



Co-funded by
the European Union

Assanova M.A.,
Glazunova S.B.,
Kalkabayeva G.M.

EUROPEAN PRACTICE OF SUSTAINABLE DEVELOPMENT MANAGEMENT TOWARDS GREEN TRANSFORMATION

Monograph

Karaganda 2025





**Co-funded by
the European Union**

Assanova M.A., Glazunova S.B., Kalkabayeva G.M.

**European practice of sustainable development management
towards green transformation**

Monograph

Karaganda 2025

УДК 005
ББК 65.290-2
A88

Reviewers:

Kurmanalina A.K., Candidate of Economic Sciences, Professor at Buketov Karaganda University named after Academician E.A. Buketov

Abdikarimova A.T., Candidate of Economic Sciences, Professor at Karaganda University of Kazpotreboyz

A88 Assanova M.A., Glazunova S.B., Kalkabayeva G.M.
European practice of sustainable development management towards green transformation: Monograph. / Assanova M.A., Glazunova S.B., Kalkabayeva G.M. – Karaganda: Karaganda University of Kazpotreboyz, 2025. – 180 p.

Recommended for publication by the Academic Council
of Karaganda University of Kazpotreboyz (Minutes No. 1 dated October 7, 2025)

ISBN 978-601-233-642-9

The monograph presents a comprehensive scientific analysis of the economic, financial, environmental, and social dimensions of the sustainable development paradigm, grounded in the institutional and practical experience of the European Union. It explores a wide range of methodological and applied issues, including sustainability indicators and metrics, territorial sustainable development governance programs, sustainable finance architecture, ESG investment principles and standards, and the integration of social sustainability goals. Particular emphasis is placed on strategic frameworks for the green transformation of the economy and on mechanisms for managing transition-related risks.

The monograph was prepared within the framework of the Erasmus+ Jean Monnet Project 2022–2025 101082914 — EPOS — ERASMUS-JMO-2022-HEI-TCH-RSCH.

The monograph is intended for students, Master's and PhD students, and it will also be of interest to members of the academic and scientific community, the business sector, and government authorities.

УДК 005
ББК 65.290-2

ISBN 978-601-233-642-9

**© Assanova M.A., Glazunova S.B.,
Kalkabayeva G.M., 2025**
**© Karaganda University of
Kazpotreboyz, 2025**

TABLE OF CONTENTS

INTRODUCTION	5
Chapter 1. Social Instruments of Sustainable Development in the EU	8
1.1 Corporate Social Responsibility.....	8
1.2 Sustainable Consumption and Production	13
1.3 EU Policy in the Field of Education and Public Awareness	15
1.4 The Role of NGOs and Civil Society in Sustainable Development	20
Chapter 2. Environmental Aspects of Sustainable Development in the European Union	25
2.1 EU Policy on Environmental Protection and Climate Change	25
2.2 Regulation of Greenhouse Gas Emissions and Decarbonization of the EU Economy	34
2.3 Development of Renewable Energy Sources and Reduction of Dependence on Fossil Fuels	45
2.4 Circular Economy: EU Strategies for Waste Reduction and Efficient Resources Use	55
2.5 Protection of Biodiversity and Restoration of Natural Ecosystems in EU	63
2.6 EU Environmental Standards and Their Impact on International Trade and Partners	72
Chapter 3. Green Finance and Its Role in the Sustainable Development of the European Union	83
3.1 The Concept of Sustainable Finance and Green Finance in the European Union	83
3.2 Trends and patterns in sustainable finance: a Scopus-based bibliometric analysis	88
3.3 Features of Investment Support for the European Green Deal and Digital Platforms for Sustainable Finance.....	98
3.4 Green Bonds as a Tool in the Green Finance System	106
3.5 Modern Trends in the Development and Standardization of Green Bonds in the EU	111
3.6 The Role of Green Loans in Achieving Environmental Sustainability	119
Chapter 4. Analysis of Trends in Sustainable Finance Regulation and Prospects for Green Transformation in Kazakhstan	128
3.1 Green Budgeting and Green Tax Policy in European Countries	128

3.2 Green Tax Policy in European Countries	136
3.3 Regulation of Financial Institutions in the Context of Green Transformation	143
3.4 Implementation of ESG Strategies in the Practices of European Banks	153
3.5 Current Trends in Green Financing in the Republic of Kazakhstan	161
CONCLUSION	168
REFERENCES	170

INTRODUCTION

Sustainable development has evolved from a theoretical concept into a pressing need, shaping global political, economic, and environmental agendas. As the consequences of climate change, resource depletion, and environmental degradation become increasingly evident, governments and institutions are compelled to adopt policies and practices that ensure long-term ecological balance. Within this context, the European Union (EU) has emerged as a global leader in designing and implementing sustainability-driven strategies aimed at achieving a green transformation of the economy and society.

The European approach to sustainable development is rooted in a holistic vision that integrates environmental protection, economic growth, and social inclusion. The EU's Green Deal, Circular Economy Action Plan, and Fit for 55 package serve as comprehensive frameworks that guide member states towards decarbonization, renewable energy integration, and sustainable production and consumption patterns. These strategies reflect a fundamental shift in development philosophy — from linear and resource-intensive models to circular, low-carbon, and inclusive paradigms.

Effective management of sustainable development requires not only legislative frameworks but also institutional capacity, multi-level governance, and cross-sectoral coordination. European practice in this regard demonstrates a strong commitment to participatory governance, where policy design and implementation actively involve stakeholders from public, private, and civil society sectors. Moreover, the EU fosters innovation through targeted funding mechanisms, such as Horizon Europe and InvestEU, which support green technologies and sustainable infrastructure projects across the region.

This monograph seeks to analyze the institutional and managerial practices of the European Union and its member states in steering sustainable development towards green transformation. It explores key areas such as climate policy, energy transition, waste management, sustainable finance, and digitalization as enablers of systemic change. Particular attention is paid to the interplay between policy, governance, and technology in building resilient and sustainable economies.

By examining both achievements and ongoing challenges in the European context, this work aims to provide valuable insights for policymakers, scholars, and practitioners beyond Europe who are engaged in sustainability transformations. Lessons from the European experience can inform adaptation strategies in different socio-economic and political

environments, including countries in transition or developing economies seeking to align growth with environmental integrity.

Ultimately, the monograph underscores the imperative of rethinking development in the face of planetary boundaries. As global environmental and social crises intensify, the European practice of sustainable development offers a roadmap — not without obstacles — for navigating towards a more balanced, equitable, and sustainable future.

The first chapter of this monograph, *Social Instruments of Sustainable Development in the EU*, focuses on the human and institutional dimensions that underpin the European sustainability model. It explores how corporate social responsibility (CSR) contributes to aligning business practices with social and environmental goals, and how the promotion of sustainable consumption and production supports behavioral change at both individual and corporate levels. The chapter also examines the EU's efforts in advancing education, awareness, and public engagement, which are vital for cultivating a culture of sustainability. Particular attention is paid to the role of NGOs and civil society, whose involvement enhances democratic participation and accountability in the implementation of sustainable development policies.

The second chapter, *Environmental Aspects of Sustainable Development in the European Union*, delves into the environmental pillars of the EU's green transition. It begins with a review of environmental protection and climate change policies, highlighting key regulatory milestones and instruments. The chapter then addresses the EU's commitment to decarbonization, including mechanisms for greenhouse gas emissions reduction and efforts to shift away from fossil fuels through the development of renewable energy sources. Further sections analyze the promotion of a circular economy, the protection of biodiversity, and the impact of EU environmental standards on international cooperation and trade. Together, these areas reveal the EU's systemic approach to balancing ecological sustainability with economic integration.

The third chapter, *Green Finance and Its Role in the Sustainable Development of the European Union*, turns to the financial architecture enabling the green transition. It introduces the concept and principles of sustainable and green finance, followed by an overview of academic and practical trends, including a bibliometric analysis based on Scopus-indexed publications. Key instruments such as green bonds and green loans are examined in terms of their role in financing EU climate goals. The chapter also assesses investment support mechanisms, particularly those aligned with the European Green Deal, and explores the emergence of digital platforms for sustainable finance. Issues of standardization and transparency

are also discussed as critical to the credibility and effectiveness of green financial tools.

Finally, the fourth chapter, Analysis of Trends in Sustainable Finance Regulation and Prospects for Green Transformation in Kazakhstan, provides a comparative perspective by linking European experience with the context of Kazakhstan. This chapter examines how green budgeting and tax policies, as well as the regulation of financial institutions, are evolving in Europe, and how these mechanisms might inform policy development in Kazakhstan. The implementation of ESG strategies in European banks is analyzed as a model for sustainable banking practices. The chapter concludes with an overview of current trends in green finance in Kazakhstan, identifying opportunities and challenges for aligning national development with international sustainability standards and practices.

Chapter 1. Social Instruments of Sustainable Development in the EU

- 1.1 Corporate Social Responsibility
- 1.2 Sustainable Consumption and Production
- 1.3 EU Policy in the Field of Education and Public Awareness
- 1.4 The Role of NGOs and Civil Society in Sustainable Development

Social aspects of sustainable development play a key role in achieving harmony between the economy, society, and the environment, ensuring the implementation of the global agenda. The European Union actively develops social instruments such as corporate social responsibility, sustainable consumption and production, educational initiatives, and the involvement of civil society. These instruments are aimed at creating an inclusive and equitable society, which contributes not only to the improvement of social conditions but also to sustainable economic growth.

In this chapter, the key social instruments employed by the European Union to achieve the goals of sustainable development are examined. The analysis focuses on the impact of corporate social responsibility and initiatives promoting sustainable production and consumption, as well as the role of civil society in driving social change that supports the transition toward a sustainable development model.

1.1 Corporate Social Responsibility

Corporate social responsibility (CSR) remains one of the key concepts underlying sustainable development; however, its multifaceted nature generates a diversity of approaches to its definition. It should therefore be recognized that interpretations of CSR may vary depending on the cultural and economic characteristics of individual countries, as well as the global objectives facing both society and business.

According to the European Commission, corporate social responsibility, or CSR, is defined as the responsibility of enterprises for their impact on society, encompassing economic, social, and environmental dimensions. This definition emphasizes the voluntary nature of CSR implementation and its linkage to the achievement of sustainable development goals, placing particular importance on the integration of sustainable practices into corporate strategy. The regulatory foundation for implementation is provided by Directive 2014/95/EU on non-financial reporting, which

establishes the requirement to disclose information on actions aimed at social and environmental development.

The United Nations Global Compact highlights CSR as a tool contributing to the achievement of global sustainable development goals, including poverty reduction, the protection of human rights, and the promotion of environmental sustainability. In this context, corporate social responsibility is viewed not only as business accountability but also as a mechanism for addressing global challenges, with companies acting as participants in international dialogue and active partners in fostering societal development and improving quality of life.

The international standard ISO 26000 defines CSR as the responsibility of business for its actions toward society, with an emphasis on fairness, transparency, and sustainability. Within the framework of a multi-dimensional analysis, this approach is particularly important as it encompasses various areas, including human rights, consumer protection, labor practices, and contributions to the development of local communities. Its main advantage lies in its universality and applicability to organizations of any size and sector.

Corporate social responsibility may also be interpreted through the lens of philanthropy, reflected in business participation in social initiatives such as the construction of schools, support for healthcare institutions, and the provision of grants to vulnerable groups. However, despite the social value of such actions, this approach is often limited, as it does not necessarily ensure long-term sustainability and is frequently used primarily to enhance corporate image.

The Global Reporting Initiative (GRI) conceptualizes CSR as the integration of sustainable practices into corporate activities, accompanied by the mandatory disclosure of outcomes through standardized forms of non-financial reporting. It underscores the importance of stakeholder engagement and highlights business transparency. Within the European Union, this interpretation has become the dominant model, as evidenced by the widespread use of GRI standards by EU-based companies.

Thus, the diversity of approaches to defining *corporate social responsibility* reflects the multidimensionality and flexibility of this concept.

The successful implementation of corporate social responsibility is based on key principles that guide companies in their interaction with society and the environment, and help to understand how this contributes to the achievement of sustainable development goals (Table 1).

Table 1. Principles of Corporate Social Responsibility

Voluntariness	Comprehensiveness	Inclusiveness
Incorporation of social and environmental aspects into the company's strategy through initiatives that go beyond mandatory standards and are driven by the internal values of the company and its leadership.	Encompasses a wide range of issues and emphasizes the necessity of integrating ESG factors into business processes at all levels, from strategic planning to operational activities.	Engagement with stakeholders, including employees, customers, suppliers, local communities, and public authorities, taking into account their interests in order to build sustainable partnerships.
Transparency	Innovativeness	Sustainability
Regular disclosure of information on company actions and achievements in the field of CSR, including non-financial reporting aligned with established standards.	Encourages the search for new approaches and solutions aimed at minimizing the negative impact of business on the environment and society, which may include the development of environmentally friendly products, the introduction of energy-efficient technologies, and the advancement of the circular economy.	Focus on long-term sustainability, meaning that companies strive not only to achieve economic results but also to maintain a balance between societal and environmental interests to ensure a stable future.
Note - compiled by the authors		

The principles of corporate social responsibility form the foundation for introducing sustainable practices that enable companies to meet the expectations of modern society.

Corporate social responsibility exerts a profound influence on sustainable development by shaping integrated approaches that allow business, society, and the environment to evolve in harmony. The implementation of CSR within companies of the European Union demonstrates its importance for ensuring long-term economic sustainability while simultaneously strengthening social trust and promoting fair labor conditions.

For instance, initiatives such as Nestlé's Cocoa Plan improve the working conditions of farmers in developing countries and contribute to combating child labor in order to enhance overall social sustainability. Covering more than 120,000 farmers in Ghana, Côte d'Ivoire, and other West African countries, the Cocoa Plan provides training in sustainable farming methods, distributes high-quality cocoa seedlings, and improves access to microfinance.

One of the key components of the program is the fight against child labor through the introduction of the Child Labour Monitoring and Remediation System (CLMRS), which identifies cases of child exploitation and ensures access to education. Since its launch in 2012, the initiative has facilitated the construction and renovation of more than 40 schools in rural areas, enabling over 20,000 children to gain access to quality education. In addition, Nestlé invests in community infrastructure, including improved water supply systems, which enhance the living conditions of farmers and their families.

These measures not only strengthen social sustainability but also reinforce the cocoa supply chain, ensuring stable access to raw materials for the company. Research by the European Commission confirms that the implementation of CSR programs increases employee engagement, leading to higher productivity and greater job satisfaction.

Corporate social responsibility plays a significant role in strengthening corporate reputation and enhancing consumer loyalty, which generates a measurable economic effect. Studies show that 65% of EU citizens prefer to purchase products from companies that actively implement CSR, thereby increasing business competitiveness and reducing vulnerability to crises. Moreover, social responsibility stimulates innovative development. Companies such as L'Oréal and Unilever demonstrate that the integration of sustainable approaches leads to the creation of new products, lower resource costs, and the advancement of "green" technologies.

For example, L'Oréal has introduced innovative packaging materials that are 100% recyclable as part of its *Sharing Beauty with All* program. The company has also developed a new line of cosmetics produced with environmentally friendly, sustainably certified ingredients. This allowed L'Oréal to reduce plastic use in its packaging by 25% and to enhance brand perception among consumers committed to environmentally responsible behavior. Similarly, under its *Sustainable Living Plan*, Unilever launched a product line manufactured using renewable energy sources and reduced water consumption. For instance, Sunlight detergents are produced with plant-based ingredients, and their packaging consists of 75% recycled materials. As a result of these efforts, the company has reduced its carbon

emissions in production processes by 32% over the past five years, strengthening its market position and expanding the share of sales from environmentally oriented products.

CSR is also an important instrument for achieving the United Nations 2030 Agenda for Sustainable Development goals. EU companies actively contribute to poverty reduction, the provision of quality education, and the fight against climate change. Within these initiatives, business acts as a key partner in addressing global challenges such as reducing the carbon footprint and supporting the circular economy.

The interaction of CSR with economic, social, and environmental dimensions demonstrates its universality and capacity to adapt to contemporary challenges. The European Union illustrates that corporate social responsibility is not merely a component of business strategy but a fundamental approach that contributes to building a sustainable society and economy.

The European Union regards corporate social responsibility as an essential instrument for achieving sustainable development goals, and its policy is aimed at integrating CSR principles into business activities through regulatory frameworks, financial support, and platforms for knowledge exchange. This makes CSR not only a voluntary initiative of companies but also an important component of the region's social and economic development strategy.

One of the key regulatory instruments in the implementation of EU policy is Directive 2014/95/EU, which requires large companies to disclose non-financial information. This stimulates transparency in corporate activities, increases the trust of investors, clients, and society, and establishes transparency as a crucial criterion for assessing corporate performance, thereby fostering the adoption of sustainable business models. Companies are obliged to provide reports including data on their environmental actions, social responsibility, labor relations, and anti-corruption measures.

Financial instruments of the EU also play a pivotal role in supporting corporate social responsibility. Programs such as Horizon Europe, COSME, and LIFE provide grants and funding for projects aimed at reducing carbon footprints, advancing the circular economy, and supporting local communities. Small and medium-sized enterprises, by gaining access to these instruments, are able to integrate CSR principles into their operations. Sustainable development initiatives are also strongly supported by the European Investment Bank, which provides preferential loans and subsidies for companies implementing environmental and social innovations.

Another important mechanism is the establishment of platforms, such as the European Platform on CSR, which brings together representatives of business, non-governmental organizations, and public authorities. These platforms facilitate the exchange of experience, the development of new standards, and the dissemination of best practices. They promote the creation of multilateral partnerships and the search for solutions to complex social and environmental challenges. Through such platforms, initiatives have been developed to improve labor conditions in global supply chains and support local communities in developing countries.

Special attention is devoted to educational initiatives, including Erasmus+, which contributes to integrating CSR principles into educational programs. This helps students and young professionals acquire knowledge on social responsibility and sustainable development, reinforcing the role of CSR in the corporate culture of future generations and ensuring its long-term impact on the economy.

The European Union also actively cooperates with international organizations such as the UN, ILO, and OECD to promote its approaches to CSR on a global scale. This enables the unification of social responsibility standards and expands their application across international supply chains, thereby contributing to sustainable development worldwide.

Overall, EU policy on the implementation and promotion of social responsibility creates favorable conditions for its integration into business activities. Regulatory mechanisms, financial support, and multilateral platforms establish CSR as an important instrument for achieving sustainable development.

1.2 Sustainable Consumption and Production

Sustainable consumption and production occupy a central place in the strategic initiatives of the European Union aimed at achieving the goals of sustainable development and the transition to a circular economy. These approaches involve the rational use of resources, the minimization of the environmental impact of goods and services throughout their entire life cycle, as well as the promotion of conscious consumption among citizens. The European Union integrates these principles into its economic and social policies, making them an integral part of the European Green Deal and the Circular Economy Action Plans.

The concept of sustainable consumption and production is based on the necessity of changing traditional models of production and consumption that are oriented toward the linear use of resources. Instead, it proposes the

introduction of circular approaches, which include the recycling of materials, the extension of product life cycles, and the minimization of waste. One of the key EU initiatives in this area is the Circular Economy Action Plan, which includes measures to develop recycling infrastructure, stimulate innovation in product design, and create new markets for recycled materials.

An important direction of this strategy has been the development of environmental certification systems such as the EU Ecolabel. This initiative allows producers to demonstrate compliance of their products with high environmental standards, while enabling consumers to make informed choices in favor of goods with a lower environmental footprint. For example, the use of household appliances certified by the EU Ecolabel helps reduce energy consumption, which not only lowers the carbon footprint but also decreases household expenses.

Food production has also become a target for transformation within the framework of sustainable development. The EU Farm to Fork strategy is aimed at creating sustainable food supply chains that reduce food losses, minimize the use of chemical fertilizers, and increase the availability of environmentally friendly products for the population. For example, the introduction of incentives for local producers has made it possible to reduce transport costs and carbon emissions while supporting small and medium-sized enterprises in the agricultural sector.

The role of business in the development of sustainable production is key. European companies actively integrate sustainability principles into their strategies. For instance, IKEA has developed a model based on the recycling and reuse of materials, which has reduced the use of primary resources and minimized waste. The company has also created services enabling customers to repair and exchange products, thereby contributing to the transition toward a circular economy. H&M, in turn, has launched a textile recycling program that allows consumers to return used clothing for recycling or reuse, thus reducing the volume of textile waste.

Consumers also play an important role in ensuring sustainable consumption. The European Union actively implements programs aimed at raising citizens' awareness of the importance of their consumer choices. For example, initiatives such as the Green Consumption Pledge help to foster a culture of environmentally responsible behavior among the population by providing consumers with transparent information about products and their environmental impact. This, in turn, encourages producers to adopt sustainable practices that meet the requirements of conscious consumption.

