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Article

The Objective Necessity, Significance and Methodological Foundations of Financing the Green Economy

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Abstract: This article examines the objective necessity and economic significance of financing the green economy. It establishes the role of green finance in mitigating environmental challenges and promoting sustainable development. The study explores the allocation of financial resources to renewable energy, resource-efficient technologies and environmentally oriented projects, with particular emphasis on the adoption of green financing mechanisms in mining and metallurgical enterprises. It also identifies approaches to achieving economic and environmental sustainability through the efficient deployment of financial resources.

Keywords: Green economy; green growth; sustainable development; green finance; environment; greenhouse gases; ecosystem; environmental challenges; CO_2 emissions; carbon neutrality; global temperature; global growth; green loans; green bonds; renewable energy; United Nations; UNEP.

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1. Introduction

The expansion of production and intensive exploitation of natural resources are exacerbating environmental challenges and increasing the need to reconcile economic growth with environmental protection. In particular, resource scarcity, deforestation, rising waste volumes and greenhouse gas emissions call for new mechanisms to achieve sustainable economic development.[1]

In these circumstances, the green economy concept represents an important means of advancing economic development, social welfare and environmental sustainability. Implementing this concept requires substantial financing for renewable energy, resource- and energy-saving technologies, waste recycling and natural-capital conservation. Green finance therefore serves as a crucial instrument for the ecological transformation of the economy.[2]

The mining and metallurgical industry is characterized by high energy and resource intensity, extensive water consumption and substantial environmental impacts. These features necessitate increased investment in production modernization, energy efficiency and waste reduction. The present study investigates the theoretical and methodological foundations of such financing and substantiates opportunities for more efficient use of financial resources.[3]

Merino-Saum, Clement, Wyss and Baldi (2020) comparatively examined the concepts of the green economy and green growth, identifying both their shared characteristics and their differences. Using conceptual coding, statistical analysis and network analysis, they demonstrated the absence of a universally accepted definition of the green economy. Ante

(2024) explored the development of research on green finance and identified key research streams. His findings reveal strong connections between green finance, climate finance, environmental investment, sustainable development and financial markets, underscoring the need for stronger scholarly collaboration across these fields.[4]

Fu, Lu and Pirabi (2023) investigated the contribution of green finance to climate-change mitigation, carbon neutrality and sustainable development and outlined promising avenues for further research. Their work supports the role of green finance in pursuing environmental and economic objectives while emphasizing that assessments of its effectiveness should consider the volume and allocation of financial resources alongside measurable environmental outcomes. Sharma, Verma, Shahbaz, Gupta and Chopra (2022) examined the theoretical foundations of green finance and mechanisms for financing renewable energy, focusing on the transition from theory to practical application. Their research also highlights the role of green finance in industrial pollution control, waste management and environmental protection. Taken together, these studies demonstrate the importance of allocating financial resources according to environmental priorities.[5]

2. Methodology

The study employs a qualitative, theory-oriented approach based on the analysis and synthesis of scientific literature, international institutional materials and conceptual approaches to the green economy and green finance. A comparative analysis is used to examine differing definitions of the green economy and green financing, while a chronological approach traces the development of the concept and its relationship with the sustainable-development agenda. The study also applies classification and analytical generalization to systematize the principal green-financing instruments (including green loans, green bonds, investment funds, carbon exchanges, YieldCos and green banks) and to consider their potential relevance to resource- and energy-intensive mining and metallurgical enterprises. The article is theoretical and analytical in scope; it does not report a separate empirical survey or econometric estimation.

Accelerating globalization and continued development of the world economy have contributed to increasing production volumes. While these processes stimulate economic growth and improve living standards, they also intensify environmental pressures. The expansion of plastic waste, the loss of forest cover and large-scale greenhouse gas emissions are evidence of mounting global environmental problems.[6]

According to the figures presented in the source manuscript, almost 300 million tonnes of plastic waste are generated worldwide annually, while human activity releases approximately 39 billion tonnes of carbon dioxide into the atmosphere each year. These trends strengthen the case for aligning economic development with ecological balance, managing natural resources responsibly and introducing effective instruments to reduce negative environmental impacts.[7]

