic Growth).

VIII. Bibliography

1. Climate Bonds Initiative (CBI), (2024), Central and Eastern Europe Sustainable Finance State of the Market. Available at: <https://www.climatebonds.net> [accessed on 20.01.2026].
2. Convergence, (2024), State of Blended Finance 2024, Convergence Blended Finance Resources.
3. Demski, J., Dong, Y., McGuire, P., & Mojon, B., (2025), "Growth of the green bond market and greenhouse gas emissions", BIS Quarterly Review, March 2025, Bank for International Settlements.
4. Döbbeling-Hildebrandt, N., Miersch, K., Khanna, T. M. et al., (2024), "Systematic review and meta-analysis of ex-post evaluations on the effectiveness of carbon pricing", Nature Communications, Vol. 15(4147).
5. EU Platform on Sustainable Finance, (2025), Platform response to the draft taxonomy delegated act consultation, European Commission.
6. European Commission, (2025), Cohesion Open Data Platform - European Structural and Investment Funds. Available at: <https://cohesiondata.ec.europa.eu> [accessed on 20.01.2026].
7. Eurostat, (2025), Online database: Share of energy from renewable sources (nrg_ind_ren) and GDP per capita in PPS. Available at: <https://ec.europa.eu/eurostat/data/database> [accessed on 10.01.2026].
8. Flammer, C., Giroux, T., & Heal, G., (2024), "Blended Finance: A Conceptual and Empirical Analysis", NBER Working Paper Series, Working Paper 32287, National Bureau of Economic Research.
9. International Capital Market Association (ICMA), (2023), Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds.

10. International Monetary Fund (IMF), (2025), The Scalability of Credit-Enhanced EM Climate Debt / Sustainable Finance, IMF Working Papers, Washington, DC.
11. Khan, M.A., (2025), "Green bond issuance and corporate environmental performance", Journal of Environmental Management.
12. Magyar Nemzeti Bank (MNB), (2024), Green Finance Report, Budapest.
13. Murafa, C., (2023), "Financial Instruments for Decarbonization: Likely Pathways in Romania", Romanian Journal of Monetary and Financial Studies.
14. Narodowy Bank Polski (NBP), (2024), Financial Stability Report, Warsaw.
15. National Bank of Romania (NBR), (2024), Financial Stability Report, Bucharest.
16. Neagu, F., (2024), "Are green loans less risky? Micro-evidence from a Romanian financial institution", Journal of Risk Finance.
17. Nipper, M., Ostermaier, A., & Theis, J., (2022), "Mandatory Disclosure of Standardized Sustainability Metrics: The Case of the EU Taxonomy Regulation", Corporate Social Responsibility and Environmental Management. Available at: <https://onlinelibrary.wiley.com/doi/full/10.1002/csr.3046> [accessed on 20.02.2026].
18. OECD, (2021), Mobilising Finance for Climate Action, OECD Publishing, Paris.
19. OECD, (2023), Financing the Climate Transition in Emerging Economies in Europe, OECD Publishing, Paris.
20. OECD, (2025), OECD DAC Blended Finance Guidance 2025, Best Practices in Development Co-operation, OECD Publishing, Paris.
21. Sachs, J., et al., (2024), Sustainable Development Report 2024: The SDGs and the Future of the European Union, Cambridge University Press.
22. Siemionek-Ruskań, M., Lepczyński, B., & Fanea-Ivanovici, M., (2022), "A Comparative Analysis of Green Finance Awareness in Poland and Romania", Journal of Environmental Management and Tourism, Vol. 13(7), pp. 1825-1834.
23. Steckel, J. et al., (2025), "Pollution and Carbon Pricing in Developing Countries", Annual Bank Conference on Development Economics (ABCDE 2025), World Bank.
24. World Bank, (2025), Online database: World Development Indicators (Population and Demography). Available at: <https://data.worldbank.org> [accessed on 20.01.2026].