Despite significant progress, the transition to sustainable consumption and production faces a number of challenges. These include high costs

associated with the introduction of innovative technologies, resistance from traditional business models oriented toward linear production, and the need to raise environmental awareness in some EU member states. Nevertheless, the long-term benefits of adopting sustainable approaches include reduced resource costs, improved quality of life, and the strengthening of the EU's position as a leader in sustainable development.

Thus, sustainable consumption and production in the European Union represent not only an important element of sustainable development but also a strategic instrument for building an economically efficient, environmentally sustainable, and socially equitable model of development. These approaches form the foundation for long-term transformations that make it possible to achieve a balance between economic growth, the preservation of natural resources, and the improvement of living standards.

1.3 EU Policy in the Field of Education and Public Awareness

Education and public awareness play a key role in the implementation of the European Union's sustainable development strategy. The creation of an environmentally and socially responsible society is impossible without raising the level of knowledge about the principles of sustainable development, corporate social responsibility (CSR), and the necessity of transitioning to a circular economy. For this reason, the EU devotes special attention to the development of educational programs, information campaigns, and the introduction of mechanisms that increase the awareness of citizens and businesses about the importance of sustainable development.

EU policy in the field of education is largely focused on integrating the principles of sustainable development into the learning system at all levels—from school to higher education and professional training programs. An important instrument in this area is the Erasmus+ program, which supports educational initiatives related to environmental education, corporate social responsibility, and the development of competences in the field of the green economy. For example, Erasmus+ provides funding to universities and research centers for the development of courses designed to prepare specialists in sustainable development, climate policy, and environmental management. In recent years, particular attention has been given to building skills related to green technologies, which strengthens Europe's human capital in the context of the transition to a sustainable economy.

The development of non-formal and continuing education programs, including vocational training and professional development, is of particular

importance. The EU has introduced the GreenComp initiative, a competency framework for environmental literacy aimed at both students and workers across various sectors of the economy. This framework includes the development of educational materials, training sessions, and online courses designed to deepen knowledge in sustainable production, responsible consumption, and corporate social responsibility. Such measures enhance the qualifications of professionals while providing businesses with access to highly skilled personnel prepared to operate in a circular economy.

In addition to educational programs, the European Union actively promotes public awareness of the importance of sustainable development through information campaigns and initiatives aimed at changing patterns of consumption and production. In this context, a significant role is played by the European Green Deal Awareness initiative, which informs citizens about climate change, the carbon footprint of products, and the need for responsible consumption. One of the tools of this policy is the development and implementation of environmental labeling, such as the EU Ecolabel, which helps consumers make informed choices in favor of products with a low environmental impact.

An important direction in raising awareness is the involvement of business and the corporate sector in educational initiatives. Within the framework of CSR Europe, projects are implemented to promote sustainable development among company employees and managers. Such projects include training sessions, thematic conferences, and the exchange of best practices, which contribute to the dissemination of principles of sustainable management in the corporate environment. For example, large European companies such as Unilever and Siemens actively develop internal educational programs on ESG (environmental, social, and governance aspects), training their employees in the principles of sustainable business practices.

Despite significant achievements, the EU faces a number of challenges in implementing its policy on education and awareness-raising. One of the key issues is the variation in the level of environmental literacy among EU member states, which requires the adaptation of educational initiatives to national contexts. In addition, raising awareness requires the active involvement not only of public authorities but also of businesses, non-governmental organizations, and civil society.

Nevertheless, EU policy in this field continues to evolve, creating the conditions for the development of knowledge and competences necessary for building a sustainable society. The introduction of educational programs, information initiatives, and corporate training makes it possible

to form a long-term strategy aimed at transforming Europe's economic and social systems in line with the principles of sustainable development.

Case: Integrating Sustainable Development into Higher Education – The Example of Wageningen University (Netherlands)

One of the successful examples of implementing EU policy in the field of education and public awareness is the experience of Wageningen University in the Netherlands, which is a leading European research and educational center in the areas of sustainable development, agriculture, ecology, and food security. Within the overall EU strategy of integrating sustainable development into higher education, the university has developed a comprehensive model that includes academic programs, research projects, and campus sustainability initiatives.

At Wageningen University, sustainable development is not treated as a separate discipline but is integrated across all fields of study, ranging from agriculture and biotechnology to economics and social sciences. For example, the Master's program in Sustainable Business and Innovation is aimed at preparing specialists capable of designing and implementing corporate sustainability strategies. As part of the curriculum, students examine the impact of ESG factors on corporate governance, develop circular economy models, and assess the effectiveness of sustainable business practices.

One of the university's key educational initiatives has been the introduction of so-called "Living Labs," which allow students to apply their knowledge in practice by addressing real environmental and social problems. For instance, within the Circular Agriculture Lab project, students collaborate with local farmers and food companies to help them develop strategies for reducing waste and transitioning to sustainable production models. This learning format enhances the practical relevance of education and fosters in students an awareness of the necessity of sustainable resource management.

In addition, the university actively promotes a culture of awareness among students and faculty. Under the Green Office Wageningen campaign, lectures, seminars, and workshops are organized on issues such as climate change, sustainable consumption, and corporate social responsibility. On the university campus, measures are also implemented to reduce the carbon footprint, including the use of solar panels, water reuse systems, and smart energy-saving solutions.

Wageningen University is part of the broader European University Initiative, within which EU higher education institutions exchange experience in sustainable development and design joint academic programs.

Through these projects, European students gain access to interdisciplinary education, enhancing their preparedness to work in the context of the “green” transformation of the economy.

The example of Wageningen University demonstrates how EU policy in education and public awareness is successfully implemented in practice. The integration of sustainable development into the educational process, the establishment of experimental laboratories, and collaboration with business and local communities prepare specialists capable of addressing urgent environmental and social challenges. This approach contributes to the formation of a new generation of professionals for whom sustainability principles become an integral part of their future careers and worldview.

Case: The Green Skills for Europe Program (GS4E)

One of the most prominent examples of a successful EU educational initiative aimed at raising awareness and building competences in the field of sustainable development is the Green Skills for Europe (GS4E) program. This project is funded by the European Commission under the Erasmus+ program and is implemented in cooperation with universities, vocational education institutions, and the business community. The main goal of GS4E is to develop new skills and competences necessary for the “green” transition of the economy and for adapting the workforce to the requirements of sustainable production.

The program was designed in response to the growing demand for specialists with competences in circular economy, sustainable resource management, renewable energy, and corporate social responsibility. According to research by the European Centre for the Development of Vocational Training (Cedefop), by 2030 around 18% of jobs in the EU will require skills related to sustainable development. GS4E is aimed at preparing such specialists through a combination of academic education, vocational training, and practice-oriented projects.

One of the key components of GS4E is the integration of sustainable development principles into vocational and professional education systems. The program cooperates with technical colleges and training centers, helping to design new curricula focused on environmentally friendly technologies, energy efficiency, and sustainable business models. For example, in Germany, several vocational colleges have introduced courses on “green” construction, training students in methods of designing energy-efficient buildings using renewable materials. In addition, GS4E develops learning platforms and digital resources that allow students and professionals to engage in distance learning on sustainable development topics. In the Netherlands, for instance, the online Green Academy platform

was launched, where specialists can obtain certification in areas such as “sustainable business models,” “environmental production,” and “waste management in a circular economy.” This learning format makes sustainable practices accessible to a wide audience and allows businesses to adapt their employees to the new demands of the labor market.

GS4E also actively engages with the corporate sector, involving companies in the development of curricula and internships. Companies such as Siemens and Bosch have become project partners, providing students with the opportunity to undertake internships at enterprises that apply advanced sustainable technologies. These internships not only help future specialists acquire practical skills but also build lasting connections between educational institutions and employers.

The Green Skills for Europe program is an example of how the EU creates integrated educational initiatives that foster the development of key competences among citizens and workers for sustainable development. The introduction of “green” skills into vocational education and training enhances the competitiveness of the European workforce and creates the foundation for a more effective and accelerated transition to an environmentally oriented economy.

The educational initiatives of the European Union considered above demonstrate a systematic approach to integrating sustainable development principles into educational programs and public consciousness. The EU not only builds awareness of the importance of sustainable consumption, corporate social responsibility, and the green economy, but also develops tools for their practical implementation. The involvement of business, the use of digital technologies, and the support of interdisciplinary programs enable the EU’s educational system to prepare specialists who are in demand in the economy of the future.

These measures contribute not only to professional development but also to the formation of a culture of conscious consumption and responsible behavior among citizens. However, to achieve maximum effect, it is important to further expand these programs, adapt them to the specific contexts of individual EU member states, and involve broader segments of the population. The European Union continues to refine its policy in this field, ensuring the necessary level of knowledge and competences for sustainable development in the region in the long term.

1.4 The Role of NGOs and Civil Society in Sustainable Development

Non-governmental organizations (NGOs) and civil society play a crucial role in promoting the principles of sustainable development in the European Union, acting as intermediaries between public authorities, business, and the population. Their activities are aimed at protecting public interests, monitoring compliance with environmental and social commitments, disseminating knowledge, and participating in the development of sustainable development strategies. With active support from the EU, NGOs and civil initiatives have become important agents of change, contributing to the formation of an inclusive, environmentally responsible, and socially just society.

Civil society in EU member states plays an important role in ensuring oversight of the implementation of sustainable development policies. NGOs such as Friends of the Earth Europe, Greenpeace EU, and WWF Europe monitor environmental and social policies in the member states, conduct independent research, assess the environmental impact of industrial enterprises, and develop recommendations for authorities and businesses. These organizations draw attention to issues such as climate change, environmental pollution, social inequality, and human rights, exerting public pressure on government institutions and the private sector.

One of the key functions of NGOs is educational activity and raising public awareness of the principles of sustainable development. They organize information campaigns, lectures, training sessions, and mass events that help citizens and businesses better understand the impact of their decisions on the environment and society. For example, the European Environmental Bureau (EEB), which brings together more than 140 environmental organizations, actively works to inform the public about the circular economy, EU environmental legislation, and opportunities for citizen participation in decision-making processes.

In addition to monitoring and educational initiatives, NGOs play an important role in the development and implementation of practical projects aimed at sustainable development. For example, the Zero Waste Europe project, supported by the European Commission, introduces initiatives to reduce waste, build recycling infrastructure, and transition to a circular economy model. These projects contribute to the development of local sustainable businesses, the involvement of citizens in waste recycling, and the creation of new economic models focused on reducing pressure on natural resources.

Civil society also actively participates in mechanisms of public oversight and consultative processes in shaping European policy. Through

platforms such as the European Economic and Social Committee (EESC), representatives of NGOs and public organizations are given the opportunity to propose amendments to EU regulations and strategies. This creates conditions for more democratic governance and ensures that the views of various social groups are taken into account in the development of sustainable development policies.

Financial support for NGOs from the EU plays an important role in ensuring their activities. Programs such as LIFE, Horizon Europe, and Citizens, Equality, Rights and Values (CERV) provide grant funding for projects aimed at environmental protection, social justice, and civic participation. These resources enable organizations to conduct research, develop educational initiatives, and implement concrete projects at the local level, thereby enhancing the effectiveness of sustainable solutions.

The role of NGOs and civil society in the sustainable development of the European Union continues to grow, driven by increasing public demand for environmental and social responsibility from business and government. These organizations serve as vital intermediaries, facilitating the implementation of sustainable development policies at all levels—from local initiatives to international cooperation. Their activities not only complement governmental and corporate strategies but also foster a culture of sustainable behavior among citizens, creating the conditions for long-term social and environmental progress.

Case: The Zero Waste Cities Initiative – A Successful Example of NGO and Civil Society Participation in Sustainable Development

One of the most striking examples of effective cooperation between non-governmental organizations, local communities, and public authorities in the field of sustainable development is the Zero Waste Cities program, implemented by Zero Waste Europe with the support of the European Commission. This initiative is aimed at reducing waste, advancing the circular economy, and fostering environmentally conscious behavior among citizens.

The Zero Waste Cities project was launched in 2013 and has since united dozens of EU cities that have committed to achieving maximum waste reduction through the introduction of comprehensive systems for recycling, reuse, and minimizing landfill disposal. Within the framework of the program, Zero Waste Europe collaborates with local administrations, businesses, and civic initiatives, helping to design local strategies adapted to the specific characteristics of individual regions.

One of the most successful examples is the city of Capannori in Italy, which became the first EU city to officially commit to achieving Zero

Waste. Thanks to the active participation of local NGOs and civil society, the city implemented a waste separation system that enabled more than 80% of waste to be recycled. Additional measures were developed to reduce single-use plastics, promote the reuse of goods, and introduce composting programs for organic waste. This model proved effective, and Capannori's experience became a foundation for similar initiatives in other European cities such as Ljubljana (Slovenia), Kassel (Germany), and Barcelona (Spain).

In addition to working with municipal authorities, Zero Waste Cities actively involves civil society through educational programs and awareness-raising campaigns. For example, initiatives promoting the "Right to Repair," supported by Zero Waste Europe, are aimed at extending product lifespans and reducing the volume of electronic waste. As a result, several European countries have adopted legislative measures requiring appliance manufacturers to design products that are easily repairable and recyclable.

The Zero Waste Cities program demonstrates that active participation of NGOs and civil society is a key factor in the successful implementation of sustainable development policies at the local level. This project not only contributes to solving the waste problem but also fosters a new culture of consumption in which environmental responsibility becomes the norm for citizens, businesses, and authorities. The European Commission continues to support such initiatives, incorporating them into the EU's overall sustainable development strategy and disseminating successful models to other regions.

Case: Energy Citizens – Civil Society Engagement in Renewable Energy Development in the EU

One of the most successful examples of civil society and NGO participation in sustainable development is the Energy Citizens initiative, supported by the European Federation of Renewable Energy Cooperatives (REScoop.eu) and the European Commission. The project is aimed at creating citizen communities that participate in the production, management, and consumption of renewable energy, reducing dependence on fossil fuels and contributing to the energy transition in Europe.

Within the framework of the initiative, models of energy cooperatives have been developed, enabling residents to pool resources for financing, constructing, and managing local renewable energy sources such as solar panels, wind turbines, and biogas plants. These cooperatives provide communities with clean energy, while participants receive direct economic benefits in the form of lower electricity costs and profit-sharing from the sale of surplus energy to the grid.

One of the most successful examples is the Som Energia cooperative in Spain, which became the country's first renewable energy cooperative. Founded in 2010, it has brought together more than 80,000 members who have jointly invested in the construction of solar and wind power plants. The cooperative operates as an independent electricity supplier, allowing its members to fully transition to clean energy. The success of this model has inspired the creation of similar initiatives in other EU countries, including Belgium (Ecopower), Germany (BürgerEnergie Berlin), and Denmark (Middelgrunden Wind Cooperative).

Civil society and NGOs, such as Friends of the Earth Europe and REScoop.eu, play a crucial role in promoting this model by providing advisory support, helping to develop legislative initiatives, and drawing attention to the importance of decentralized energy supply. For example, in 2018, thanks to the efforts of REScoop.eu, amendments were introduced into EU legislation to facilitate the establishment of energy cooperatives and ensure equal conditions for local energy production alongside large energy corporations.

The Energy Citizens initiative demonstrates that active involvement of civil society and NGOs in sustainable development processes can lead to significant changes in energy policy. By supporting such projects, the European Union accelerates the transition to renewable energy while simultaneously strengthening local communities, raising public awareness of sustainable energy consumption, and creating economic incentives for local clean energy production.

Case: The Right to Repair – Promoting Sustainable Consumption through Civic Initiatives

One of the most striking examples of how civil society and NGOs contribute to sustainable development is the Right to Repair movement, supported by the European Environmental Bureau (EEB), as well as initiatives such as iFixit Europe and the Restart Project. This initiative is aimed at protecting consumer rights and combating planned obsolescence of products, which is one of the key challenges in modern production systems.

The main objective of the movement is to secure consumers' legal right to repair their electronics, household appliances, and other goods instead of prematurely replacing them. Within this initiative, NGOs and civic activists put pressure on EU regulators, demanding amendments to the Eco-Design Directive that would require manufacturers to make products more repairable. This would significantly reduce electronic waste, lower dependence on new materials, and decrease the carbon footprint associated with mass production of new goods.

Already in 2021, thanks to the efforts of the Right to Repair movement, the European Commission adopted a series of measures aimed at increasing product durability. In particular, requirements were introduced obliging manufacturers of household appliances (washing machines, refrigerators, televisions, etc.) to provide spare parts and repair instructions for at least 10 years after a product's release. This decision marked an important step toward reducing electronic waste and changing consumption patterns in the EU.

An important part of the campaign has been raising public awareness of the problems of disposable consumption and planned obsolescence. Within the Restart Project, community repair workshops are organized, where volunteers teach citizens how to extend the lifespan of their devices on their own. These events take place in many European cities and serve as an important tool of informal environmental education.

Activists have also succeeded in bringing the issue to the European Parliament, which has begun considering the introduction of a mandatory repairability scoring system for products, similar to the one already implemented in France. This system would allow consumers to know, before purchase, how easily a given product can be repaired, representing another step toward sustainable consumption.

The example of the Right to Repair movement shows that civil society and NGOs can exert significant influence on the shaping of EU sustainable development policies. Thanks to their efforts, legislative changes have been achieved, consumer awareness has been raised, and mechanisms have been created that, in the long term, will reduce waste volumes and promote a more sustainable model of consumption.

Chapter 2. Environmental Aspects of Sustainable Development in the European Union

2.1 EU Policy on Environmental Protection and Climate Change

2.2 Regulation of Greenhouse Gas Emissions and Decarbonization of the EU Economy

2.3 Development of Renewable Energy Sources and Reduction of Dependence on Fossil Fuels

2.4 Circular Economy: EU Strategies for Waste Reduction and Efficient Resources Use

2.5 Protection of Biodiversity and Restoration of Natural Ecosystems in EU

2.6 EU Environmental Standards and Their Impact on International Trade and Partners

2.1 EU Policy on Environmental Protection and Climate Change

Environmental policy in the European Union began to take shape in the early 1970s. At the Paris Summit in October 1972, the heads of state for the first time agreed on the need to develop a common position on environmental protection. As a result, the following year saw the adoption of the First Environmental Action Programme (1973–1976), which outlined the key principles and directions of joint environmental efforts at the EU level. Initially, the creation of a unified environmental policy was driven by concerns that differing environmental requirements among the member states might negatively affect the single market by creating trade barriers and distorting competition.

In its early years, European environmental policy evolved primarily as a reaction to emerging issues, focusing on solving specific problems. For example, separate laws were adopted for the protection of rare bird species (1979) and others. However, by the mid-1980s it became evident that a more systematic approach was necessary. An important milestone was the Single European Act of 1986, which for the first time enshrined environmental objectives in the Union's founding treaties alongside economic provisions. Later, in the Maastricht Treaty (1992) and the Amsterdam Treaty (1997), environmental concerns gained even greater importance. The treaties established requirements to integrate environmental considerations across all areas of EU activity, including the principles of sustainable development. These were reflected in the Fifth (1993–2000) and Sixth (2002–2012) Environmental Action Programs.

The 2000s marked a shift toward comprehensive solutions. For instance, in 2000 the Water Framework Directive was adopted, introducing an integrated system for the protection of water resources across all EU member states. Since 2005, the EU Emissions Trading System (EU ETS) has been in operation, providing a market-based mechanism for reducing greenhouse gas emissions. In the 2010s, the EU consolidated its role as one of the global leaders in combating climate change. The “Energy Package” of 2008 set ambitious 2020 targets (“20-20-20”), while in 2015 the EU played a decisive role in the adoption of the international Paris Agreement.

The current stage of EU environmental policy began with the launch of the European Green Deal in 2019, aimed at achieving climate neutrality by 2050. Today, the Eighth Environmental Action Programme, running until 2030, is in force. The main milestones in the development of EU environmental policy over the past fifty years are illustrated in Figure 1.

Key Milestones in EU Environmental Policy



Figure 1. Chronology of the Formation of EU Environmental Policy (1972–2022)

Over the past half century, the European Union has developed an extensive system of laws and regulations governing environmental protection and ecology. According to the European Environment Agency,

approximately 500 different legal instruments – directives, regulations, and decisions – have been adopted to date [1]. Several EU institutions are involved in the creation and implementation of these rules, with the European Commission acting as the primary initiator of new environmental legislation. Since 1981, it has had a dedicated department – the Directorate-General for the Environment – which also monitors compliance with adopted standards by member states.

The legislation is debated and approved by two other institutions: the Council of the European Union (specifically, the environment ministers of the member states) and the European Parliament, which jointly make decisions on most environmental issues. Compliance with the rules and standards is overseen by the Court of Justice of the European Union, which adjudicates violations and can oblige states to implement environmental requirements. In 1993, the European Environment Agency was established to monitor the state of the environment and collect the necessary statistical data.