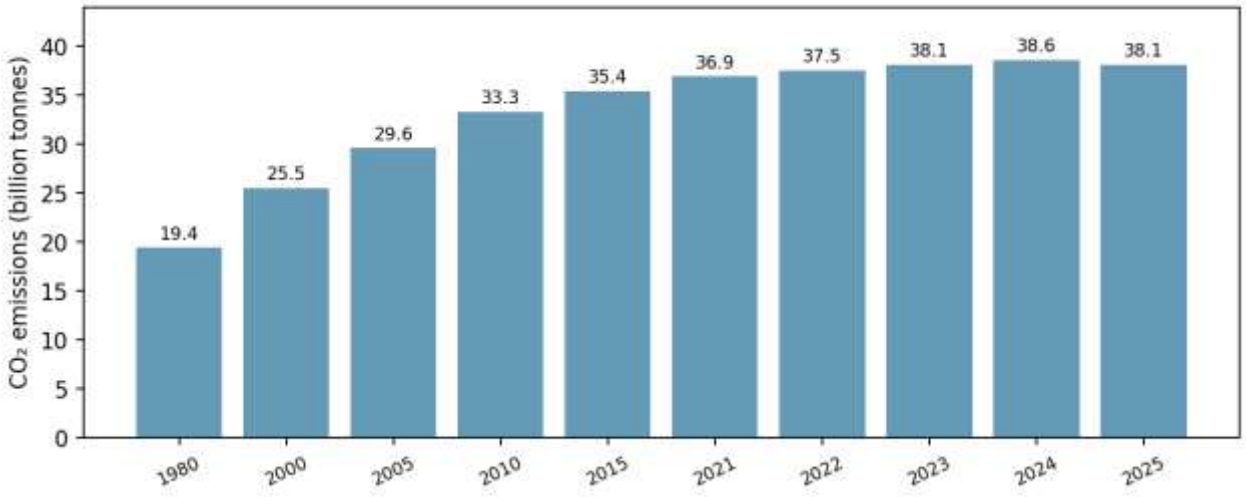

Figure 1. Global CO_2 emissions, 1980–2025

Note: Values are reproduced from the source chart. The original caption specifies "million tonnes", although the plotted magnitudes are consistent with billion tonnes;

3. Results

The green economy concept emerged as a response to the need to reconcile environmental protection with economic growth. Implementing it requires substantial financial resources, making the financing of green transformation one of its most important dimensions. This is especially relevant to resource- and energy-intensive industries such as mining and metallurgy.[8]

3.1. Emergence and Evolution of the Green Economy Concept

The green economy concept has a distinct history and has evolved through successive stages. The limited availability of natural resources, some of which are non-renewable, affects all areas of society, including economic activity, and requires new approaches to the organization of economic development.

Scientific inquiry into these problems gained prominence during the 1960s and 1970s. During that period, environmental economics emerged within conventional economic thought, focusing on the socioeconomic consequences of economic activities for the environment. Scholars argued for addressing environmental problems within existing economic relationships and for coordinating action internationally; emissions trading provides an example of such an approach.[9]

In the 1980s and 1990s, ecological economics developed as an alternative to narrowly economic approaches to environmental problems. Unlike environmental economics, it came to be regarded not merely as a branch of economics but as an independent, interdisciplinary field of research. Establishing a unified methodological basis for economic, social and ecological phenomena presented numerous challenges and contradictions. Nevertheless, its close association with sustainable development accelerated its acceptance in public and political debate.[10]

The integration of principles developed in environmental and ecological economics into economic policy gave rise to the concept of the green economy. The term was prominently articulated in the 1989 report Blueprint for a Green Economy, prepared for the British government by David Pearce, Edward Barbier and Anil Markandya. In 2008, amid the global financial crisis and economic downturn, the concept regained prominence in policy discussions. The United Nations Environment Programme (UNEP) promoted green stimulus packages and identified sectors in which substantial public investment could lay the foundations for a green economy.[11]

Major international milestones include:

• In 2008, UNEP launched the Green Economy Initiative and promoted the Global Green New Deal, emphasizing economic resilience, lower carbon emissions, protection of ecosystems and vulnerable populations, and the broader objectives of sustainable development.

• In 2011, UNEP published a report setting out key principles and pathways for the transition towards a green economy.

• In 2012, the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro, placed the green economy among its central themes.

The green economy is better understood as a practical economic-policy approach spanning such areas as energy, innovation and agriculture than as a wholly independent scientific discipline. It is closely associated with the aims of sustainable development.[12]

3.2. Sustainable Development: Concept and Stages

Sustainable development is development that meets present needs without compromising the ability of future generations to meet their own needs. It is a process of economic and social change in which resource use, investment priorities, scientific and technological progress, human development and institutional transformation are mutually reinforcing. Its overarching objective is to improve quality of life while safeguarding future opportunities.

Economic approaches to sustainable development are associated in the source with E. Lindahl and J. Hicks. According to the principle of maintaining aggregate capital, a sustainable stream of income must be generated without eroding the underlying capital stock. This entails efficient use of scarce resources and environmentally sound technologies, production of sustainable goods and responsible waste management.[13]

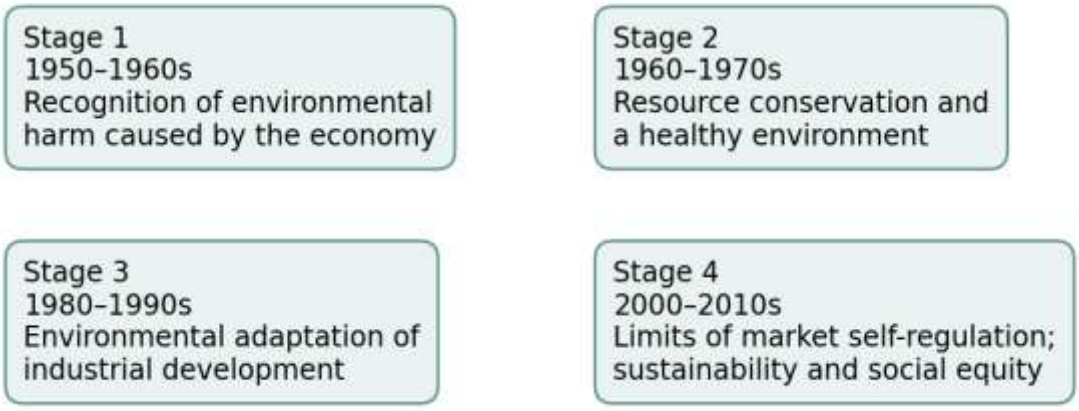

Figure 2. Stages in the evolution of the transition towards a green economy

Note: The source diagram contains inconsistent dates for Stages 3 and 4; the dates above follow the accompanying explanatory text.

The first stage (1950s–1960s) was marked by growing recognition of the environmental consequences of economic development. Environmental concerns attracted increasing attention; the source references a 1955 international conference on air pollution and a 1962 United Nations General Assembly resolution on economic development and environmental conservation.

The second stage (1960s–1970s) involved recognizing the economic and social consequences of intensive resource exploitation and pollution. Policy attention shifted

toward conserving resources and maintaining a healthy environment. Relevant landmarks included the first Earth Day in the United States in 1970, the establishment of an environmental protection institution in England in 1971, and the 1972 Stockholm Conference that led to the establishment of UNEP.[14]

The third stage (1980s–1990s) was characterized by the development of green technologies and the idea of ecological modernization. The World Commission on Environment and Development, established in 1983, popularized sustainable development through its 1987 report Our Common Future. The 1992 Rio Earth Summit and the 1997 Kyoto Protocol further advanced international commitments to limit greenhouse gas emissions and established mechanisms associated with emissions quotas. The first commitment period of the Kyoto Protocol covered 2008–2012.

The fourth stage (2000s–2010s) consolidated sustainable-development principles and encouraged green investment. Key events included the 2000 Millennium Summit, the 2002 World Summit on Sustainable Development (Rio+10), the 2012 Rio+20 Conference, and UNEP's 2009 Global Green New Deal report advocating investment in clean technologies.

The United Nations played a leading role in international initiatives on sustainable development. The Millennium Development Goals were adopted in 2000. At Rio+20, world leaders agreed to develop a post-2015 framework, which ultimately led to the 17 Sustainable Development Goals (SDGs), accompanied by 169 targets for the 2015–2030 period.[15]

Figure 3. The United Nations Sustainable Development Goals (English reference table)

Goal	Official English title	Goal	Official English title
1	No Poverty	10	Reduced Inequalities
2	Zero Hunger	11	Sustainable Cities and Communities
3	Good Health and Well-being	12	Responsible Consumption and Production
4	Quality Education	13	Climate Action
5	Gender Equality	14	Life Below Water
6	Clean Water and Sanitation	15	Life on Land
7	Affordable and Clean Energy	16	Peace, Justice and Strong Institutions
8	Decent Work and Economic Growth	17	Partnerships for the Goals
9	Industry, Innovation and Infrastructure	17	Partnerships for the Goals

A further milestone was the 2015 United Nations climate conference in Paris. Participating countries agreed to pursue efforts to keep global warming well below 2°C. Countries also presented green-economy plans, renewable-energy programmes and measures to improve energy efficiency.[16]

3.3. Approaches to Defining the Green Economy

Although the concept has been used since 1989, its meaning is interpreted in different ways. Some accounts emphasize new economic sectors that improve the natural environment; others focus on innovative technologies and ecosystems; still others view the green economy as a new stage of development built around the production of environmentally friendly goods and clean technologies.