Thus, the formation of the EU's environmental strategy is carried out within a complex institutional framework involving all the Union's main bodies. Figure 2 presents a diagram of this process.

The Commission develops and submits legislative initiatives, while the Council and the Parliament adopt directives and regulations, after which the member states implement them in practice; compliance is monitored by the Commission with expert support from the EEA, and judicial enforcement is carried out through cases before the Court of Justice of the EU. This institutional approach has ensured the formation of a unified and effective system of EU environmental legislation.

Let us now examine in more detail the main EU environmental directives and the areas they regulate. Modern EU environmental law covers a wide range of domains – from nature conservation and air quality to waste management and climate change. Some of the first acts were the directives on wildlife conservation, such as the Birds Directive of 1979 and the Habitats Directive of 1992, which laid the foundation for the Natura 2000 network of protected areas, covering about 18% of EU land and a significant part of marine areas.

In the field of pollution prevention, a key role was played by the Water Framework Directive (2000/60/EC), which set the goal of achieving “good” ecological status of all water bodies by 2015 and stimulated integrated river basin management. Although full success has not yet been achieved (by 2020, only about 38% of EU surface waters had good status), this directive improved standards for wastewater treatment and water quality monitoring.

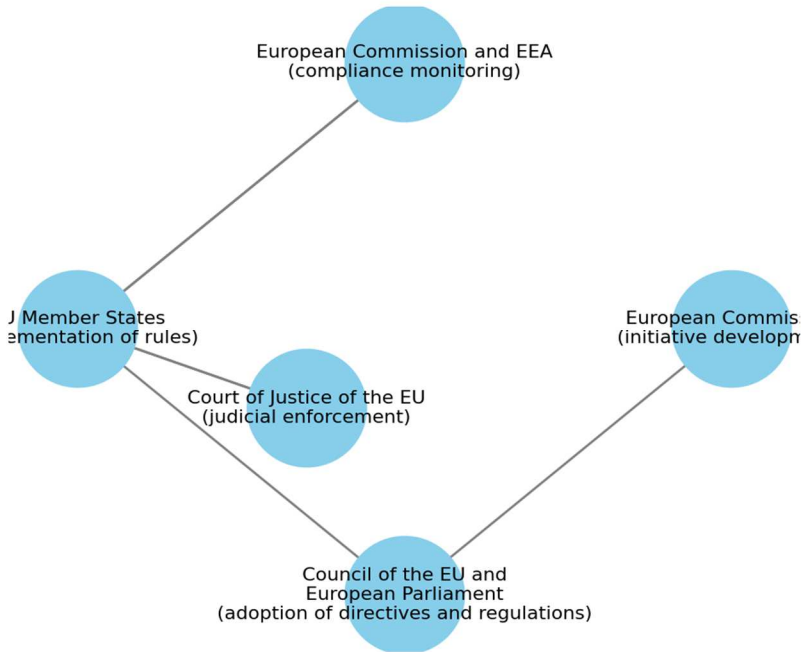


Figure 2. Institutional Mechanism of EU Environmental Policy

In the area of air protection, the Air Quality Directives package (1996–2008) established maximum permissible concentrations of pollutants (PM_{2.5}, NO₂, etc.) and required cities to prepare plans for meeting these standards. At the same time, through technological regulations (the Large Combustion Plants Directive of 2001, Euro standards for cars, and others), emissions of pollutants were significantly reduced. From 1990 to 2021, total sulfur dioxide (SO_x) emissions in EU countries decreased by more than 90%, and nitrogen oxides (NO_x) by about 63%, reflecting the effectiveness of European fuel standards, industrial filters, and related measures [3].

In the field of waste management, the EU adopted the Waste Framework Directive (2008/98/EC) and a number of specialized acts (on packaging, electronic waste, landfills, etc.), which led to significant growth in recycling and recovery rates in many countries. Also noteworthy is the regulation of chemical substances through the REACH Regulation of 2006, which introduced mandatory registration and assessment of thousands of substances. The EU's restrictive and prohibitive lists have limited the use of

many toxic and hazardous substances. As a result, the Union today has one of the strictest and most comprehensive systems of environmental regulation in the world.

This is confirmed by real improvements: according to the EEA, levels of air, water, and soil pollution in Europe have declined noticeably over the decades, largely due to the implementation of comprehensive environmental legislation [1]. For example, concentrations of sulfur compounds and lead in the air have dropped significantly compared to the 1970s, while the quality of drinking water and bathing water has improved (according to the European Commission, EU citizens today enjoy some of the cleanest water in the world).

At the same time, not all environmental problems have been solved: ecosystem degradation and biodiversity loss continue. The latest State of Nature report shows that only about 27% of species and 25% of habitats protected under EU directives are in a favorable condition, while the rest are assessed as poor or inadequate [1]. Thus, many of the past targets (for example, achieving favorable status for most species by 2020) have not been reached, despite the availability of legal instruments, which points to the importance of proper implementation of adopted directives in practice.

The enforcement of EU environmental norms relies on several mechanisms.

First, the European Commission monitors the timely transposition of directives into national legislation and the implementation of their requirements. In cases of non-compliance, the Commission initiates infringement procedures against a member state, which may ultimately be referred to the Court of Justice of the EU, playing an important role. Research shows that EU enforcement measures often bring significant benefits for citizens and the environment by reducing the economic damage caused by non-compliance with environmental legislation [4]. In well-known cases, lawsuits initiated by the Commission prompted countries to accelerate the construction of wastewater treatment facilities, strengthen species protection, and take other measures, thereby saving national budgets from costs related to pollution consequences.

Second, monitoring and reporting play a crucial role: member states are required to regularly submit data on key indicators (emissions, environmental quality, species status, etc.) to the European Commission and the EEA. Based on these data, the EEA prepares independent assessment reports (for example, the cyclical report “The European Environment: State and Outlook”), which allow progress to be tracked. If systemic shortcomings are identified, the Commission may issue targeted recommendations or launch initiatives to address the gaps. Since 2017, the

Environmental Implementation Review (EIR) has been practiced – a regular analysis of the achievements and challenges of each member state, accompanied by country-specific recommendations.

Third, mechanisms of public and NGO participation are becoming increasingly important. In accordance with the Aarhus Convention, the EU guarantees the right to information and access to justice in environmental matters, which enables civil society organizations to demand compliance with environmental norms through national and European courts. Overall, the effectiveness of control is confirmed by statistics. According to Eurobarometer, 75% of EU citizens consider European environmental laws necessary for the protection of nature, and 80% support the authority of EU institutions to check how these laws are applied in practice [4].

The European Commission emphasizes that full implementation of environmental legislation could save the EU economy up to 50 billion euros annually by reducing costs related to damage to health and nature [4], which highlights the high price of insufficient implementation and the importance of Union oversight instruments.

The impact of EU environmental policy on practical indicators is generally positive, although uneven across sectors.

Greenhouse gases. Owing to the EU's climate change mitigation policy, the target for emission reductions was achieved ahead of schedule: by 2020, total greenhouse gas emissions had decreased by 32% compared to 1990 levels, exceeding the set threshold of –20%. All major EU economies reduced emissions, except for the transport sector, where by 2020 emissions had still increased by 7% [5]. However, thanks to reductions in other sectors (energy: –46%; industry: –44%, etc.), the overall European target was exceeded.

Renewable energy. By 2020, the share of renewable energy in the EU's final energy consumption reached 22%, surpassing the target of 20% [6]. Most countries achieved their national renewable energy plans, and some significantly overfulfilled them (Table 2). For example, Sweden reached over 60% renewables compared to its plan of 49%, and Bulgaria 23% against a plan of 16%. The only country that did not meet its target was France (around 19% compared to the planned 23%) [6].

Overall, EU policy (the Renewable Energy Directive of 2009) has proven effective, stimulating investments in clean energy across all member states.

In addition to climate and energy, significant progress has been achieved in reducing pollution. The aforementioned decline in emissions of major air pollutants has led, according to estimates, to a reduction of about 42% in premature deaths from air pollution in Europe between 1990 and 2019 [7].

Table 2. Achievement of EU member states' mandatory renewable energy targets in 2020 (percentage points – difference between actual and planned values)

Country	Target share of RES by 2020	Actual share of RES in 2020	Target achievement
Sweden	49%	>60%	+11 p.p.
Croatia	20%	~31%	+11 p.p.
Bulgaria	16%	~23%	+7 p.p.
France	23%	~19.1%	–3.9 p.p.
EU-27	20%	22%	+2 p.p.
Note – compiled on the basis of source [6]			

Stricter wastewater treatment standards (Directive 91/271/EEC) have enabled most EU countries to achieve high bathing water quality: according to the EEA, more than 85% of bathing waters are of excellent quality. At the same time, the results of directive implementation are uneven. As noted, the goal of the Water Framework Directive remains far from being achieved (more than 60% of water bodies have not reached good status). Southern and Eastern European countries face difficulties in the field of waste management, with recycling rates varying more than twofold across the EU. Analysts note that “incomplete implementation of agreed policies” remains a frequent cause of local environmental problems [1]. Thus, the existence of progressive legislation in itself does not automatically guarantee the achievement of environmental objectives – political attention to implementation on the ground, sufficient funding for environmental measures, and strengthening of institutional capacity in member states are critically important.

Since the 2020s, the EU environmental agenda has entered a new phase, characterized by both increased ambitions and serious challenges. The main strategic goal has been declared as climate neutrality by 2050 (enshrined in the European Climate Law of 2021), and by 2030 the EU aims to reduce greenhouse gas emissions by at least 55% compared to 1990 levels. However, a gap is emerging between political objectives and their practical implementation. According to the latest EEA assessments, even taking current measures into account, the Union is only partially on track to meet its 2030 environmental and climate goals [8], a finding confirmed by national projections. If existing policies remain unchanged, emission reductions by 2030 may amount to about 49% instead of the required 55% [9].

Similarly, plans on waste management, chemical safety, and ecosystem protection require substantial reinforcement. A persistent problem is

incomplete compliance with already adopted norms in a number of countries. Despite enforcement mechanisms, in 2020 infringement procedures continued against many EU states concerning issues such as exceeding NO₂ limits in urban air, illegal logging, and failure to meet wastewater treatment requirements. Delays in implementation come at a cost: as noted above, unrealized environmental benefits are estimated at tens of billions of euros annually.

Thus, closing the “implementation gap” has become one of the most urgent tasks for the EU. In response, the European Commission is strengthening monitoring and support: the Environmental Implementation Review cycle helps identify weaknesses by country and provide targeted recommendations, while new legislative initiatives (for example, the proposed Nature Restoration Regulation of 2022) are aimed at addressing gaps in the existing framework [10].

Another major challenge consists of financial and technological barriers to achieving sustainability goals, since the transition to a green economy requires unprecedented investments. According to the European Commission, in order to reach the 2030 targets (including a 55% reduction in emissions), the EU must attract an additional approximately 260 billion euros annually into green projects until the end of the decade [11]. These funds are needed for the modernization of energy, industry, transport, and other sectors. A significant share of the burden falls on the private sector, yet without EU budget support it is difficult for certain regions (especially those dependent on fossil fuels) to undergo transformation. In this regard, the Just Transition Mechanism, with a budget of about 100 billion euros for 2021–2027, was introduced to help the most vulnerable regions (such as coal-mining areas) finance environmental restructuring.

Technological challenges are also considerable: existing low-carbon technologies do not yet provide a full replacement for fossil fuels in all sectors. As representatives of energy-intensive industries have emphasized, achieving climate neutrality for EU industry will require unprecedented volumes of clean energy and the adoption of innovative solutions, which will not be possible without radical changes in the energy system [12].

A massive rollout of renewable generation, electric transport, green hydrogen, carbon capture technologies, and others will be necessary. However, some of these (such as hydrogen-based metallurgy and long-term energy storage) are still at the demonstration stage. Overcoming these barriers will require not only financial resources but also effective coordination of R&D and industrial policy at the EU level.

Finally, modern environmental policy is being tested for resilience against global crises. The COVID-19 pandemic, the energy crisis of 2021–

2022, and geopolitical instability all affect priority-setting and may hinder long-term green transformations. In 2020, due to the pandemic, global CO₂ emissions temporarily declined, but governments' attention shifted to emergency economic support measures. The EU sought to integrate environmental priorities into recovery plans: a significant part of the NextGenerationEU recovery fund was directed toward green projects, and under the Recovery and Resilience Facility a requirement was introduced that at least 37% of national plan expenditures must be allocated to climate objectives.

An even greater challenge was the energy turbulence caused by the geopolitical situation in Ukraine. The sharp reduction in imports of Russian gas in 2022 forced several EU countries to temporarily increase coal-based generation, contradicting climate goals. At the same time, the Union launched the REPowerEU initiative to accelerate the deployment of renewables and energy efficiency, in order to strengthen energy independence and offset the use of hydrocarbons.

Thus, crises may simultaneously create risks of setbacks for the environmental agenda and new opportunities for its strengthening. The European Environment Agency notes that all these factors have “tested the European Green Deal and its ambitions to build a climate-neutral economy” [13], and have demonstrated the continuing relevance of the principle of resilience.

EU leadership reaffirms its commitment to the Green Deal, recognizing that delaying action will only increase future costs. The key challenge is to secure broad public support in times of social upheaval. Just transition has moved to the forefront: environmental policy must take into account the interests of vulnerable groups and ensure the creation of new green jobs to replace those lost. Without this, public backing may weaken, putting the success of the entire project at risk [13]. In response, the EU is strengthening communication and citizen participation (such as through the European Climate Pact) and emphasizes that the Green Deal is not a luxury but the foundation for the future resilience of the economy.

In conclusion, EU environmental policy has achieved significant progress in recent decades: a robust regulatory and institutional system has been established, enabling reductions in traditional forms of pollution and the beginning of an economic transformation toward low-carbon foundations. Yet some of the most complex challenges remain on the agenda: preventing climate catastrophe, halting biodiversity loss, and advancing the transition to a circular economy. Meeting these challenges will require bridging the gap between ambition and action, mobilizing investment and innovation, and ensuring that EU policy can withstand both

external and internal crises without lowering its environmental aspirations. Only by successfully responding to these challenges will the EU be able to realize its vision: to ensure by 2050 life within the planet's limits while maintaining a high quality of the environment for its citizens. This will require the continued evolution of environmental strategy, its integration across all sectors, and the consolidation of efforts at all levels of governance – from Brussels down to each region of Europe.

2.2 Regulation of Greenhouse Gas Emissions and Decarbonization of the EU Economy

The European Union is implementing a comprehensive policy to reduce greenhouse gas emissions and to transition to a carbon-neutral economy. These measures are aimed at fulfilling international climate commitments and science-based recommendations. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) notes that anthropogenic emissions have already increased global temperature by about 1.1°C, and urgent and deep emission reductions are required to limit warming. In response to the challenges of climate change, the EU has set the goal of achieving carbon neutrality by 2050 and reducing emissions by at least 55% by 2030 compared to 1990 levels [14].

The EU strategy combines economic instruments (for example, emissions trading), sectoral regulation, and the promotion of the energy transition to renewable sources.

A key market mechanism of EU climate policy is the EU Emissions Trading System (EU ETS). The EU ETS was launched in 2005 and became the world's first international system for trading carbon emission allowances. Its principle is based on the “cap-and-trade” approach: setting an overall cap on emissions and issuing a limited number of allowances that can be traded on the market. The system covers about 40% of all EU greenhouse gas emissions, including major sources in energy, industry, and domestic aviation (in all EU countries, as well as Iceland, Norway, and Liechtenstein) [14]. For the sectors subject to the EU ETS, a total emissions cap is set, which is annually reduced in line with EU climate targets. Companies participating in the system must monitor and report their emissions and annually surrender allowances equal to the volume of their CO₂ emissions. If a company reduces its emissions, it can sell surplus allowances or save them for future use; if it exceeds its emissions, it must purchase additional allowances on the market. By lowering the emissions cap, the EU ETS has ensured substantial reductions in greenhouse gases: by

2023, cumulative emissions from stationary energy and industrial installations had declined by about 47% compared to 2005 levels. This demonstrates the important role of the EU ETS in decarbonizing sectors where reductions are achieved where they are most cost-effective.

Over its existence, the EU ETS has undergone a series of reforms to strengthen its environmental effectiveness. The system develops in phases: it is now in its fourth trading period (2021–2030), where restrictions have been significantly tightened. In particular, within the Fit for 55 climate package, reforms were agreed in 2022 setting a stricter target for 2030 – a 62% reduction of emissions in EU ETS sectors relative to 2005. From 2024, the EU ETS has also expanded to cover emissions from maritime transport (ships entering EU ports). Furthermore, a decision has been made to establish a separate emissions trading system for the buildings and road transport sectors (the so-called ETS 2) [15]. An important element of the reforms was the introduction of the Market Stability Reserve, a mechanism that automatically withdraws surplus allowances from the market to prevent oversupply and maintain a stable carbon price. In the new phase, a gradual reduction of free allowances for energy-intensive industries has been envisaged, alongside the introduction of the Carbon Border Adjustment Mechanism (CBAM). These reforms are designed to strengthen price signals for emission reductions and encourage companies to invest in low-carbon technologies, ensuring the contribution of the ETS to achieving the EU Green Deal targets.

Impact on competitiveness. The introduction of a carbon price inevitably affects industry, particularly energy-intensive sectors, and raises questions about competitiveness. If EU companies bear additional costs for emissions while their foreign competitors do not, there is a risk of carbon leakage: the relocation of production to jurisdictions with less stringent climate regulation. To prevent this and mitigate the impact of the ETS on industry, the EU initially granted a significant share of allowances free of charge to companies in sectors with a high risk of carbon leakage. Such support will remain in the fourth phase of the EU ETS (2021–2030), although the criteria for identifying at-risk sectors have been tightened. The list of sectors considered exposed to carbon leakage is reviewed and approved by the European Commission with the participation of member states and the European Parliament. Free allocation reduces costs for European producers of steel, cement, chemicals, and others, supporting their competitiveness on the global market. At the same time, the EU is developing new instruments to ensure a level playing field: in 2023, the Carbon Border Adjustment Mechanism (CBAM) was launched in a transitional mode. The CBAM will impose a carbon charge on imports of certain carbon-intensive goods (steel,

cement, electricity, etc.), equivalent to the carbon price within the ETS [2]. This is intended to prevent the substitution of European low-carbon products with more carbon-intensive imports, while also encouraging foreign producers to reduce emissions. In the future, as the CBAM is phased in, the share of free allowances for European industry will decline, with a complete replacement of free allocation by cross-border carbon regulation planned by 2035. Thus, EU policy seeks to combine strict environmental objectives with measures to preserve industrial capacity and jobs.

Problems and shortcomings of the system. Despite its successes, the EU ETS has faced and continues to face a number of challenges. One problem in the early phases was the excessive allocation of allowances and the resulting low carbon prices. During 2008–2012, the economic downturn led to lower actual emissions, while the number of allowances issued remained high. The resulting surplus of allowances collapsed the CO₂ price to just a few euros per ton, weakening decarbonization incentives. A similar situation occurred in 2013–2016, until EU institutions took measures to withdraw part of the allowances from circulation (through backloading and the creation of the Market Stability Reserve). Only after these reforms did carbon prices begin to rise, reaching about 80–100 € per ton of CO₂ in recent years. Another challenge has been the sectoral coverage of the ETS: for a long time, the system did not include significant shares of emissions (for example, transport, households, and small sources), being limited to large enterprises. Only recently has a decision been made to extend emissions trading to new sectors. In addition, the carbon market is inherently volatile: prices are influenced by economic cycles, fuel prices, and investor expectations. The sharp decline in demand for allowances in 2020 (due to lockdowns and reduced production) led to a temporary fall in CO₂ prices [13], although the market later recovered. This highlighted the need for stabilization mechanisms. Finally, the ETS has been criticized for administrative complexity and potential abuses (for example, cases of VAT fraud in allowance trading in the system's early years). The EU continues to improve regulation (enhancing monitoring, introducing a unified registry, etc.), but it is difficult to completely eliminate risks.

Overall, the EU ETS remains the cornerstone of EU climate policy, but its effectiveness depends on the fine-tuning of system parameters and complementary measures to avoid the shortcomings of a purely market-based approach.

In addition to the emissions trading market, the EU applies direct regulatory measures for emissions in specific sectors through standards, technical norms, and binding targets for member states. Such measures are particularly important for sectors not fully covered by the EU ETS, notably

transport, buildings, agriculture, as well as certain modes of transport (aviation and shipping).