The green economy is currently developing through clean and efficient technologies, renewable-energy sources, products and services based on biodiversity and ecosystems,

improved regulation of chemicals and waste, and the construction and modernization of green buildings.

According to specialists from the United Nations Economic Commission for Europe, a transition to the green economy should encourage green investment in economic sectors and social infrastructure. Such investment should support efficient use of natural capital and ecosystems, develop substitutes where resources face depletion, promote social justice and create decent employment.

Proponents of the green economy contend that the prevailing "brown economy" model is inadequate. Despite improvements in living standards for some population groups, it has contributed to environmental degradation, depletion of natural capital, persistent poverty, shortages of fresh water, food and energy, and inequality. These consequences create risks for future generations.[17]

In 1934, Simon Kuznets, one of the architects of national income accounting, cautioned that national welfare could not be adequately measured by national income alone. GDP does not fully capture environmental impacts or social costs. The source manuscript reports that humanity's ecological footprint exceeds the Earth's biological capacity by approximately 20% and notes a positive relationship between GDP per capita and ecological footprint per capita across countries.

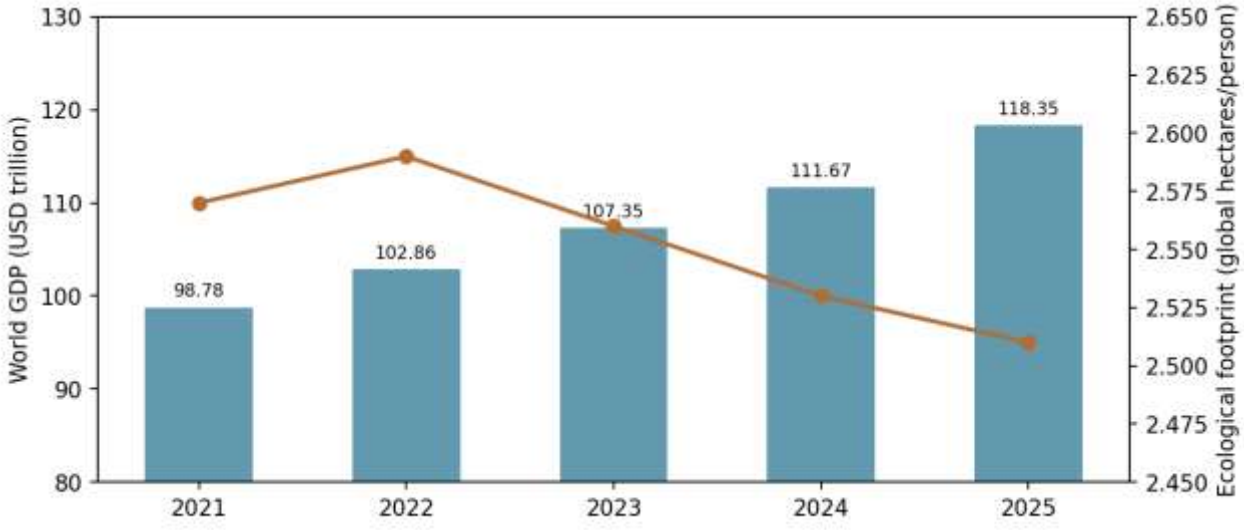

Figure 4. World GDP and ecological footprint indicators, 2021–2025

Note: The source caption refers to the industrial share of GDP, but the chart actually plots GDP and ecological footprint. Data and source references are retained as presented in the manuscript: World Bank and York University ecological-footprint data. Verify comparability and units before submission.

3.4. The Concept and Scope of Green Financing

Financing is one of the main challenges in the transition to a green economy. There is no single universally accepted definition of green finance in the academic literature, reflecting the range of approaches to the concept.

In general, green finance encompasses investments and financial instruments supporting environmentally sustainable, energy-efficient and low-carbon projects. It overlaps conceptually with environmentally responsible and climate-related investment. Karl Burkart has distinguished several green-economy sectors: renewable energy, green buildings, clean transportation, water-resource management, household and industrial waste management, and land improvement. Because these sectors are at different stages of development, their financing methods and sources also vary.

International organizations and consultancy firms offer complementary definitions:

• Bloomberg New Energy Finance notes that "green finance" is frequently used alongside "green investment", although financing is broader in scope than investment alone.

• PricewaterhouseCoopers defines green finance from a banking perspective as financial products and practices that integrate environmental factors throughout the lending process, from origination to repayment.

• The International Finance Corporation (IFC) treats green financing as a broad category of financial commitments, projects and investments supporting sustainable economic growth, including emission reduction, prevention of water pollution, biodiversity conservation, and climate-change mitigation and adaptation.

Accordingly, green financing may be understood as a set of financial mechanisms encompassing various forms of investment and lending that incorporate environmental considerations and seek to achieve ecological sustainability.

According to the Global Landscape of Climate Finance reports cited in the manuscript, financing for measures to address climate change increased from approximately USD 1 trillion in 2020 to USD 2.1 trillion in 2025, reflecting growing attention to climate-related investment.[18]

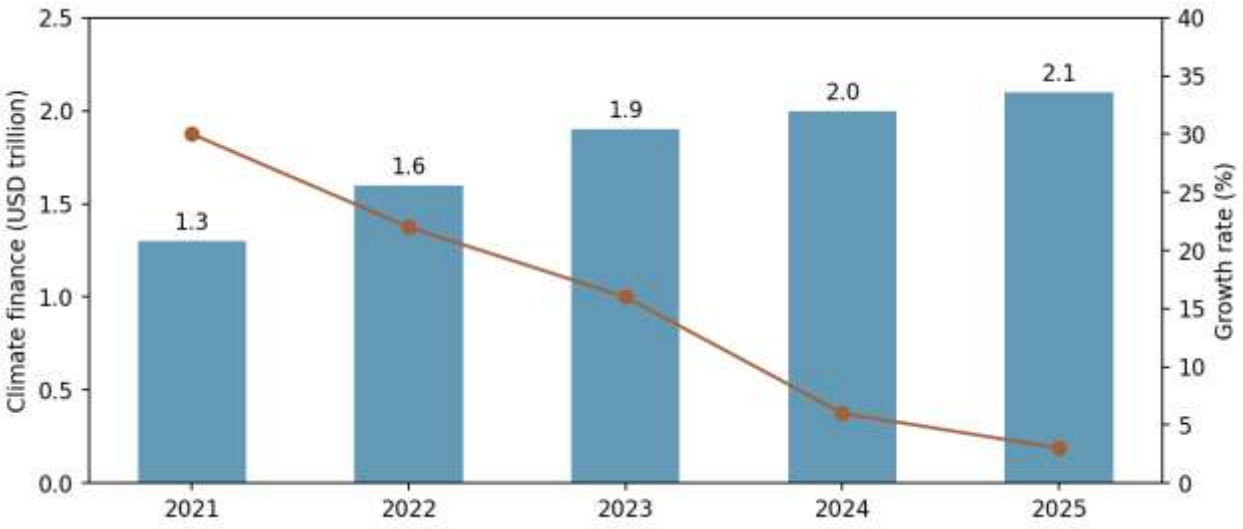

Figure 5. Climate-finance volumes and reported growth rates, 2021–2025

Note: Figures are reproduced from the original chart, attributed there to the Climate Policy Initiative. The percentage series should be independently checked before publication.

3.5. Green Financing Instruments

Many countries are incorporating environmental, social and governance (ESG) principles into their business environments. Green projects often require substantial initial capital, and innovative green business models may entail heightened uncertainty and non-standard risks. Traditional financing instruments therefore may be insufficient. To address this challenge, financial markets have developed green loans, green bonds, green investment funds, carbon exchanges, asset-backed securities (ABS), yield companies (YieldCos) and green banks.[19]

Figure 6. Main instruments of green finance

Instrument	Primary financing role
Green loans	Debt provided for eligible green projects
Green bonds	Bond proceeds earmarked for eligible green projects
YieldCos	Listed entities holding income-generating clean-energy assets
Asset-backed securities (ABS)	Securities backed by pools of eligible assets
Green investment funds	Pooled capital invested in green assets or enterprises
Carbon exchanges	Trading of emissions allowances and other eligible carbon instruments
Green banks	Public-purpose financing institutions mobilizing private green investment

Green loans are debt instruments whose proceeds are applied exclusively to financing or refinancing eligible new or existing green projects, in whole or in part. Green lending principles comprise four core components: use of proceeds; project evaluation and selection; management of proceeds; and reporting. Eligible sectors commonly include renewable energy, energy efficiency, pollution prevention and control (including emission reduction, land remediation and waste recycling), sustainable natural-resource and land management, biodiversity conservation, sustainable water and wastewater management, and circular-economy technologies.