Restrictions for industry and transport. For large stationary industrial sources, the primary tool for reducing CO₂ is the EU ETS, described above. However, alongside it, direct regulation of energy efficiency and technologies is also in place. Industrial enterprises in the EU are required to comply with best available techniques (BAT) standards under the Industrial Emissions Directive, which indirectly contribute to greenhouse gas reductions. In sectors not covered by the ETS, national emission quotas are introduced under the Effort Sharing Regulation (ESR), which allocates emission reduction targets across member states in non-ETS sectors (transport, buildings, agriculture, waste). Each country is obliged to reduce emissions in these sectors by a certain percentage by 2030, which encourages the introduction of local measures (CO₂ taxes, norms, etc.).

Decarbonization of transport receives the most attention, since it accounts for nearly one quarter of CO₂ emissions in Europe. The EU has consistently tightened environmental requirements for vehicles. The key mechanism is CO₂ emission standards for new vehicles. Since 2015, standards have limited average emissions of new passenger cars first to 130 g CO₂/km, then to 95 g/km (from 2021). These standards forced manufacturers to develop more efficient engines and to electrify their model range. Average specific emissions of new cars in Europe fell by 27% in just three years – from 122 g/km in 2019 to 89 g/km in 2022 – thanks to the growth of electric vehicle sales (13% of new cars in 2022). In 2023, an even more ambitious target was adopted: under amendments to Regulation (EU) 2019/631, by 2035 all new passenger cars and vans in the EU must achieve a 100% reduction in CO₂ emissions relative to 2021, effectively making them zero-emission. This means that the sale of new gasoline and diesel internal combustion engine vehicles will end by 2035, except for niche cases (the regulation includes review clauses and potential exemptions for synthetic fuels). In parallel, requirements are being established for heavy-duty vehicles: since 2019, CO₂ standards for trucks have required a reduction in average emissions of new heavy-duty vehicles by 15% by 2025 and by 30% by 2030. Such regulatory policy encourages the automotive industry to invest in electric vehicles, hydrogen fuel cells, and other alternatives to fossil fuels, while reducing oil product consumption in transport.

In addition, to promote renewable fuels in transport, a requirement was introduced for a minimum share of biofuels and green electricity in overall transport consumption (at least 10% by 2020, actually achieved at about 10.2%; the new target for 2030 is 14% and above). These measures, along

with national fuel taxes and restrictions on the entry of older cars into cities, form a comprehensive regulatory framework reducing emissions from road transport.

Impact of new standards on aviation and shipping. Until recently, international aviation and maritime shipping remained outside strict regulation under the Kyoto Protocol and the Paris Agreement, despite their significant and growing emissions. The EU was a pioneer in including aviation in emissions trading: since 2012, the EU ETS has applied to emissions from the aviation sector, though so far only for flights within the European Economic Area (EEA). Airlines are required to purchase allowances for CO₂ emissions from intra-European flights. Initially, part of the allowances was allocated for free, but reforms have established the full phase-out of free aviation allowances by 2026, with a reduction of 25% in 2024 and 50% in 2025. This means that airlines will bear the full carbon cost of their flights within Europe, creating an incentive to improve fuel efficiency and use more sustainable fuels.

For international flights beyond the EEA, the EU has so far limited itself to implementing the global CORSIA scheme (Carbon Offsetting and Reduction Scheme for International Aviation), adopted by the International Civil Aviation Organization (ICAO). Since 2021, CORSIA requires compensation for emissions growth above 2019 levels through the purchase of carbon credits. The EU has implemented CORSIA obligations for flights departing from the EU while maintaining ETS requirements for intra-EU flights. Additionally, in 2022 the EU adopted the ReFuelEU Aviation initiative, requiring fuel suppliers to gradually increase the share of sustainable aviation fuels (advanced biofuels, synthetic kerosene) in aircraft refueling – from a minimum of 2% in 2025 to 70% by 2050. These measures aim to reduce aviation's carbon footprint, though the sector is recognized as one of the hardest to decarbonize.

For maritime transport, European regulation developed later but is now rapidly advancing. Maritime shipping carries over 80% of world trade and accounts for around 3% of global greenhouse gas emissions.

In 2023, the EU adopted several important measures for the decarbonization of shipping. First, starting in 2024, large commercial vessels (over 5,000 gross tonnage) were included in the EU ETS and must acquire carbon allowances for 100% of their emissions on routes within the EU, as well as for 50% of emissions on voyages beginning or ending in EU ports. This makes CO₂ emissions an economically significant factor for shipping companies. Second, the new FuelEU Maritime Regulation entered into force (with full implementation from 2025), setting progressively stricter requirements for the carbon intensity of marine fuels. Shipowners

are required to reduce the average greenhouse gas emissions per unit of energy used by their fleets by switching to cleaner fuels (LNG, biofuels, green ammonia, methanol, etc.) or through technical measures. Non-compliance will result in fines, which effectively stimulate the market for biofuels and electrofuels. Although these new rules increase operating costs for carriers, they aim to reduce emissions from shipping and promote innovations (such as wind-assisted propulsion and more efficient engines). Overall, the inclusion of aviation and shipping in EU climate policy closes sectoral gaps and supports global efforts (through ICAO and IMO) to reduce emissions from international transport.

The energy sector – the production of electricity and heat – has historically been the largest source of CO₂ emissions in Europe. Therefore, the decarbonization of electricity generation is at the core of EU policy. On the one hand, power plants are directly affected by the EU ETS: electricity generation accounts for about 34% of all EU greenhouse gas emissions, and it is in this sector that the largest absolute reductions have been achieved through the ETS (coal-to-gas and renewables substitution). On the other hand, targeted directives for the development of renewable energy are also applied. Directive 2009/28/EC set mandatory national shares of renewable energy (RES) by 2020, which stimulated explosive growth of wind, solar, and biomass-based generation. As a result, by 2020 the share of RES in the EU's gross final energy consumption reached 22% (against the 20% target). For 2030, the RES target was recently raised from 32% to at least 42.5% (under the 2023 agreement), with aspirations up to 45%.

Almost all EU countries have introduced financial mechanisms to support green energy (quotas, feed-in tariffs, capacity auctions). This has led to nearly half of EU electricity now being generated from renewable sources – in 2023 their share in power generation reached about 45%. At the same time, many states have announced deadlines for phasing out coal-fired power plants: France and Italy by 2025, Germany by 2038 at the latest, Poland around 2049, and so on. Over the past decade (2010–2020), installed coal-fired capacity in the EU fell by tens of gigawatts, while renewable capacities (solar and wind) more than doubled. Carbon pricing through the ETS accelerated this trend, making coal plants economically less viable. In 2019–2021, a significant number of coal units were closed in countries such as Germany, Spain, and Portugal, precisely due to rising allowance prices and stricter environmental requirements.

In the heating and cooling sectors of buildings, the share of RES is also gradually increasing (to about 26% in 2023, including the use of heat pumps and biomass combustion). Nevertheless, full decarbonization of the energy sector requires further efforts: beyond phasing out coal, a significant share

of natural gas must also be abandoned or compensated for through CO₂ capture technologies. Within the REPowerEU strategy (2022), the EU set an accelerated course for phasing out fossil fuels, highlighting the dimension of energy security. The events of 2022 (the gas supply crisis) stimulated additional investments in RES as a more reliable domestic energy source.

Thus, carbon regulation (ETS, carbon taxes) combined with programs supporting clean energy has transformed the EU energy sector: emissions from energy production have fallen significantly, and the economy increasingly relies on renewable energy (Figure 3).

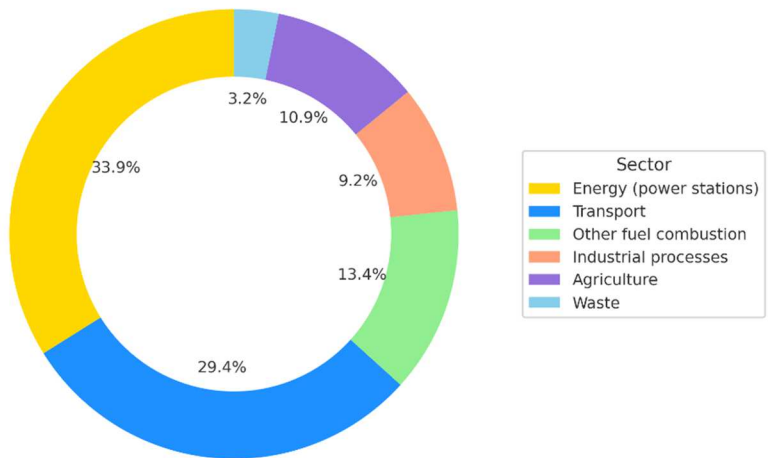


Figure 3. Structure of EU Greenhouse Gas Emission by Sector (2021)
Note - calculated based on EEA data, 2023 [9].

It is evident that the predominant share of greenhouse gas emissions is associated with fossil fuel combustion (approximately 77% in total), particularly in energy production and transport.

The European Union has set some of the most ambitious climate targets in the world, enshrined in the 2021 European Climate Law and related strategies. The main long-term objective is to achieve net-zero greenhouse gas emissions by 2050 (i.e., to reach climate neutrality). This goal is consistent with scientific findings: according to the IPCC, limiting global warming to around 1.5°C requires achieving global net-zero CO₂ emissions around the middle of the century.

The EU's mid-term objective is to reduce total greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels (previously,

under the Paris Agreement, the EU committed to a –40% target, but in 2020 it was raised to –55%). This “–55%” goal covers all sectors of the economy and sinks, and is considered a net target (which can be achieved through a combination of emission reductions and enhanced CO₂ absorption by forests and technologies). In absolute terms, the task is to cut annual EU emissions from approximately 4.0 billion tons of CO₂-equivalent in 1990 to about 1.5 billion tons by 2030, and to near zero by 2050.

Between 1990 and 2020, the European Union already managed to reduce emissions by about 28–30%, even with economic growth, as a result of structural changes (a decline in energy-intensive industries, closure of inefficient facilities in Eastern Europe in the 1990s) and targeted policies (RES development, energy efficiency, ETS, etc.). However, the remaining reductions are more difficult to achieve since the “low-hanging fruit” has already been harvested. The new target requires roughly doubling the pace of decarbonization compared to historical trends.

Within the EU, the contribution of individual countries to overall reductions has been uneven. The largest emitter, Germany, reduced its emissions by nearly 40% since 1990 (through energy and industrial modernization, as well as the effect of reunification). Similar trends are observed in other older EU members: France (–23% by 2021 relative to 1990), Italy (–20%), while Spain, by contrast, has made virtually no reduction compared to 1990 (+0.4%), due to prolonged economic growth and increased transport. New Eastern European EU members often showed the sharpest declines in emissions, driven by economic transformation in the 1990s: the Baltic states, for example, reduced emissions by more than half. At the same time, several small countries (Ireland, Cyprus) increased their emissions during this period.

This divergence has necessitated fair burden-sharing among member states. The EU set national emission reduction quotas in non-ETS sectors by 2030: from –40% for wealthy countries (Sweden, Denmark) to 0% for less developed ones (e.g., Bulgaria), reflecting the principle of “common but differentiated responsibility.” Overall, by 2020 all EU countries had met their emission targets, and the Union as a whole overachieved (–30% actual vs. –20% target by 2020).

The next milestone, 2030, requires large-scale restructuring of energy, transport, and industrial systems, which is enshrined in the European Green Deal and the Fit for 55 package. Progress monitoring is carried out annually by the European Environment Agency (EEA) and the European Commission, with risk assessments and recommendations for strengthening measures.

Transition to renewable energy. The growth of renewable energy use is a central element of the EU's decarbonization strategy. Replacing fossil fuels (coal, oil, gas) with renewable energy directly reduces CO₂ emissions and also improves energy security. Over the past two decades, the EU has nearly tripled the share of RES in its energy mix: from about 8.5% in 2004 to 24.5% in 2023. This progress has been largely driven by EU-wide targets and national support programs. As noted, for 2030 the updated target is set at 42.5% RES in final energy consumption (with a possible increase to 45%). Achieving this level will require roughly doubling the annual rate of RES capacity deployment compared to the previous decade. The main contribution is expected from wind and solar power, which have already become cost-competitive.

The transition to RES proceeds unevenly across EU countries, reflecting differences in resources and government policies. For example, Sweden, due to abundant hydro resources and biofuels, has achieved the highest share of renewable energy – about 66% of final energy consumption in 2023.

High shares are also observed in Finland (~46%) and Denmark (~44%), where hydropower/biomass and wind energy, respectively, play a major role. By contrast, industrialized states with traditionally high shares of nuclear and fossil energy are lagging behind: the share of RES in France is only about 24%, in Germany around 22% (2023), compared to the EU average of ~24.5%. The lowest performers are Belgium (~15%) and Luxembourg (~12%), where the use of renewables is minimal.

It should be noted that a low share of RES does not always imply high CO₂ emissions—for example, France has substantial carbon-free generation due to nuclear power, although in statistics nuclear is counted separately from renewables. Nevertheless, the expansion of renewable energy is considered the key to reducing emissions across all sectors—from electricity generation to transport and heating.

To stimulate this transition, the EU implements investment programs such as the NextGenerationEU fund (multi-billion financing for green economic recovery after the pandemic) and national RES development plans. Particular attention is paid to the removal of administrative barriers: in 2022–2023 amendments were adopted to simplify the permitting process for RES projects, and “renewables acceleration zones” are being established with minimal delays. In addition, a strategy is being implemented to develop infrastructure for electric transport and smart grids, which are essential for the integration of renewable energy.

Thus, the EU is purposefully restructuring the energy basis of its economy, increasing the share of RES for the sake of climate objectives and

energy independence. The current status and progress of the RES transition in individual EU member states can be compared on the basis of the latest data (2023), presented in Table 4.2.1.

Table 3. Share of Renewable Energy in Final Energy Consumption in Selected EU Countries (2023) [10]

Country	RES share, % of final energy consumption (2023)
Sweden	66.4%
Finland	46%
Denmark	44%
EU-27 average	24.5%
France	24%
Germany	22%
Belgium	15%
Luxembourg	11.6%
Source: European Environment Agency (EEA), 2025.	

The table illustrates the wide disparity in performance among countries: from leading Sweden (more than half of its energy from RES, mainly hydro and biomass) to lagging Belgium and Luxembourg (less than 15%). The EU average (24.5%) has been achieved largely thanks to high RES shares in several states, while other countries still need to intensify efforts to approach the 42.5% target by 2030.

Implications for the labor market and industry. The transition to a low-carbon economy entails not only environmental but also socio-economic consequences. Decarbonization triggers structural shifts in employment: jobs in fossil fuel and traditional energy sectors are shrinking, while “green” sectors—renewable energy, energy efficiency, and electric mobility—are expanding. In the European Union, a considerable number of workers are still employed in coal mining, oil refining, the production of internal combustion engine (ICE) vehicles, and other carbon-intensive industries. For example, in 2020 the coal industry in the EU accounted for about 230,000 jobs (direct and indirect).

According to European Commission estimates, the planned closure of about two-thirds of coal-fired power plants by 2030 will lead to the loss of around 30,000 direct jobs in coal mining and energy. Similar challenges face the oil and gas sector and fossil-fuel-based energy industries. To mitigate social impacts, the EU is implementing a “Just Transition” policy. Within this framework, a dedicated Just Transition Mechanism has been established with a budget of approximately €55 billion for 2021–2027,

aimed at supporting regions dependent on carbon-intensive industries. These funds are directed towards workforce retraining, economic diversification of coal regions, and the creation of new businesses on the sites of closed mines and power plants. The EU has also created the Just Transition Platform, which brings together authorities, businesses, and trade unions to exchange best practices and plan support measures for regions (primarily coal basins in Poland, Germany, the Czech Republic, Romania, and others).

On the other hand, the “green” economy opens up new opportunities for employment and industrial growth. The renewable energy sector and related services are showing rapid job creation. According to the International Renewable Energy Agency (IRENA), in 2022 about 1.4 million people were employed in the RES sector in Europe, 10% more than five years earlier. Growth is especially strong in wind power (turbine manufacturing, wind farm operation) and solar equipment production. In addition, the development of electromobility is generating demand for jobs in battery production, charging infrastructure, and software.

Studies indicate that the overall net employment effect of the energy transition in the EU may be positive: thanks to investment inflows and the creation of new industries, the total number of jobs will increase in the long term. One modeling study showed that by 2050 about 1.3% of EU jobs will be reallocated between sectors as a result of the low-carbon transition, accompanied by an overall increase in employment. However, this positive outcome is only possible with effective retraining and social adaptation of workers made redundant. Otherwise, coal miners, oil workers, and other categories risk facing prolonged unemployment, which could lead to social discontent and resistance to climate policy.

For this reason, the EU integrates “just transition” principles into all climate initiatives, striving to ensure the creation of new jobs comparable in quality to those lost. Through the Just Transition Fund, educational programs are financed, small and medium-sized enterprises in post-coal regions are supported, and investments are directed into innovative industries (e.g., green hydrogen production on the sites of closed coal mines). Efforts are also being made to geographically distribute new “green” industries—for instance, factories producing RES components and batteries are strategically located in countries most affected by the phase-out of fossil fuels. This approach is intended to prevent regional imbalances and ensure the political acceptability of the decarbonization course.

On the industrial side, the low-carbon transition stimulates technological innovation and investment. European companies have already become global leaders in several “green” technologies (wind turbines, electrical

equipment, hydrogen electrolyzers). EU innovation programs (Horizon Europe, the ETS Innovation Fund, etc.) finance R&D in clean energy, thereby enhancing the competitiveness of industry in new segments of the global market. At the same time, traditional energy-intensive sectors face pressures—rising energy and carbon prices can temporarily reduce output. The task of policy is to offset these effects by supporting modernization and preventing the “leakage” of investment outside the EU. Thus, the decarbonization of the EU economy is inextricably linked with the energy transition and requires balanced social policies. If managed properly, the path to climate neutrality can become a source of economic opportunities, but it must take into account the interests of workers and regions so that the European Green Deal is both economically sustainable and socially just.

2.3 Development of Renewable Energy Sources and Reducing Dependence on Fossil Fuels

The European Union views the expansion of renewable energy sources (RES) as a key pathway to strengthening energy security and reducing dependence on fossil fuel imports. In recent years, the EU has accelerated the shift toward “clean” energy, especially in response to energy crises and geopolitical risks (such as the reduction of Russian gas supplies in 2022). The following section analyzes the achievements and persistent challenges in the RES sector, strategic plans for hydrogen, as well as the overall prospects and challenges of the EU’s energy transition.

The share of renewables in the EU’s final energy consumption continues to grow steadily. According to Eurostat, in 2023 this share reached 24.5%, compared to only about 9.6% in 2004. Thus, in less than two decades, the weight of RES has nearly tripled. The EU successfully achieved the 20% target by 2020 and continues to move forward: in 2023, a more ambitious plan was adopted—to reach 42.5% renewable energy by 2030 (up from the previous 32%), with an indicative upward revision to 45%. These targets reflect the EU’s determination to become climate neutral by 2050 and significantly reduce fossil fuel imports (Figure 4).

The achievements of individual EU member states vary considerably. As shown in Figure 4, the leader is Sweden, where about 66.4% of final energy consumption is provided by RES (thanks to the widespread use of hydropower, biofuels, and wind). Finland (50.8%) and Denmark (44.9%) have also achieved high levels, actively developing bioenergy, wind, and hydro resources. By contrast, in some countries the share of RES remains modest: for example, in Luxembourg it was only 11.6% in 2023, with

similarly low levels recorded in Belgium, Malta, and the Netherlands (around 12–15%). These differences are driven both by natural factors (the varying potential of hydro, wind, and solar energy) and by the pace of “green” technology deployment and government support.

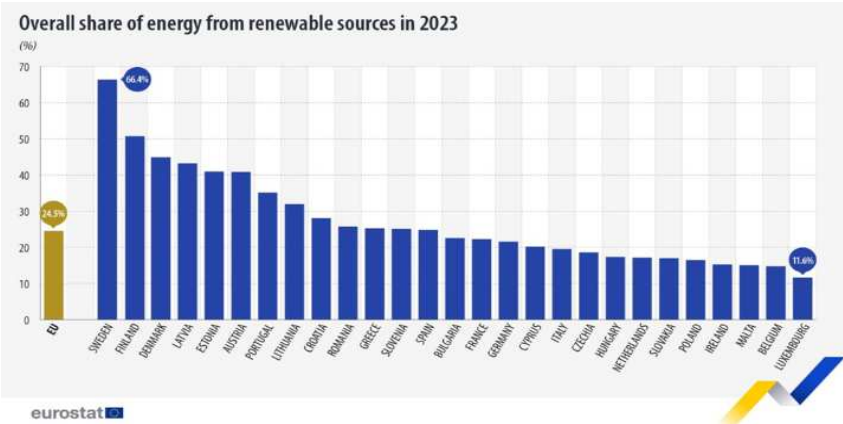


Figure 4. Share of Renewable Energy in EU Countries in 2023, % (EU average – 24.5%)

Barriers to RES development. Despite progress, the spread of renewable energy faces a number of obstacles. Research highlights several key categories of barriers:

1. Political and administrative – complexity and length of permitting procedures, regulatory instability. Long approval cycles slow down the construction of new solar and wind farms: in Europe, RES projects can take up to 10 years to implement due to complicated requirements and the need for approvals from multiple authorities. To accelerate the process, the European Commission recommends adopting a “one-stop shop” approach and simplifying rules without lowering environmental standards.
2. Infrastructure (grid-related) – the limited capacity of electricity grids to integrate intermittent energy sources. Many regions require grid upgrades and the construction of new lines to connect remote wind farms and solar plants. A shortage of grid infrastructure and energy storage capacity leads to curtailment: without significant scaling up of storage systems (e.g., large batteries or pumped hydro stations), it is difficult to ensure stability at high RES penetration levels.