Green bonds are bonds whose proceeds are allocated exclusively to the full or partial financing or refinancing of eligible green projects. Issuers should assess and disclose the projects' environmental benefits using appropriate qualitative and quantitative indicators. Like other fixed-income securities, green bonds are subject to applicable securities-market regulations.

The European Investment Bank pioneered this form of financing with its Climate Awareness Bonds. In 2008, the International Bank for Reconstruction and Development issued instruments explicitly branded as green bonds and engaged external environmental experts to assess the allocation of proceeds against environmental criteria.

Major investors in global green-bond markets include private pension funds, insurance companies and other institutional investors seeking long-term investment opportunities and relatively predictable risk profiles. The following types of green bonds are used internationally:

- Standard green use-of-proceeds bonds: conventional issuer obligations with proceeds allocated to green development objectives.
- Green revenue bonds: non-recourse securities whose credit exposure depends on pledged cash flows from taxes, fees or other revenue streams.
- Green project bonds: securities financing one or more green projects, with repayment risk linked to the performance of those projects.
- Green securitized bonds: securities secured by underlying assets or project portfolios, including asset-backed and mortgage-backed structures.

A green fund is a pooled investment mechanism that channels capital to environmentally responsible companies or firms supporting socially responsible development. In Europe, many such funds historically held predominantly equities. The emergence of green-bond funds in 2015 contributed to market diversification. In 2017, the IFC and the French investment manager Amundi established a green-bond fund focused on emerging markets.

Carbon exchanges and emissions trading systems assign a market price to greenhouse-gas emissions and create economic incentives to reduce them. Governments and companies buy and sell emissions allowances under applicable regulatory systems.

According to the source, governments generated USD 104 billion in revenue from carbon-pricing mechanisms in 2023.

YieldCos are publicly traded entities that own portfolios of operating renewable-energy assets producing relatively stable cash flows. They raise capital by issuing shares and typically derive revenue from electricity sales. Their business model is often associated with regular dividend distributions. The source reports indicative asset portfolios of approximately USD 500 million and initial public offerings of USD 150–200 million, although these figures should not be treated as universal thresholds. The viability of this model depends on reliable regulation, effective legal protections and a stable investment environment.

A green bank is a financing institution, often capitalized with public funds or resources from international, regional and national financial institutions, that seeks to stimulate private-sector investment in green markets. Its core functions include reducing project risks and mobilizing private investors while using limited public resources efficiently. As noted in OECD research, green banks may provide reserves, credit-loss protection, insurance-related support and other risk-management mechanisms, thereby strengthening the financial viability of climate-related projects.

4. Discussion

The analysis indicates that green financing is not limited to providing capital for individual environmental projects. It also creates a framework for directing financial resources towards long-term structural changes in production, energy use and natural-resource management. The variety of instruments discussed in the article reflects the different financing needs and risk profiles of green projects: loans and bonds provide debt-based funding, investment funds pool capital, carbon-pricing mechanisms create incentives to reduce emissions, and green banks can help mobilize private investment by mitigating project risks. For mining and metallurgical enterprises, the practical significance of these mechanisms lies in their potential to support modernization, energy efficiency, pollution prevention, water management and waste reduction. However, the selection and effectiveness of a financing instrument depend on project eligibility, transparent use-of-proceeds arrangements, reliable reporting, a stable regulatory environment and the ability to demonstrate environmental benefits. The article provides a conceptual and methodological basis for considering these factors; a quantitative assessment of their impact at enterprise level remains a subject for further research.

5. Conclusion

The green economy concept has evolved over a long historical period, drawing on environmental economics, ecological economics and the broader sustainable-development agenda. Its implementation requires substantial, long-term investment, often in projects with considerable risk. Conventional sources of finance are therefore not always sufficient, creating an objective need for specialized mechanisms such as green loans and bonds, investment funds, carbon markets, YieldCos and green banks.

These financing challenges are particularly acute for mining and metallurgical enterprises because of their high energy and resource intensity, significant environmental footprint and substantial upfront costs of adopting low-carbon technologies. The concepts, sources and instruments discussed in this article therefore provide a methodological foundation for subsequent examination of corporate practices and for evaluating opportunities to expand green financing across the industry.

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