3. Socio-economic – high upfront investment costs and limited access to capital, a shortage of qualified personnel, as well as local public resistance. Although the cost of wind and solar power generation has sharply declined over the past decade, project launches still require significant investments and robust supply chains. In some countries, there is a lack of specialists for the design, construction, and operation of RES facilities. In addition, cases of public opposition (the so-called NIMBY effect) against wind turbine installations or large solar plants can also slow down projects.

The identified barriers manifest in different combinations across EU member states. For example, in Central and Eastern European countries, the development of RES was until recently constrained by political priorities favoring coal and gas, whereas in states with limited territory (Malta, Luxembourg) the main obstacle is the shortage of sites for large-scale RES facilities. Awareness of these problems has led the EU to develop measures for overcoming them—streamlining permitting procedures, increasing investment in grids, and training personnel in the “green” sector.

Impact on energy security and energy costs. The shift to renewables brings not only environmental but also strategic benefits. Expanding RES diversifies energy supply and reduces dependence on external fossil fuel markets (primarily oil and gas). Thus, every additional megawatt-hour of solar or wind power reduces the need for imported gas, strengthening the EU’s energy independence. In 2022, the record deployment of new solar and wind capacity helped Europe mitigate the “gas shock” caused by the suspension of Russian supplies [15]. According to the International Energy Agency, without the new RES capacity wholesale electricity prices in the EU in 2022 would have been about 8% higher. Between 2021 and 2023, the additional renewable generation saved European consumers about €100 billion in total, preventing an even sharper spike in electricity prices. Another analysis shows that solar power growth alone in 2022 (+24% year-on-year) helped avoid gas purchases worth around €10 billion.

However, increasing the share of RES in the energy mix requires solutions to support system reliability. Renewable generation is weather-dependent, meaning that back-up capacity or storage is still required to cover demand during calm or cloudy periods. Insufficient preparedness for such situations can result in price spikes and energy shortages. A telling example was the 2021 energy crisis: due to unusually weak winds, Europe’s wind power generation fell, forcing the system to compensate by burning more gas and coal. As a result, electricity prices soared to record levels, and several energy-intensive industries had to cut production. This experience highlighted the importance of developing energy storage systems and

demand-side flexibility. In response, the EU is scaling up investments in batteries, hydrogen storage technologies, and the expansion of cross-border interconnections to ensure supply stability even with a very high RES share. Thus, the growth of renewable energy both strengthens the EU's energy security by reducing import dependence and places new demands on infrastructure and markets to maintain system reliability.

Hydrogen energy development outlook. "Green" hydrogen is an energy carrier that the EU plans to deploy at scale over the coming decades to decarbonize sectors that are difficult to electrify directly. In 2022, hydrogen accounted for less than 2% of Europe's energy consumption, and almost all of it was produced from natural gas (so-called "grey" hydrogen), accompanied by significant CO₂ emissions. The European Hydrogen Strategy, adopted by the European Commission in 2020, and the REPowerEU plan (2022) aim to radically change this situation. By 2030, the EU intends to establish annual production of 10 million tons of renewable (low-carbon) hydrogen and secure an additional 10 million tons from imports. This is a highly ambitious goal, given that current hydrogen consumption (mainly in the chemical industry) amounts to about 8–10 million tons per year and is almost entirely unmet by "green" hydrogen. By 2050, hydrogen is expected to supply up to 10% of the EU's total energy demand—primarily through its use in the steel and chemical industries, aviation, heavy transport, and other energy-intensive sectors where direct electrification is difficult.

Achieving these targets requires a rapid scale-up of hydrogen infrastructure. A sharp increase in electrolyzer capacity is planned: the target is 40 GW of total electrolyzer capacity in the EU by 2030 (compared with ~1–2 GW in 2020). According to the strategy, by 2024 EU countries must install at least 6 GW of new electrolyzers, and by 2030 at least 40 GW, enabling annual production of up to 10 million tons of "green" H₂. In the long term, the plan foresees the creation of an extensive hydrogen production network (including so-called Hydrogen Valleys—regional clusters of H₂ generation and consumption), as well as dedicated transport infrastructure—hydrogen pipelines and storage facilities integrated with the existing gas transmission system.

The EU has already adopted a package of regulatory changes (the 2023–2024 gas directive and related regulations) laying the foundation for the hydrogen market and infrastructure requirements. Several EU member states have put forward their own national hydrogen strategies to complement the EU-wide goals. For instance, Germany aims to produce 5 GW of renewable hydrogen by 2030 (and import significant volumes from abroad), France plans up to 6.5 GW of electrolyzer capacity, and the

Netherlands is betting on offshore wind power to generate hydrogen and establish hydrogen hubs in the ports of Rotterdam and Hamburg. Southern European countries (Spain, Portugal), thanks to abundant solar and wind resources, plan to produce surplus “green” hydrogen and export it to Central Europe (including through the planned H2Med pipeline to France).

Thus, by the end of the decade, a European hydrogen network could emerge, with production hubs on the Atlantic and North Sea coasts and consuming industrial clusters in Germany, the Benelux countries, Italy, and beyond.

Infrastructure and economic barriers. Such a massive hydrogen transformation is associated with serious infrastructure and economic challenges. The main problems of hydrogen energy development in the EU include:

- *High cost of “green” hydrogen.* Producing hydrogen through electrolysis requires large volumes of inexpensive renewable electricity. At present, the cost of hydrogen from RES (so-called “green” hydrogen) averages €5–6 per kg, significantly more expensive than conventional hydrogen from natural gas. Without additional support or carbon pricing, hydrogen products are not competitive in the fuel market. Further cost reductions in electrolyzers, cheaper renewable electricity, and the development of subsidy schemes (such as the Hydrogen Bank—an EU fund supporting the first large-scale renewable hydrogen deals) are needed.

- *Lack of infrastructure.* There is virtually no extensive infrastructure for hydrogen transport and storage. Existing gas pipelines need retrofitting for hydrogen (or new pipelines built from hydrogen-resistant materials). Large storage facilities (e.g., salt caverns) are also required to balance seasonal fluctuations in H₂ production and consumption. Hydrogen refueling infrastructure for transport is still in its infancy: across the EU, there are only a few hundred hydrogen refueling stations, whereas thousands will be needed for widespread adoption of hydrogen buses, trucks, and trains. Creating this entire system will require coordination among countries and investment amounting to hundreds of billions of euros.

- *Underdeveloped demand and market risks.* Demand for hydrogen energy carriers remains limited. Industrial companies are cautious about planning a switch to H₂, given its price and uncertainty of availability. According to Breakthrough Energy analysis, less than 5% of the EU’s target hydrogen consumption for 2030 has been secured by contracts (only about 0.9 million tons of low-carbon H₂ contracted by consumers). The lack of guaranteed demand undermines project economics: investors are uncertain whether produced hydrogen will find buyers at a viable price. To address this problem, the EU is introducing mandatory quotas for the use of

renewable hydrogen in certain sectors (e.g., replacing at least 50% of the hydrogen consumed by refineries and ammonia plants with “green” hydrogen by 2030, and adding at least 2.6% hydrogen-based fuels into transport fuels). Nevertheless, creating a full-fledged hydrogen market is a complex task, requiring synchronous development of both supply and demand.

- *Competition and technological challenges.* The hydrogen sector is developing not only in Europe but globally. For example, the United States has adopted an unprecedented subsidy package (Inflation Reduction Act, 2022) providing tax credits for “green” hydrogen producers of up to \$3/kg, attracting investors and potentially making U.S. hydrogen cheaper than European hydrogen. In China, mass production of electrolyzers is expanding, with current costs 50–70% lower than Western equivalents, albeit with somewhat lower efficiency. European companies must compete in this arena, maintaining their technological edge (e.g., more efficient membrane electrolyzers) while simultaneously striving to cut costs. Another challenge is access to raw materials: electrolyzers require platinum, iridium, and other rare elements, for which global demand is rising, forcing the EU to compete for resources with other regions.

Given these challenges, independent experts warn that achieving the hydrogen targets by 2030 will not be easy. In 2024, the European Court of Auditors (ECA) issued a special report, calling the target of producing 10 million tons of renewable hydrogen by 2030 “excessively ambitious” and demanding a “sober assessment” of realistic capabilities. The auditors noted that at the current pace of development and with the missing infrastructure links, the EU is unlikely to meet the set benchmarks within the designated timeframe. The European Commission, for its part, acknowledges the scale of the problems but remains optimistic, pointing to the measures being undertaken (funding of innovations through the Innovation Fund, large Important Projects of Common European Interest – IPCEI, the creation of the European Hydrogen Alliance, etc.).

At the end of 2023, the so-called European Hydrogen Bank was established at the EU level – a mechanism for subsidizing the cost gap between “grey” and “green” hydrogen, designed to stimulate the first major transactions and launch the H₂ market.

Export potential of hydrogen technologies. The EU’s hydrogen strategy is important not only in terms of domestic energy policy but also as an opportunity to gain leading positions in a new global industry. European companies have traditionally been strong in hydrogen energy technologies – in particular, the EU is home to 9 of the world’s 15 largest electrolyzer manufacturers. By combining industrial initiatives and R&D support,

Europe plans to scale up equipment production: the Electrolyser Partnership under the European Clean Hydrogen Alliance was created, whose participants committed to raising the combined electrolyzer production capacity in Europe to 17.5 GW per year by 2025.

According to experts, the global market for electrolysis technologies and related equipment could reach €50 billion by 2030, and European industry aims to capture a significant share of this market. This will open up opportunities for exports: the EU will be able to supply other countries with equipment (electrolyzers, fuel cells, compressors, materials) and engineering services related to hydrogen. In addition, the development of the domestic hydrogen market will allow European companies to refine advanced solutions that can later be applied worldwide. For example, H₂ storage technologies, hydrogen turbines for power plants, and transport solutions (hydrogen trains, trucks) – in all these areas, pilot projects are being implemented in the EU, laying the groundwork for future exports.

Some EU countries are already aiming to become net exporters of hydrogen itself: Spain and Portugal plan to produce hydrogen in excess of their domestic needs and export it to Central Europe and beyond (with routes under consideration to North Africa and the Middle East). However, in the medium term, it is more likely that the EU will remain a major importer of hydrogen (to meet industrial demand), while the export product will be technology and industrial equipment. By setting standards and investing in innovation now, the European Union seeks to strengthen its technological competitiveness in the hydrogen sector and secure a leading role in the emerging global hydrogen economy.

The large-scale transition to renewable energy sources and electric transport entails a sharp increase in demand for a number of critical materials – lithium, cobalt, nickel, copper, as well as rare earth elements (neodymium, dysprosium, terbium, etc.). These metals are essential for the production of wind turbines (permanent magnets in turbines), solar panels (various rare metals for photovoltaic cells), batteries for electric vehicles and energy storage systems, power electronics, and electric grids. According to estimates by the European Commission, demand for rare earth elements and other key minerals will grow exponentially as fossil fuels are phased out and the shift to clean energy accelerates.

At the same time, the extraction and processing of many such materials are geographically concentrated outside the EU. For instance, EU countries are almost entirely dependent on imports of rare earth metals from China, which controls over 90% of their global processing. This situation creates new risks for energy security: dependence not on oil and gas, but on supplies of critical raw materials, without which “green” energy is

impossible. The European Union recognizes this problem and is taking steps to mitigate it.

In 2023–2024, the EU developed the Critical Raw Materials Act, aimed at diversifying supply sources and developing its own resource base in Europe. The document sets quantitative targets for mining, processing, and recycling of important minerals: by 2030, at least 10% of annual EU consumption of critical materials should come from domestic mining, at least 40% should be processed in European facilities, and up to 15% should be met through secondary use (recycling). For rare earth elements in particular, the goal is to establish a full cycle from mining to magnet production within the EU. First progress is already visible: a major rare earth deposit has been discovered in Sweden, projects to manufacture magnets are underway in Estonia and France, and recycling of lithium batteries is expanding.

Nevertheless, the raw materials challenge cannot be resolved quickly – the launch cycles for mining projects are measured in years, while global competition for resources is intensifying. In the coming years, the EU is likely to combine import strategies (by concluding supply partnerships for critical materials with friendly countries in Africa, North America, and Australia) with strengthening domestic capacities and seeking substitutes (e.g., moving to magnet-free generator technologies or batteries with lower concentrations of scarce metals). Successfully addressing the raw materials issue will be a necessary condition for the sustainability of the energy transition and Europe’s technological independence.

Natural gas has traditionally played an important role in the EU energy system, not only as a source of heat and electricity but also as a flexible reserve that can be quickly deployed during peak demand or low renewable generation. A complete phase-out of gas without an equivalent replacement of its functions poses risks to the reliability of energy supply. The main threat is capacity shortages and balancing issues during periods when renewable sources cannot meet the load (for example, prolonged calm periods with little wind, or winter with minimal solar and wind generation – a situation known in Germany as *Dunkelflaute*). If by then all gas (and coal) power plants are prematurely shut down, the energy system may face a shortage of backup generation, leading to rolling blackouts or the need for emergency energy imports at any cost.

Recent years’ experience confirms this vulnerability. In addition to the 2021 case of low wind output, the winter of 2022–2023 saw Europe on the verge of energy shortages due to the simultaneous occurrence of several factors: a sharp reduction in gas supplies, extremely low hydropower generation (due to drought), and a significant share of nuclear capacity

offline (planned maintenance and problems at French NPPs). Nevertheless, increased renewable generation and reduced demand helped Europe get through this period without blackouts. This case demonstrated that the energy transition must be accompanied by the development of balancing mechanisms.

If gas-fired capacity is phased out, it must be replaced by either other flexible low-carbon plants (e.g., fast-ramping hydrogen or biogas power stations), significant energy storage capacity, or demand response mechanisms – i.e., consumer demand management to smooth peaks. Experts agree that energy storage systems are critically important for balancing the growing share of renewables and maintaining the reliability of energy supply.

The EU has already set targets for the deployment of battery storage: for example, it plans to reach an installed capacity of around 200 GW of electricity storage by 2030 (including pumped hydro storage). The concept of using electric vehicles as a distributed storage system is also being developed (Vehicle-to-Grid technology, which allows EV batteries to feed energy back into the grid during peak demand hours).

Another safeguard mechanism is international interconnections: the integration of EU countries' power systems enables capacity sharing—excess renewable generation in one country can offset shortages in another. Thus, the phase-out of natural gas as an energy source must inevitably be accompanied by a set of measures preventing reliability crises. The EU is gradually implementing this package—ranging from investments in storage and smart grids to the creation of a strategic gas reserve for the transition period. In the long term, “green” hydrogen and synthetic methane, stored in large volumes and used during extreme periods, may serve as insurance. Provided such solutions are introduced in time, the energy transition can proceed without compromising energy security. However, the transitional period requires extremely careful planning to ensure the EU energy system remains resilient even with a minimal share of fossil fuels.

Impact of the transition on the structure of the EU energy system. The shift to renewables is not limited to replacing some energy sources with others—it entails a deep structural transformation of the entire energy system. Traditional energy was built on a vertical principle: each sector of final consumption was largely tied to a specific type of fuel (e.g., transport to oil products, power generation to coal, gas, and nuclear, heating to gas or fuel oil). In a climate-neutral economy, these boundaries are blurred due to sectoral integration. Electricity becomes the main energy carrier, linking different industries.

Electrification growth is one of the key trends: more and more processes are being converted to electricity directly (transport electrification via EVs, heating electrification via heat pumps, electrification of industrial processes). By 2050, the share of electricity in the EU's final energy consumption may reach 50% (compared to ~20–25% in 2020), indicating a fundamental restructuring of the energy balance in favor of electricity. At the same time, subsystems are becoming interconnected: excess renewable electricity can be converted into other energy carriers (e.g., hydrogen via electrolysis) and then used in sectors where direct electrification is difficult. For instance, in transport, alongside direct electrification of passenger vehicles, renewable synthetic fuels (e-fuels) made from hydrogen are being developed for aviation and shipping.

As a result, a more flexible and interconnected system is emerging, where different types of energy complement one another. The old boundaries between sectors are dissolving: electricity, heating, transport, and industry merge into a unified energy complex operating as a whole.

Structural changes also affect the topology of the energy system itself. Decentralization of generation is increasing: instead of a small number of large CHP plants and NPPs, there are thousands and millions of distributed sources—from large wind farms to household rooftop solar panels. Consumers are turning into prosumers, able not only to take energy from the grid but also to feed in excess self-generated power. This requires the introduction of smart grids and digital control systems capable of coordinating bidirectional energy flows. Across Europe, smart meters and automated dispatch systems are already being deployed, and flexibility markets are developing, where consumers are rewarded for shifting loads over time. Without digitalization, the efficient operation of such a complex system would be impossible.

In addition, cross-border interconnections between EU countries are being strengthened. The integrated European energy market helps smooth out local surges and drops in renewable generation by enabling electricity trade across borders. For example, excess wind generation in Northern Germany can be transmitted to Poland or the Czech Republic during their shortages, and vice versa. The EU is investing in expanding the capacity of cross-border power lines and harmonizing electricity market rules.

The ultimate goal is to create a resilient pan-European energy system capable of operating reliably with a high share of renewables.

In conclusion, the transition to RES fundamentally changes the architecture of the EU energy system. It becomes more decentralized, cross-sectorally integrated, and digitalized. The electricity grid turns into the

backbone of the entire system, linking production, storage, and consumption of energy in all its forms.

The introduction of energy storage systems and demand-side management enhances the flexibility and resilience of the grid. At the same time, the requirements for reliability and cybersecurity of such a complex infrastructure are increasing. The EU is placing emphasis on innovation and policy coordination to ensure that this new energy system meets the criteria of reliability, affordability, and sustainable development. The transition period already demonstrates both advantages (reduced emissions, decreased energy dependence) and new challenges (resource constraints, the need for investments in grids and storage). Nevertheless, Europe's strategic course remains unchanged: by the middle of the 21st century, to build a modern "green" energy system capable of guaranteeing energy security and the long-term competitiveness of the EU's economic development.

2.4 Circular Economy: EU Strategies for Waste Reduction and Efficient Resource Use

The transition to a circular economy in the European Union aims to drastically reduce waste generation and ensure more efficient use of resources. Unlike the traditional linear model of "produce–use–dispose," the circular model seeks to preserve the value of materials for as long as possible through reuse, repair, and recycling. The EU is consistently implementing strategies and policies to encourage waste prevention, increase recycling rates, and return secondary resources into the economy. Below are the main EU initiatives in this field, practices of separate collection and recycling in Member States, as well as measures to combat plastic pollution.

The European Union is a global leader in shaping circular economy policy. The key framework document is the EU Waste Framework Directive, which establishes a waste management hierarchy giving priority first to waste prevention, then to reuse, recycling, other recovery methods (e.g., energy recovery), and only as a last resort to landfilling. This hierarchy is reflected in all EU waste strategies. Between 2015 and 2018, the Circular Economy Package was adopted, which included revisions of several directives (on waste, packaging, and landfilling) and introduced new binding targets. For example, it set a mandatory municipal waste recycling rate of at least 55% by 2025 (increasing to 60% by 2030 and 65% by 2035), while the share of waste sent to landfill must be reduced to no more than 10% by 2035.

At the same time, requirements for extended producer responsibility (EPR) were introduced to encourage the collection and recycling of categories such as packaging, electronics, and batteries. The revised Landfill Directive also imposes significant restrictions, forcing countries to decrease landfill volumes, which is particularly important for lagging regions of Europe.

It is also important to note that in 2020 the European Commission adopted the New Circular Economy Action Plan (CEAP) as part of the European Green Deal. This plan addresses the entire product life cycle—from eco-design, product life extension, and the promotion of rental/service models instead of ownership, to the creation of secondary materials markets and waste prevention. In particular, the plan provides measures for resource-intensive sectors (electronics, batteries, packaging, plastics, textiles, construction, etc.), and emphasizes the goal of “ensuring less waste” and keeping resources in the economy for as long as possible. Under this plan, in 2022, policy frameworks for bioplastics and biodegradable materials were developed, and the circular economy monitoring system was updated with new indicators (e.g., material footprint, resource productivity).

An important role is played by specific EU legislative initiatives on waste. For instance, the Packaging and Packaging Waste Directive sets progressively increasing recycling targets for packaging (e.g., at least 70% by 2030), encouraging a shift towards recyclable and reusable packaging types. The Waste Shipment Regulation tightens controls on the export of waste from the EU, preventing the transfer of poorly recyclable materials abroad.

The EU Plastics Strategy (2018) for the first time introduced the goal of ensuring that all plastic packaging is recyclable by 2030 and of reducing the use of single-use plastics. The subsequent Directive on Single-Use Plastics (2019/904) established a ban on a number of disposable plastic items (plates, cutlery, straws, cotton buds, etc.), which entered into force in July 2021.

To reduce food waste, the EU has committed to achieving the UN target of halving food waste by 2030; legally binding targets for reducing food waste at the Member State level are expected to be introduced. Many EU countries are already implementing national waste prevention programs. For example, France adopted a Circular Economy Law, which prohibits the destruction of unsold goods and promotes product reparability.

The circular economy policy has a significant impact on EU industry. On the one hand, the strengthening of environmental standards stimulates innovation – the development of recycling technologies, new materials, and business models. Industrial companies are shifting to product design with

long lifespans and recyclability in mind, introducing Product-as-a-Service models, whereby goods are leased and then returned to the manufacturer for upgrading or recycling. For example, electronics and household appliance producers in Europe are expanding programs for collecting used products for remanufacturing components. The automotive industry is establishing plants for the refurbishment and reuse of vehicle parts (in France, Renault has created the first “circular” plant for the repair and reuse of car components).

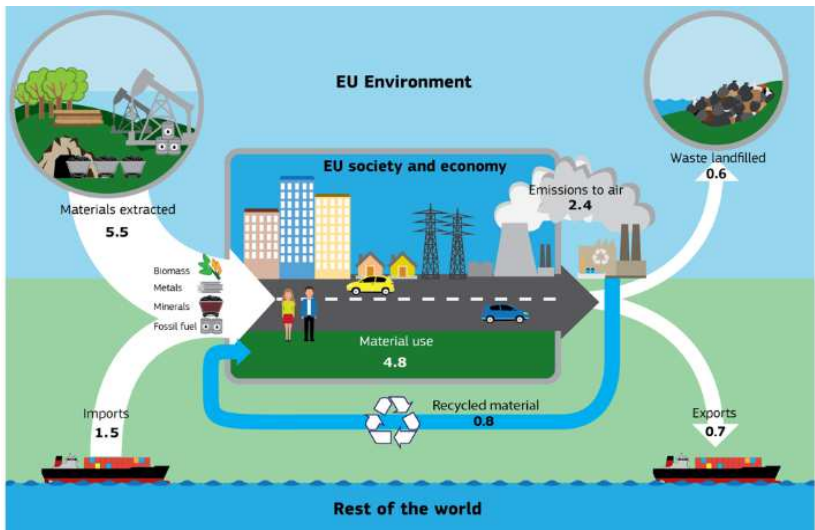


Figure 5. Material flows in the EU economy (2023), billion tonnes per year
 Note - compiled from the source Eurostat

On the other hand, compliance with regulations requires businesses to invest in modernization and may increase costs in the short term. Nevertheless, in the long run, the circular economy promises economic benefits: according to the European Commission, a 2% increase in resource productivity could create up to 2 million new jobs in the EU by 2030, while the transition to a closed-loop economy could boost EU GDP by approximately 0.5%. Moreover, reducing dependence on raw material imports strengthens the resource security of EU industry.

A striking example is the practice of industrial symbiosis: in the Danish city of Kalundborg, for several decades a cluster of enterprises from different industries has been operating, where the waste of one production

process serves as raw material for another. This Kalundborg Symbiosis project annually recycles around 62,000 tonnes of by-products and saves about 0.59 million tonnes of CO₂ emissions, serving as a model of a closed industrial cycle. Thus, the EU's strategic course towards a circular economy is transforming the industrial sector, turning environmental requirements into a driver of technological development and competitiveness.

Waste management practices and recycling rates vary considerably across EU countries, although overall there is positive progress. In 2004, the average recycling rate of municipal waste in the EU-27 was around 31%, and by 2021 it had reached nearly 50%. However, the gap between leaders and laggards remains large. Germany recycles about 69–70% of municipal waste – the highest figure in Europe. Austria (~62%) and Slovenia (~61%) are close to this level. Several other countries (the Netherlands, Belgium, Luxembourg, Switzerland, Italy) have achieved recycling rates above 50%.

At the other extreme are countries where landfilling still dominates: Romania recycles only about 11–12% of municipal waste, while Malta, Greece, and Cyprus recycle less than 20%. In 2023, the European Commission even identified 18 EU Member States at risk of failing to meet the 55% recycling target by 2025. These differences are partly due to historical reasons and investment levels: Northern and Central European states introduced separate collection and recycling infrastructure earlier, whereas some newer EU members previously relied on cheap landfilling. Nevertheless, even lagging countries are making progress – for example, Latvia, Lithuania, and Slovenia increased their recycling shares by more than 40 percentage points between 2004 and 2022 thanks to reforms in waste collection systems.

High recycling performance can be achieved through a comprehensive approach that combines mandatory separate waste collection, economic incentives, and modern technologies. In most EU countries today, a multi-fraction collection system is in place: households separate waste into at least the following groups – paper/cardboard, glass, plastics/metals (packaging), biodegradable waste, while the remaining mixed “residual” waste is sent either for incineration or landfill disposal. The separate collection of organic waste (biowaste) became an EU-wide requirement in 2023 under the revised Waste Framework Directive. However, frontrunners implemented these practices much earlier: for instance, Ljubljana (Slovenia) began separate collection of major fractions as early as 2002, and since 2006 has organized citywide doorstep collection of biowaste, becoming the first European capital to declare itself a “zero waste” city. As a result, Ljubljana's recycling rate rose from 29% in 2008 to 68% in 2019, making it the EU leader among capitals.

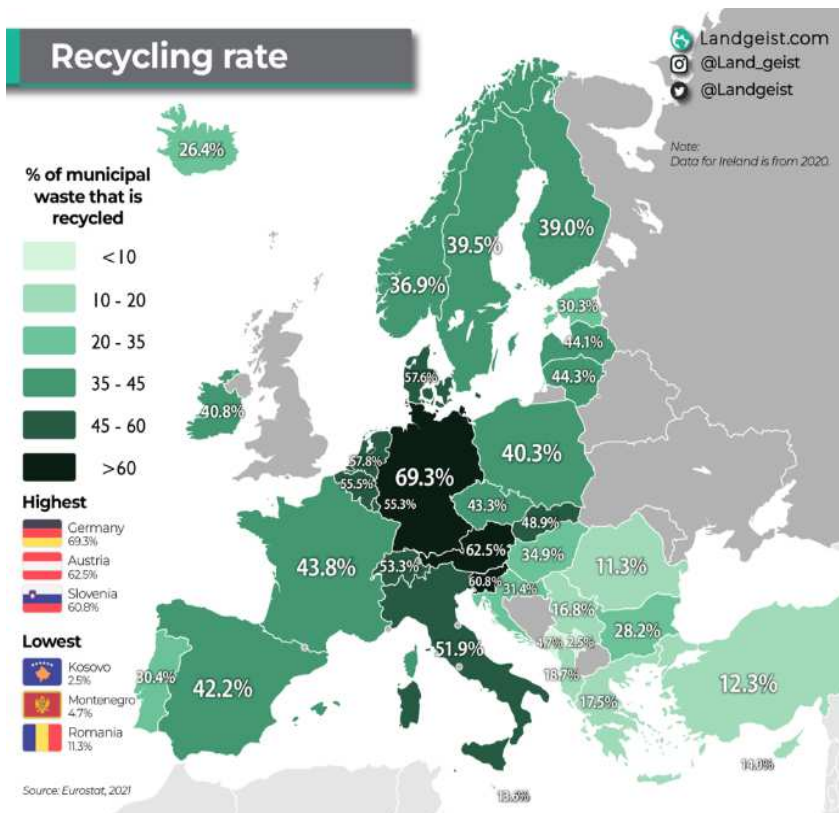


Figure 6. Share of municipal waste recycling by European countries (% , Eurostat data for 2021)

Dark green indicates the leaders (Germany 69.3%, Austria 62.5%, Slovenia 60.8%), light shades – countries with low recycling rates (e.g., Romania 11.3%).

Note - Landgeist based on Eurostat data, landgeist.com

Mandatory citizen participation is reinforced by the “pay-as-you-throw” principle: in Ljubljana and several Italian cities, waste collection fees depend on the volume of unsorted refuse, which economically motivates households to separate recyclables more effectively. In high-performing countries, deposit return systems are also widespread (all Nordic countries, Germany, the Baltic states) – automated reverse vending machines ensure

the collection and recycling of the majority of plastic and metal beverage containers.

Technological solutions play a key role in improving recycling efficiency. Modern sorting facilities are equipped with optical sorters, magnetic and eddy-current separators, which automatically divide mixed waste into plastics by type, metals, paper, glass, etc. In Austria, Germany, and France, advanced plastic sorting plants have been built that separate up to 10–15 individual polymer fractions for recycling. The development of chemical recycling (pyrolysis, depolymerization) makes it possible to return problematic plastic waste, unsuitable for mechanical recycling, back into circulation. In areas with high waste volumes, integrated waste treatment plants are being constructed: for example, the RCERO complex in Ljubljana combines mechanical-biological treatment – biowaste is composted and anaerobically digested to produce biogas, while up to 95% of recyclable materials are automatically extracted from residual mixed waste.

The non-recyclable remainder is increasingly used for energy recovery: Waste-to-Energy plants (incineration with energy generation) are replacing landfills as a disposal method in a number of countries (Denmark, Sweden, Belgium have virtually eliminated landfilling of unsorted waste).

The contribution of digital technologies to improving waste management efficiency should also be highlighted. The “smart cities” concept is being extended to waste management: intelligent bins with fill-level sensors transmit real-time data to municipal services. This allows optimization of collection routes, reducing fuel consumption and CO₂ emissions. The collection and analysis of big data on waste generation help cities plan infrastructure – for instance, identifying where additional recycling points are needed. Recycling facilities are beginning to use artificial intelligence algorithms and robotics to identify and sort waste by image recognition, improving the purity of separated fractions. According to expert assessments, digitalization can accelerate the transition to a circular economy by increasing transparency in supply chains and engaging consumers: the development of item-exchange applications, rental platforms, and sharing services all help to reduce waste generation at the consumption stage.

Thus, the combination of advanced collection, sorting, and recycling technologies with digital management solutions enables European countries to increase recycling rates and move closer to circularity targets.

Plastic waste poses a particular challenge for the EU due to its enormous volume and persistence in the environment. The strategy to reduce plastic pollution has become an integral part of circular economy policy. First and

foremost, the EU introduced restrictions on single-use plastics. Under Directive (EU) 2019/904, since July 2021 the sale of certain single-use plastic items for which affordable alternatives exist has been prohibited across all Member States. The ban covers disposable plastic plates and cutlery, drinking straws, balloon sticks, cotton swabs, as well as containers and cups made of expanded polystyrene and oxo-degradable plastics.

For other products (such as single-use plastic cups and food containers), consumption reduction measures were introduced – national governments apply economic instruments (environmental charges, consumer fees) and requirements to provide reusable alternatives. These steps are already having an impact: according to the European Commission, demand for some banned items (such as plastic cotton swabs) has virtually disappeared, while businesses are rapidly shifting to paper, wooden, and other alternatives.

Earlier, Directive 2015/720 on reducing the consumption of lightweight plastic carrier bags was adopted, leading most countries to introduce charges or ban the free distribution of thin bags in shops – this reduced the average consumption of plastic bags per capita in the EU from ~200 per year to 90 (the target level) or less.

The restriction of single-use plastics is accompanied by the development of reuse infrastructure: in several EU cities, systems of reusable beverage cups and refill stations for liquid products (detergents, beverages) are gaining popularity, supported by legislative initiatives (the proposed 2022 EU Packaging Regulation requires minimum shares of reusable containers in the food service and retail sectors).

At the same time, the EU is investing in the development of biodegradable and bio-based materials as substitutes for traditional plastics. In 2022, the European Commission presented a Policy Framework for Bioplastics, defining the conditions and applications for such materials to ensure environmental benefits. Biodegradable plastics (e.g., based on polylactic acid – PLA, or polyhydroxyalkanoates – PHA) are intended for strictly targeted use – where collection and recycling are difficult and the product is likely to end up in the environment (e.g., in agriculture, or in certain types of packaging). The EU stresses that bioplastics are not a panacea: they degrade only under specific conditions (in industrial composting at high temperatures) and should not give the false impression of harmlessness. Nevertheless, the development of compostable materials for food packaging, disposable tableware, and biowaste bags is a promising direction.

In some countries (Italy, France), the use of biodegradable bags for organic waste collection is already legally mandated, simultaneously

addressing the task of bio-waste collection and reducing conventional plastics. In addition, the production of bio-based polymers from renewable raw materials (corn, sugarcane, cellulose) is increasing – although they are not always biodegradable, their life cycle may have a smaller carbon footprint. The EU funds research projects on new materials – from edible seaweed-based films to mushroom mycelium packaging – which could in the future replace hard-to-recycle plastic products.

Finally, special attention is given to the problem of microplastics – invisible plastic particles (<5 mm) that accumulate in aquatic ecosystems and food chains. Research has found microplastics in the world's oceans, freshwater, marine organisms, and even in human food and drinking water. In response, the EU has taken pioneering regulatory measures: since 2018, microplastics (microbeads) in rinse-off cosmetics and cleaning products (scrubs, exfoliants, etc.) have first been voluntarily, and later legally, banned.

In 2023, a comprehensive restriction on intentionally added microplastics entered into force. Under Regulation (EU) 2023/2055, from October 2023 the sale of products containing synthetic polymer microparticles is prohibited in the EU market (covering, for example, glitter, microplastic additives in paints, fertilizers, encapsulated microbeads in detergents, etc.), with phased transition periods for different categories of products.

Work is also underway to reduce unintentional sources of microplastics: standards are being developed for capturing microfibrils from washing machines, and environmental requirements for tire products (a source of microparticles through tire wear) are being tightened. Within the framework of the EU Zero Pollution Action Plans and water protection measures, requirements are being introduced for equipping urban wastewater treatment plants with finer filters capable of removing microplastics from effluents. At the same time, research is being funded on the effects of microplastics on human health and on methods for cleaning the environment from already accumulated particles.

To illustrate innovative approaches in tackling plastic waste, several successful pilot projects can be cited. In the Netherlands, the PlasticRoad project was implemented – in the city of Zwolle, a 30-meter cycling path made entirely of recycled plastic was opened in 2018. The road surface is assembled from modular sections containing the equivalent of ~218,000 discarded plastic cups, and according to engineers' estimates, it lasts 2–3 times longer than conventional asphalt. Moreover, it is equipped with sensors for condition monitoring, while its hollow sections allow rainwater

drainage. This pilot project clearly demonstrates the potential for secondary use of plastics in infrastructure.

Another example is the Ocean Cleanup initiative, supported in part by the EU, which is testing barrier systems to collect floating plastics in the Pacific Ocean and at river estuaries. The collected plastic is then recycled; for instance, it has already been used to produce sunglasses as a demonstration product.

Within the EU itself, projects to remove microplastics have also been launched: in some coastal cities (Antwerp, Rotterdam), special filters and mesh traps are being tested on stormwater drains to capture plastic pellets washed off from urban areas.

In conclusion, the EU strategy for waste and resource management represents a comprehensive approach, combining strict regulatory restrictions (such as bans on problematic types of waste), economic incentives, support for innovation, and the exchange of best practices among Member States. Successful examples – from high recycling rates in Germany and Slovenia to innovative projects such as Denmark’s industrial symbiosis or the Dutch PlasticRoad – highlight the potential of the circular economy transition. The implementation of circular economy principles enables the EU not only to reduce the environmental burden of waste but also to reap benefits in terms of job creation, technological development, and enhanced resource independence. This confirms that the circular economy is one of the key elements of sustainable development in Europe.

2.5 Protection of Biodiversity and Restoration of Natural Ecosystems in the EU

The European Union (EU) pursues a comprehensive approach to halting biodiversity loss and restoring ecosystems, which constitutes an integral part of the European Green Deal. In 2020, the EU Biodiversity Strategy for 2030 was adopted, aimed at bringing nature back into people’s lives. The Strategy provides for the expansion of the network of protected areas, the restoration of degraded ecosystems, as well as the reduction of air and water pollution to levels safe for ecosystems. At the same time, the New EU Forest Strategy for 2030 is being implemented, intended to ensure sustainable forest management, increase forest cover, and counteract deforestation. Particular attention is devoted to the issue of environmental pollution: within the framework of the “Zero Pollution” concept, the EU is tightening air and water quality standards and restricting the use of hazardous chemicals. The following section considers the key directions of

these environmental efforts, supported by relevant data, project examples, and analytical evidence.

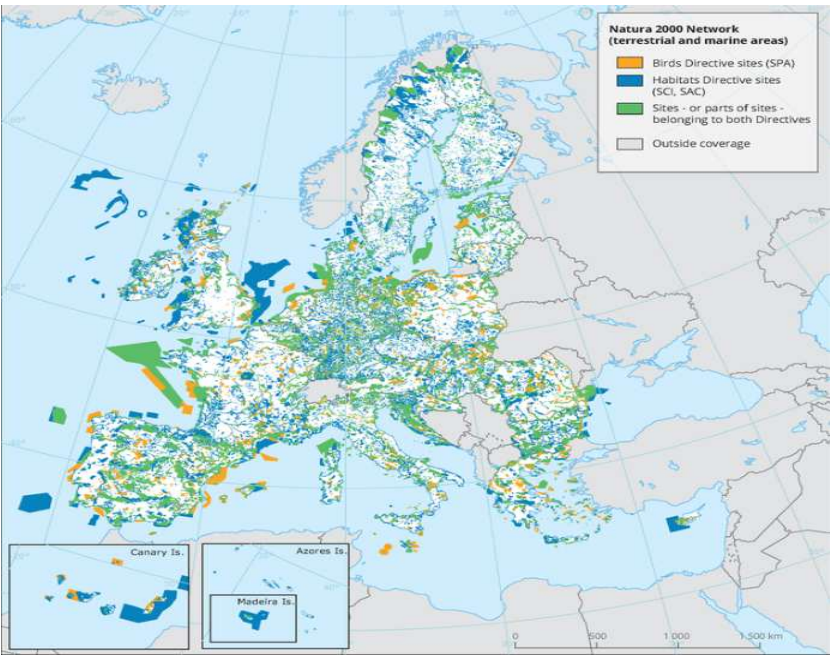


Figure 7. Map of the Natura 2000 network in Europe (terrestrial and marine sites)

Expansion of the NATURA 2000 network. The core of the EU nature conservation policy is the NATURA 2000 network, the largest coordinated network of protected areas worldwide. By 2022, it covered approximately 18% of the EU’s land territory and 7–8% of its marine areas. The Biodiversity Strategy for 2030 sets the objective of placing under legal protection at least 30% of the Union’s land and 30% of its sea territory by 2030, of which one third (10% of EU territory) should be subject to strict protection. To achieve this objective, Member States are required to expand both the NATURA 2000 network and their national protected areas. The European Commission has published criteria and methodological guidelines for designating new protected sites, aimed at ensuring scientifically grounded and coherent network expansion. For example, in Spain, France and other Member States, programmes are being implemented to increase

the share of protected land in line with this pan-European objective. As a result, by 2023 the total area of newly designated marine protected zones and biotopes had considerably increased. The expansion of protected natural areas is directed towards conserving key species and habitats, as well as establishing an ecologically coherent pan-European “green infrastructure”.

Protection of marine and freshwater ecosystems. The Biodiversity Strategy places particular emphasis on marine ecosystems and inland waters. Among its targets are the designation of 30% of marine areas as protected by 2030 and the strict protection of 10% of marine territory. This requires the creation of new marine reserves and effective management of existing ones, including restrictions on fishing in particularly sensitive areas. Thus, in 2023 the establishment of a network of marine protected areas in the waters of the Baltic, North, and Mediterranean Seas was announced, aimed at restoring fish stocks and protecting the habitats of marine mammals.

For freshwater bodies, the central instrument is the EU Water Framework Directive, which requires the achievement of “good” ecological status for rivers and lakes. However, at present only about 37% of Europe’s surface water bodies are in satisfactory ecological condition, and around 29% have good chemical status, which indicates that the Directive’s targets are not being met in most countries. The main causes include diffuse pollution from agricultural runoff, hydromorphological alterations (dams, regulated flow), and outdated infrastructure. In response, the EU has launched initiatives to restore rivers and wetlands. The Action Plan envisages returning at least 25,000 km of rivers to free-flowing status by 2030, primarily by removing obsolete hydraulic structures and restoring floodplains. Projects to dismantle small dams are already being implemented: for example, in France, Spain, and Finland, dozens of barriers have been removed in recent years, enabling the restoration of fish migration (salmon, eel, etc.) and natural river self-purification.

At the same time, wastewater treatment is being improved: over 90% of urban wastewater in the EU is now collected and treated in accordance with EU standards, which has significantly reduced the inflow of organic pollution and nutrients into rivers. As a result of these integrated measures, water quality for the population has also improved. Bathing waters are indicative in this respect: according to the EEA report, in 2023 85.4% of EU beaches and recreational zones had “excellent” water quality, and 96% met minimum standards, reflecting success in reducing microbiological pollution.

Restoration of natural landscapes. The EU Biodiversity Strategy 2030 includes an ambitious Nature Restoration Plan, providing for large-scale

rehabilitation of degraded ecosystems – from forests and grasslands to wetlands and coastal dunes. In 2022, the European Commission proposed the first-ever regulatory act of this kind – the EU Nature Restoration Regulation, which sets legally binding targets to restore at least 20% of EU territories by 2030, with the prospect of extending restoration measures to all ecosystems in need of assistance by 2050.

This initiative sets quantitative targets: for example, planting 3 billion additional trees by 2030 (in line with the principle “the right tree in the right place”), restoring large areas of peatlands and floodplains, and reintroducing pollinators into agricultural landscapes. Numerous projects supported by EU funds (the LIFE programme and others) are already being implemented to remediate landscapes. In particular, the LIFE Peat Restore project (2016–2021) enabled the restoration of ~5,300 hectares of degraded peatlands in five countries (Germany, Poland, Latvia, Lithuania, and Estonia) through rewetting. This not only preserved rare peatland ecosystems but also enhanced carbon sequestration.

Another example is the transboundary initiative for the rehabilitation of Carpathian wildlife: within the framework of the Carpathian Convention and rewilding projects, habitat connectivity for large carnivores (brown bear, wolf, lynx) has been ensured, wildlife corridors for animal migration introduced, and the last old-growth forests of the Carpathians placed under protection. For instance, in Slovakia alone the project preserved 6,500 hectares of ancient forests, significantly reduced bear and wolf mortality on roads, and stimulated ecological tourism in rewilding areas.

These examples confirm that the restoration of natural landscapes produces a dual effect – the return of biodiversity and the strengthening of ecosystem services (flow regulation, CO₂ sequestration, recreation), which in the long term benefits both society and the economy.

EU policy on forest restoration. Forests cover a significant part of Europe (~39% of the EU territory in 2022), and their area is gradually expanding. The increase in forest cover is largely the result of reforestation measures and natural regeneration on abandoned agricultural land. The New EU Forest Strategy for 2030, adopted in 2021, aims to further expand forest areas and improve their condition in the interests of climate and biodiversity. The Strategy emphasizes the need to plant new forests and restore lost ones – in connection with climate objectives (enhancing CO₂ sequestration) and biodiversity conservation goals. In particular, this initiative complements the target of planting 3 billion additional trees by 2030, as outlined in the Biodiversity Strategy.

A number of Member States have developed national reforestation plans. For example, Ireland has announced a programme to plant 440

million trees by 2040 – approximately 22 million seedlings annually – in order to increase forest cover and offset greenhouse gas emissions. Finland and Sweden (where forests cover 63–66% of the territory) are actively introducing sustainable forest management practices while simultaneously conserving old-growth forests.

Thanks to the efforts of recent decades, the EU’s forest resources have shown steady growth: the volume of timber in standing forests increased by ~32% between 2000 and 2020. This demonstrates that increment (both natural and through planting) exceeds timber removal. Nevertheless, the Strategy stresses that it is not the quantity but the quality of forests that is of decisive importance. Therefore, at the EU level, the principles of close-to-nature (non-exhaustive) forestry practices are being promoted, along with the increase of mixed and climate-resilient stands, and the restoration of forest ecosystems (wetlands, forest lakes, forest edges) in order to support biodiversity.

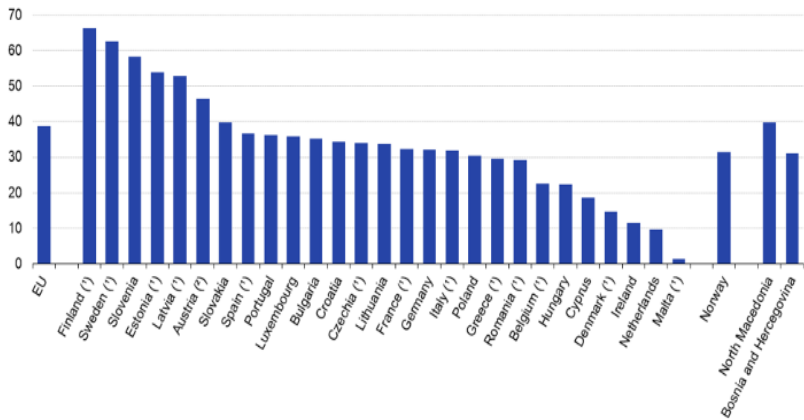


Figure 8. Share of forest in the land area of EU countries (estimate for 2022, %). On average, forests cover 39% of the EU territory
 Note - compiled from the source ec.europa.eu

Restrictions on illegal logging. Combating illegal timber harvesting and deforestation is a key element of EU forest policy. Since the 2010s, the EU Timber Regulation (EUTR) has been in force, prohibiting the import and placing on the EU internal market of illegally harvested timber. For its implementation, supply chain control systems have been established, timber labelling introduced, and partnership agreements with timber-exporting countries concluded (FLEGT initiative). However, problems persist,

particularly with regard to the last remaining areas of Europe's primary forests. For example, in Romania large-scale illegal logging in the virgin forests of the Carpathians, including within Natura 2000 protected areas, was identified over the past decade. In 2020, the European Commission initiated legal proceedings against Romania for systematic non-compliance with environmental legislation and failure to prevent illegal logging in protected forests. This precedent sent a clear signal to all EU Member States about the need to strengthen control and transparency in the forestry sector.

In addition, the European Union is expanding corporate responsibility for the preservation of global forests. In June 2023, the new EU Regulation on deforestation-free products (EUDR) entered into force. According to this Regulation, companies importing agricultural products and timber into the EU (e.g., palm oil, soy, coffee, beef, cocoa, rubber, as well as wood products) are required to prove that these goods do not contribute to deforestation and are produced on land not subject to forest clearance after 2020. The new Regulation replaces the EUTR and significantly raises the requirements: it now covers not only illegal logging but any forest clearance for the production of regulated goods. A due diligence system and a country risk rating for deforestation are introduced. In this way, the EU seeks to reduce its "imported" carbon and environmental footprint, promoting globally sustainable supply chains and responsible forestry practices.

Economic implications of forest restoration. Forest restoration and the transition to sustainable forestry generate important economic effects. The direct contribution of the forest sector to the EU economy was estimated at €27.9 billion in gross value added in 2022, which is 13% higher than the previous year, partly due to increased demand for timber and wood-based products. Approximately 0.48 million people are employed in forestry and logging in the EU, with the sector creating jobs primarily in rural regions, thereby contributing to their development.

The implementation of reforestation projects usually requires investment (in nurseries, planting, and care for young stands), but in the long term can yield economic returns. New forests become sources of renewable timber, non-timber products (mushrooms, berries, medicinal raw materials), and ecosystem services. For example, restoring coastal protective forest belts reduces coastal protection costs, while afforestation of watersheds improves water quality, thereby lowering water treatment expenses. Experts estimate that every euro invested in ecosystem restoration pays off multiple times through ecosystem services and avoided damage.

Of particular importance is the role of forests in carbon sequestration: to achieve climate neutrality by 2050, the EU aims to increase the overall carbon sink capacity of forests, which is economically equivalent to

reducing future costs of technological CO₂ capture. Furthermore, healthy forests are less vulnerable to fires and diseases, thereby reducing disaster-related losses: in 2019–2021, fires in Southern Europe caused damage amounting to hundreds of millions of euros, and programmes to restore forest resilience are considered economically justified adaptation measures. Finally, restored forests stimulate ecotourism and recreation, providing additional income to local communities.

Thus, in addition to their environmental value, forest restoration in the EU is regarded as an investment in the “green economy,” creating new jobs and reducing long-term costs from environmental degradation.

Clean air is a fundamental prerequisite for the health of ecosystems and the population; therefore, the EU is gradually tightening maximum permissible levels of pollutants. The existing EU Air Quality Directives set standards for fine particulate matter (PM₁₀, PM_{2.5}), nitrogen dioxide, ozone, and others. Despite significant emission reductions over recent decades, concentrations in many European cities still exceed EU standards and, even more so, the new guidelines of the World Health Organization (WHO). According to the European Environment Agency (EEA), in 2021 about 97% of the EU’s urban population was exposed to PM_{2.5} levels above the WHO recommendation (5 µg/m³ annual average). The main sources are the burning of solid fuels in households (especially in Eastern Europe), transport, and industry.

The EU is developing responses on several fronts. First, within the framework of the “Zero Pollution” strategy, the goal has been set to reduce by 55% (compared to 2005 levels) the number of premature deaths caused by fine particles PM_{2.5} by 2030. To this end, in October 2022 the European Commission proposed a revision of air directives, aligning EU standards more closely with WHO recommendations. Already in February 2024, a political agreement was reached between EU institutions on new, stricter air quality standards, including lowering the PM_{2.5} limit (from the current 25 to about 10 µg/m³ annually, approaching the WHO guideline).

Second, technological measures are being adopted: cleaner emission standards for vehicles are introduced (Euro 6/7 standards, transition to electric vehicles), and stricter rules for power plants and factories are enforced (Industrial Emissions Directive). Third, cities are encouraged to develop sustainable mobility – public transport, electric buses, “green zones” restricting access for polluting vehicles. Already 12 EU capitals (including Copenhagen, Helsinki, Stockholm) met the daily PM₁₀ limit in 2023, which indicates real improvements. Overall, the trend is positive: for instance, in 2022 only 2% of monitoring stations recorded exceedances of

the EU annual PM_{2.5} limit, although almost 96% of the EU's urban residents still breathe air dirtier than the stricter WHO criteria.

To protect the population, in addition to emission reductions, the EU is strengthening monitoring and accountability. Since 2021, obligations have been introduced to inform citizens in real time about high pollution; the right of citizens to clean air and the possibility of legal action in cases of non-compliance are under consideration. It is expected that the combination of new standards and emission reduction measures will lead to a sharp improvement in air quality by 2030, saving tens of thousands of lives and restoring natural ecosystems affected by smog and acid rain.

EU policy on reducing water pollution. To protect aquatic ecosystems, the EU has been implementing for more than 20 years a comprehensive policy based on the Water Framework Directive (2000/60/EC). Its objective is to achieve good ecological and chemical status of all waters. However, as noted, progress has been slower than planned: less than 40% of rivers and lakes are in good condition. In the “State of Europe’s Waters 2024” report, the EEA points to the urgent need to step up measures, particularly in agriculture. Agricultural runoff remains the main source of pollution: about 32% of groundwater and 29% of surface waters in Europe are significantly contaminated with nitrates and pesticides from fields.

In response, the EU is actively revising standards and introducing new initiatives. The Farm-to-Fork Strategy has been adopted, which sets targets for 2030: to reduce the use and risk of pesticides by 50%, cut nutrient losses by 50% – which should allow at least a 20% reduction in fertilizer use.

To achieve these objectives, in 2022 an updated Regulation on the Sustainable Use of Pesticides was proposed, introducing mandatory reduction targets for Member States. Already, the use of a number of the most hazardous agrochemicals (for example, neonicotinoid insecticides harmful to bees) has been banned in the EU. The practice of Integrated Pest Management (IPM) is expanding – farmers are offered alternatives to chemical products, such as biological preparations and agronomic techniques. At the same time, the Nitrates Directive is in force, which limits nitrate concentrations in water (50 mg/l) and obliges countries to implement manure and fertilizer management plans. In some regions (for example, the Netherlands and Denmark), significant progress has been achieved in reducing nitrate content in groundwater thanks to strict regulations and precision farming technologies.

Within the framework of the Zero Pollution Action Plan, the EU aims by 2030 to reduce the share of aquatic ecosystems suffering from pollution by plastics, agricultural chemicals, and other waste. Lists of controlled hazardous substances in water are being revised and supplemented –

pharmaceutical residues, pesticide degradation products, and others have been added in order to better monitor modern threats to the aquatic environment. In addition to regulatory measures, significant EU funds are invested in wastewater treatment (modernization of treatment facilities in Eastern Europe, construction of infrastructure in rural areas) and in nature-based solutions for water systems. For example, LIFE projects have restored floodplain sections of the Danube and Elbe, which not only increase biodiversity but also reduce pollution, acting as a natural filter. Progress is also noted in local initiatives: in Finland and Sweden programmes of liming acidified lakes have been implemented and salmon spawning grounds restored; in Belgium and France “water steward” farmers reduce agrochemical application while receiving compensation for protecting drinking water sources. These examples confirm that achieving water quality goals requires joint efforts by the agricultural sector, industry, and government regulation, but brings tangible benefits – healthier ecosystems and secure water resources for people.

Regulation of the use of chemicals in agriculture. As noted above, reducing agrochemical load is the cornerstone of EU water and environmental policy. The use of pesticides and fertilizers directly affects biodiversity (through poisoning of non-target species, eutrophication of water bodies, degradation of soil biota). Therefore, the EU is consistently tightening the regulation of agrochemicals. Since 2009, the Directive on the Sustainable Use of Pesticides has been in force, requiring countries to develop national plans to reduce the risk and volume of plant protection product use. Many hazardous substances have been withdrawn from circulation: for example, the EU has banned insecticides based on imidacloprid, clothianidin and others, dangerous for pollinators. It is planned to completely eliminate their use in “sensitive areas” (e.g., in urban parks, protected areas) by 2030.

At the same time, organic farming is being encouraged – the goal is to bring the share of agricultural land under organic management to 25%. The expansion of the organic sector is already underway: according to Eurostat, the share of organic areas in the EU increased from about 8.5% (2019) to about 10% (2022), with Austria (~26%) and Estonia (~23%) leading. This contributes to the reduction of synthetic chemical use.

Regarding fertilizers: in addition to the mentioned target reduction of 20%, innovations are being introduced – processing manure into concentrated fertilizers, applying precision fertilization techniques, and developing crop varieties requiring fewer nutrients. Regulation of agrochemicals is yielding results: in the EU, between 2011 and 2020 the overall pesticide risk index decreased by 21%. In surface waters, declining

concentrations of several herbicides have been recorded. However, challenges remain – the emergence of new persistent substances (for example, per- and polyfluoroalkyl substances, PFAS, the so-called “forever chemicals”) requires continuous updating of lists of controlled pollutants. In response, the EU is developing the Chemicals Strategy for Sustainability, aimed at the gradual phase-out of the most harmful substances and their replacement with safer alternatives.

In agriculture, emphasis is placed on agroecological practices: crop rotation, biological pest control (predatory insects, bacteria), and agroforestry. The new Common Agricultural Policy (CAP, from 2023) links subsidies to environmental conditions (“cross-compliance”), providing farmers with payments for reducing chemical loads and maintaining landscape elements (shelterbelts, grasslands), which simultaneously improves habitats for wild species.

In conclusion, the EU’s policy on biodiversity protection and ecosystem restoration is comprehensive. It combines legal mechanisms (directives, regulations), financial instruments (LIFE funds, Horizon Europe, agricultural subsidies), scientifically grounded targets, and broad engagement of Member States. Certain achievements have already been made: the network of protected natural areas is expanding, populations of rare species are gradually recovering, and pollution levels are decreasing. Nevertheless, the EU faces considerable challenges in the context of global change – from climate change to increasing anthropogenic pressures. The implementation of the Biodiversity Strategy for 2030 and related initiatives will require intensified efforts and political will from all Member States.

Analysis shows that investments in Europe’s natural capital pay off manifold, ensuring ecosystem resilience, climate neutrality, and societal well-being in the long term. Such a systemic approach by the EU can serve as a model for other regions of the world in reconciling societal development with nature conservation.

2.6 EU Environmental Standards and Their Impact on International Trade and Partners

In recent years, the European Union has been actively introducing environmental standards into trade policy, which has significantly affected the structure of international trade and relations with trading partners. The key aspects of this process are considered below.

To prevent “carbon leakage” and ensure a level playing field, the EU has introduced the Carbon Border Adjustment Mechanism (CBAM). CBAM is

a carbon tax on imports of energy-intensive products, based on the volume of greenhouse gas emissions generated during their production. Importers into the EU will be required to purchase certificates equivalent to the CO₂ price that European producers would have paid under the ETS. Thus, carbon-intensive goods from countries with less stringent climate policies are subject to an additional charge, offsetting the difference with the carbon price in the EU.

The mechanism was launched in a transitional phase in October 2023 (requiring only emissions reporting), while full payment of the levy will begin in 2026. Initially, CBAM covers the most energy-intensive and trade-relevant sectors: cement, steel and iron products, aluminium, fertilizers, electricity generation, and hydrogen. These account for about 3% of EU imports from third countries (0.37% of global trade). The list may gradually expand, in parallel with the phase-out of free allowances under the ETS by 2034.

According to the EU's design, CBAM is intended to encourage foreign producers to adopt clean technologies, otherwise their products will lose price competitiveness on the EU market.

Impact of CBAM on trade flows and EU partners. The introduction of the carbon tariff primarily affects countries that are major suppliers of products in the targeted sectors. Among the most vulnerable are exporters of steel, aluminium, and fertilizers with high carbon intensity. For example, a significant share of the EU's imports of ferrous metals comes from China, Russia, and Turkey. These countries will face the greatest pressure from CBAM if they do not have comparable domestic carbon pricing systems.

Overall, analysis by the Carnegie Endowment indicates that the main exporters of goods subject to CBAM are Russia, China, the United Kingdom, Turkey, and the United States. Many of them are large economies capable of adaptation (China, Turkey, and the United Kingdom are already developing their own emissions trading systems, while the United States subsidizes low-carbon production). At the same time, developing countries such as India, Vietnam, Ukraine, and Brazil also heavily depend on exports of such goods and may face difficulties in adaptation (Figure 9).

Figure 9 presents the ranking of countries by relative vulnerability to the carbon tax: the highest CBAM exposure indices are observed in Zimbabwe, Ukraine, Georgia, Mozambique, and India. This means that the economies of these countries will be most affected by the new mechanism. By contrast, exporters such as the United States, Australia, and the United Kingdom have low vulnerability indices due to cleaner production or climate policy.

So far, no direct decline in trade flows has been recorded – during the transitional period 2023–2025 importers bear only administrative costs

(accounting and reporting of emissions) and continue deliveries. However, by 2026, with the start of payments, supply chains are expected to adjust. Producers oriented towards the EU market are likely to redirect “cleaner” products to Europe, while more carbon-intensive products will go to other markets. Such export “screening” may lead to segmentation of global markets: “green” goods for the EU and “grey” goods for countries without carbon constraints.

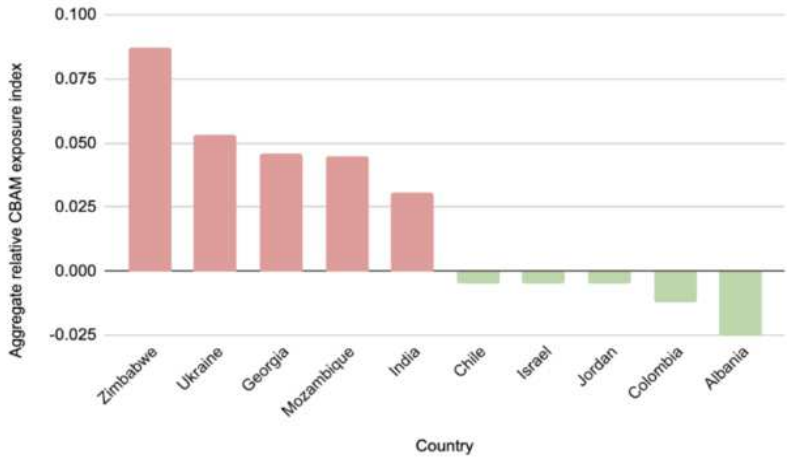


Figure 9. Countries with the highest (pink) and lowest (green) relative vulnerability to the CBAM mechanism according to the World Bank index.

OECD modelling confirms that CBAM will redirect EU imports from less environmentally friendly suppliers to cleaner ones, thereby effectively reducing carbon leakage. From an economic perspective, the effect for the EU is assessed as moderate: the sectors covered by CBAM account for only about 0.6% of EU employment and 1.1% of EU value added, and even full expansion of the product list would increase production costs in the EU by less than 0.1%. At the same time, for individual partner countries the consequences may be substantial: according to UNCTAD estimates, the introduction of CBAM will reduce the total income of developing countries by \$10 billion, while developed countries will gain about \$5.9 billion (net global lost income about \$8.3 billion). Thus, the EU’s gains (through improving the price competitiveness of its low-carbon producers) translate into losses for exporters with less clean production.

Although designed as a climate instrument, cross-border carbon regulation also has trade implications. Importers into the EU will have to account for the new “carbon duty,” which will increase the cost of importing materials (steel, fertilizers, etc.) for European industry. This may slightly reduce the competitiveness of downstream EU sectors dependent on imported raw materials. However, for Europe’s main energy-intensive sectors (metallurgy, cement), CBAM will serve as a protective mechanism, removing the advantage of foreign goods with a higher carbon footprint. Within the EU, the long-term effect should stimulate decarbonisation: the gradual phase-out of free ETS allowances and the external pressure of CBAM encourage companies to invest in clean technologies.

EU external trade policy may also gain an additional source of revenue – the sale of CBAM certificates – which is proposed to be directed towards supporting decarbonisation in the poorest countries. Geopolitical risks must also be considered: a number of countries perceive CBAM as a protectionist measure. China and India have openly threatened to challenge it in the WTO. At the COP-28 climate summit, a group of developing countries (Brazil, South Africa, India, China – the BASIC bloc) sought to include the issue of “unilateral trade measures under the pretext of ecology” on the agenda, supported by 134 states. Although a compromise was reached, the final COP-28 text reflected the position that environmental measures should not lead to unjustified discrimination in trade. In other words, the international community calls on the EU to implement CBAM transparently and fairly.

In response, the EU points to CBAM’s compliance with WTO rules and its willingness to take into account the level of development of partners. For example, exemptions are being discussed in the initial stage for least developed countries and Ukraine. In addition, the EU has declared the possibility of “recycling” part of CBAM revenues into clean development technologies for affected countries. Thus, the cross-border carbon tax is already stimulating active negotiations and adjustments in the strategies of trading partners – from launching their own carbon pricing systems (as in Turkey and China) to seeking compromises within climate diplomacy.

In addition to the carbon tariff, the EU extends environmental, social, and governance (ESG) criteria to a wide range of imported goods and industrial supply chains. Within the framework of the European Green Deal, regulations are adopted requiring companies and products to comply with the objectives of sustainable development. For example, the Sustainable Products Initiative expands eco-design and energy efficiency requirements to virtually all industrial goods. Since 2024, mandatory non-financial reporting (ESG reports) has been introduced in the EU for large companies

– both European and foreign operating on the EU market – under the ESRS standards, which also cover carbon footprint and environmental impact. This obliges businesses to monitor environmental indicators throughout their supply chains.

In addition, a Corporate Sustainability Due Diligence Directive is being developed, which will require companies to identify and prevent environmental damage and human rights violations among their suppliers abroad. Direct technical regulations are also being introduced: for example, the new EU Regulation on deforestation-free products (2023) prohibits the import of certain agricultural commodities (palm oil, soy, coffee, cocoa, timber, etc.) if their production has involved deforestation. Full traceability of origin is required, which effectively compels exporters to comply with European environmental standards.

Similarly, starting from 2024, the EU Battery Regulation comes into force, establishing maximum carbon footprint thresholds for batteries sold in the EU and requiring their recycling. All these measures make ESG characteristics an integral attribute of product competitiveness. Producers from third countries targeting the European market are forced to implement “green” practices in order not to lose access to it. For instance, Asian electronics exporters are already adapting to the EU’s new energy efficiency and recycling requirements, while agricultural enterprises in Africa are adjusting to sustainable land use standards. Thus, the EU regulatory framework on ESG is becoming standardized and de facto a global benchmark (the “Brussels effect”), whereby foreign companies adopt European rules voluntarily in order to maintain their market share.

The most serious consequences of Europe’s environmental transformation concern fossil fuel suppliers. The EU intends to drastically reduce oil and natural gas consumption in the coming decades in pursuit of carbon neutrality by 2050. According to forecasts, after 2030 oil imports to Europe will decline by about 78%, and gas imports by 58–67% compared to 2015 levels. This dramatic reduction deprives traditional energy exporters – Russia, the Gulf states, North Africa, and Norway – of their key sales market. In 2019, the EU accounted for about 20% of global oil imports, so Europe’s withdrawal from hydrocarbons will have a global effect: an oversupply of oil on the market is possible, with falling prices and reduced revenues for major oil producers.

The EU’s closest neighbours, whose economies are heavily dependent on energy exports, are particularly vulnerable: for example, more than 60% of Russia’s total exports to the EU before 2022 consisted of oil and gas, while Algeria and Nigeria earned significant foreign exchange revenues from gas sales to Europe. These countries now face the prospect of

economic restructuring to avoid the crisis of an export-oriented model. The EU is directly urging oil and gas partners to diversify, offering support for the development of “green” sectors. A strategic paper by the ECFR notes that Brussels should build cooperation with oil and gas exporters to develop renewable energy and produce green hydrogen for export to Europe.

Practical steps are already being taken: in 2022 the EU signed memoranda with Egypt, Namibia, and Kazakhstan on green hydrogen supplies; the Gulf countries (Saudi Arabia, UAE) are investing in carbon capture technologies and renewable energy, focusing on future EU demand for clean fuels. At the same time, in the short term the European energy transition has also created turbulence: in 2022, following sanctions against Russia, the EU was forced to import more gas from the United States, Qatar, and Africa. This brought temporary benefits to some exporters, but the long-term trajectory remains downward. African fossil fuel exports are estimated at \$50 billion annually – revenues that are under threat as EU demand declines.

Overall, OPEC countries and other oil producers increasingly perceive the European Green Deal as a challenge: at G20 and COP summits they lobby for recognition of “differences in approaches” and the inadmissibility of drastic measures such as CBAM. The EU seeks to ease the situation by attracting investment: the Global Gateway initiative provides €300 billion for sustainable infrastructure worldwide, including clean energy projects in partner countries.

Thus, for oil and gas exporters, EU environmental standards mean the need for structural economic transformation in order to overcome dependence on declining demand.

Developing economies in Africa and Asia, closely integrated into trade with the EU, are also affected by the new “green” requirements. Many African countries export raw materials and agricultural products (cocoa, coffee, cotton, timber, ore) to Europe, the production of which is associated with environmental risks – deforestation, land degradation, CO₂ emissions. European regulations (for example, the mentioned ban on products linked to deforestation) create new barriers for them. According to experts, about 84% of all African goods exported to the EU (worth \$135 billion annually) fall under the scope of the European Green Deal. This is equivalent to about 5% of Africa’s total GDP.

Thus, virtually all traditional African exports – from oil and gas to agricultural raw materials – require adaptation to the new EU environmental standards. Failure to do so may lead to export contraction, damaging development. In particular, CBAM could reduce Africa’s GDP by almost 1%, hitting the metallurgy of North Africa and South Africa especially hard.

Facing this challenge, African states, with EU support, are developing response measures: the African Green Industrialization Strategy, a regional carbon market, and “debt-for-climate-investment” mechanisms. The EU, in turn, is launching programmes of technical assistance and financing. An example is the Just Energy Transition Partnership (JETP) with South Africa: a consortium of countries (EU, USA, UK, France, Germany) allocated \$8.5 billion to support South Africa’s coal phase-out and the development of clean energy. Similar deals were concluded in 2022 with Indonesia (\$20 billion) and Vietnam (\$15.5 billion). These partnerships demonstrate a new approach: instead of trade sanctions – support for the “green” transition of developing countries, enabling them to comply with global environmental standards.

In Asia, the EU’s key trading partner is China, which accounts for about 8.5% of the carbon footprint of European consumption. China is already experiencing the consequences of European requirements: restrictions on emission-intensive products are encouraging Beijing to accelerate its own target of peaking emissions before 2030 and to develop systems for monitoring the carbon footprint of exports. Other Asian economies – Vietnam, Thailand, Malaysia – are including environmental chapters in their free trade agreements with the EU and implementing domestic reforms (for example, laws against illegal logging, carbon pricing plans) in order to maintain the competitiveness of their goods on the European market. Nevertheless, for many poorer countries, the ESG requirement remains a serious challenge. To “bring them up” to the necessary level, the EU combines a carrot-and-stick approach: on the one hand, financing for technologies and incentives are promised (within initiatives such as the Alliance for Sustainable Trade); on the other hand, in future trade preferences (GSP+) the EU plans to tighten conditions, including ratification of environmental conventions. All this demonstrates that European environmental standards are becoming an integral part of the architecture of global trade, and partners must either accept the new reality or risk losing access to the EU market.

Prospects for the integration of environmental standards into trade agreements. The European Union seeks to embed the environmental agenda not only through domestic laws but also via multilateral agreements. The new generation of EU trade agreements includes detailed chapters on Trade and Sustainable Development (TSD). Since the 2010s, virtually every free trade agreement concluded by the EU has contained commitments by the parties to implement the Paris Agreement on climate, protect biodiversity, and comply with environmental production standards. Whereas in the 1990s only about 20% of agreements contained references to the environment, by

2016 around 85% of all global trade agreements included environmental provisions (Figure 10).

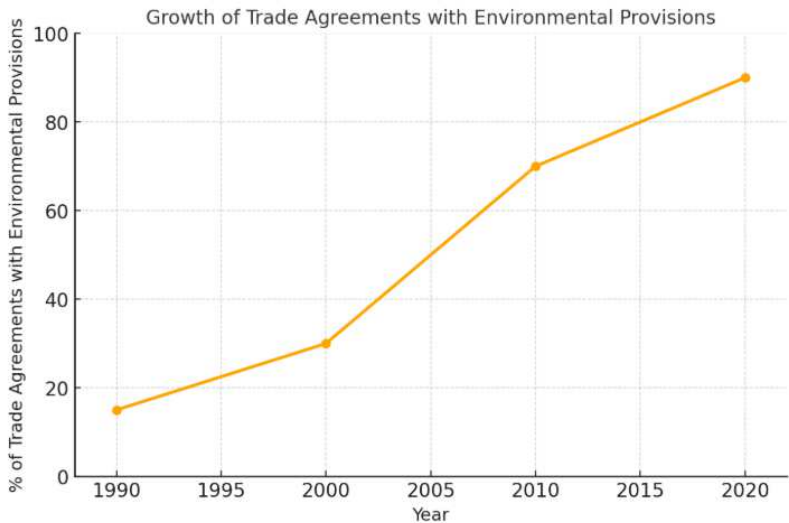


Figure 10. The “greening” of trade agreements

The EU positions itself as the leader of this process. In 2022, the European Commission conducted a review of the implementation of TSD chapters and developed recommendations to strengthen their effectiveness. In particular, it was proposed to make the fulfillment of environmental commitments legally binding under the threat of sanctions. Already in the EU–New Zealand agreement of 2023, unprecedented commitments on sustainable development were enshrined and a dispute settlement mechanism was introduced, extending to non-compliance with environmental provisions.

For the first time in EU practice, that agreement contained a separate chapter on sustainable food systems and an article on the reform of fossil fuel subsidies – an important step given that subsidizing fossil energy is considered an obstacle to climate goals. In addition, the parties (the EU and New Zealand) explicitly indicated the possibility of applying trade sanctions in case of violation of the provisions of the Paris Agreement – a precedent reflecting Brussels’ new course of linking trade to climate. In further negotiations – for example, with India, Indonesia, and African countries –

the EU intends to secure the inclusion of similar chapters and to guarantee that “no new deal will undermine the EU’s climate goals.”

In fact, a model is being formed in which access to the EU market depends on the partner’s acceptance of environmental commitments. At the same time, the EU is promoting the idea of “climate clubs” – agreements among a group of countries on mutual recognition of carbon pricing and the elimination of the need for CBAM between them. Such a club is being discussed with close partners (for example, among G7 participants, where the initiative originated from Germany and received support from the EU and the United States). According to the EU’s concept, the integration of environmental standards into trade should scale up climate action globally and prevent “unfair competition” at the expense of environmental degradation. In the long run, this implies an increasing intertwining of trade and environmental arrangements – from WTO levels to bilateral agreements.

EU environmental diplomacy at international forums. The European Union actively promotes the environmental agenda in international diplomacy platforms – the UN, G20, WTO, and specialized summits. At the UNFCCC conferences, the EU traditionally acts as a leader of coalitions for ambitious targets. For instance, at COP-21 in Paris (2015) with EU participation, the “High Ambition Coalition” was formed, which succeeded in securing the 1.5°C warming target. At recent climate summits, the EU also played a key role as a mediator between the developed and developing world – for example, at COP-26 in Glasgow (2021), European diplomats facilitated the adoption of the Glasgow Pact, a compromise for India and China.

However, geopolitical shifts complicate the EU’s leadership: it is noted that the Union has to withstand competition from China and the United States in climate matters. Nevertheless, the EU continues to initiate new agreements: in 2021, jointly with the United States, the Global Methane Pledge was launched, supported by over 100 countries that committed to cut methane emissions by 30% by 2030.

The EU is also engaged in multilateral negotiations on biodiversity conservation (successfully lobbying for the adoption of the Montreal Global Biodiversity Framework in 2022, which provides for the protection of 30% of natural areas). Within the World Trade Organization, the EU supports the resumption of negotiations on the Environmental Goods Agreement – the elimination of tariffs on environmental goods. Brussels has also joined the TESSD (Trade and Environmental Sustainability Structured Discussions) and ACCTS (New Zealand’s initiative on climate, trade, and sustainability), which seek ways to align trade rules with emission reduction goals.

It is also worth noting the EU's efforts on subsidy reform: at G20 and OECD forums, the Union consistently promotes the idea of phasing out fossil fuel subsidies by 2025, setting an example with its internal policy (the EU has already banned financing of coal projects through development banks and the EIB).

Such diplomatic activity demonstrates the EU's ambition to set the tone in the global environmental discourse. At the same time, the Union employs economic instruments: within the framework of "green development diplomacy," the EU pledges significant investments and assistance to developing countries (for example, the €4 billion fund announced to support poor countries in adapting to climate change). All this strengthens the EU's image as a "leader in climate diplomacy," although it is accompanied by criticism – developing countries often point to insufficient funding and the EU's reluctance to assume historical responsibility for past emissions.

The European Union, possessing significant economic weight (around 15% of global GDP) and political influence, has in effect become a generator of many initiatives in the field of global environmental governance.

First, the EU demonstrates an example of internal transformations – climate legislation such as the European Climate Law and the world's largest carbon market (EU ETS) serve as models studied and adopted by other regions.

Second, through external trade relations the EU projects its standards abroad: by requiring partners to comply with environmental norms, it stimulates the modernization of production worldwide. For example, the introduction of rules on plastic packaging recycling in the EU prompted major Asian economies to adopt their own plans to combat plastic pollution.

Third, the EU actively participates in the creation of new institutions: it supports the UN initiative to develop a global treaty on plastic pollution, promotes the idea of an international court for environmental crimes, and funds the IPBES – the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services – analogous to the IPCC on climate.

Thanks to EU efforts, environmental issues are increasingly regarded as an integral part of the international security and development agenda. Significantly, in the new EU Economic Security Strategy of 2023, resilience and climate are named as key components of security.

Of course, the EU's influence is not unlimited: the Union accounts for only about 8% of global CO₂ emissions, and without the participation of major emitters (China, the United States, India) global environmental goals are unattainable. Yet the EU often sets regulatory benchmarks. Even competitors – such as the United States – have strengthened their own

initiatives in response to European actions (for instance, the U.S. Inflation Reduction Act of 2022, providing unprecedented subsidies for clean energy, was partly stimulated by the successes of the European Green Deal).

EU–China cooperation in the environmental sphere is also indicative: since 2018 a high-level dialogue on environment and climate has existed, where issues such as the alignment of emissions trading systems and joint standards for electric vehicles are discussed.

All these steps shape the EU's reputation as the “locomotive” of global environmental policy. At the same time, within the Union there is recognition that maintaining leadership is not easy – geopolitical shocks and the associated energy crisis have tested the EU's commitment to green objectives. Nevertheless, in 2023 the EU reaffirmed its Green Deal and Fit for 55 courses, adopting new ambitious laws (for example, the Nature Restoration Regulation). This is a signal to international partners that the EU “remains committed to the green course, no matter what.”

If the European Union succeeds in implementing its internal green transformation and at the same time engaging the maximum number of countries in joint environmental efforts (through trade, diplomacy, and financing), its role as a global leader of the environmental agenda will be strengthened and will become one of the defining factors in world economy and politics in the 21st century.

Chapter 3. Green Finance and Its Role in the Sustainable Development of the European Union

3.1 The Concept of Sustainable Finance and Green Finance in the European Union

3.2 Trends and patterns in sustainable finance: a Scopus-based bibliometric analysis

3.3 Features of Investment Support for the European Green Deal and Digital Platforms for Sustainable Finance

3.4 Green Bonds as a Tool in the Green Finance System

3.5 Modern Trends in the Development and Standardization of Green Bonds in the EU

3.6 The Role of Green Loans in Achieving Environmental Sustainability

3.1 The Concept of Sustainable Finance and Green Finance in the European Union

The shift towards a green economy became a significant global event in the 1970s when issues related to sustainable development and environmental conservation gained increasing attention. The concept of the "green economy" was first mentioned in the report "Blueprint for a Green Economy," prepared by Pearce et al. (1992) for the UK government [39]. This report was aimed at measuring progress in sustainable development and assessing related policies.

The United Nations Environment Programme (UNEP) outlines measures to reduce environmental risks and deficits, improve human well-being, and promote social equity [40]. According to this program, the green economy is characterized as a low-carbon, resource-efficient, and socially inclusive economy. The implementation of green policies must encompass these three dimensions of sustainable development. The priorities of green economy policies include human well-being, social equity, and the rational use of natural and human resources, making these aspects central to economic development strategies.

The European Union bases its strategies on sustainable development and the green economy, setting ambitious long-term goals aimed at preventing climate change and other negative environmental impacts caused by human activities.

The transformation of the economic paradigm towards environmental goals is closely tied to the integration of "green" practices into economic systems. A critical step in this direction was the emergence of green

finance. Green finance plays a key role in mobilizing the necessary capital to achieve the objectives of the European Green Deal and the EU's international commitments to sustainable ecological development.

The adoption of the sustainable development concept necessitates a scientific understanding of the terms "green finance," "climate finance," and "sustainable finance," as well as the systematic organization of societal relationships encompassed by these categories.

Figure 11 illustrates the interconnections between climate finance, green finance, and sustainable finance.

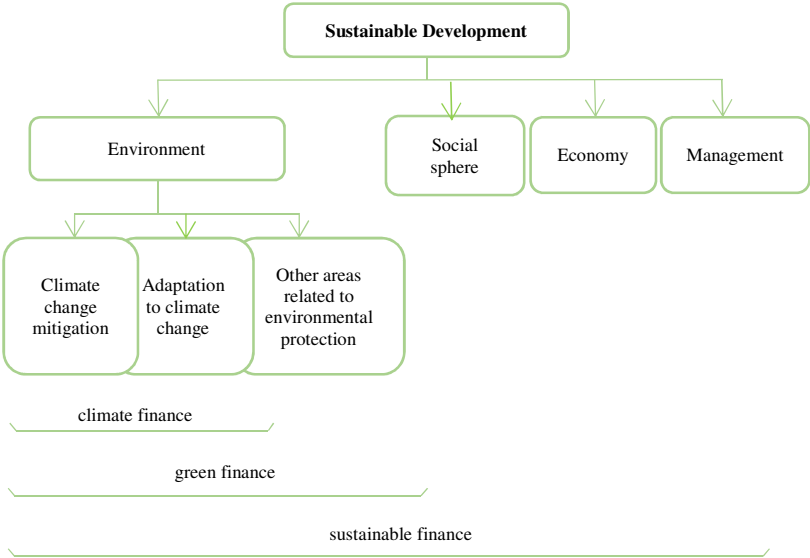


Figure 11. The relationship between sustainable, green and climate finance
Note - compiled by the authors

Historically, the term "climate finance" was the first to gain widespread usage, driven by the escalating issue of greenhouse gas emissions and climate change. Today, the concept of climate finance is predominantly used in its narrow sense, referring to the funding of projects and programs aimed at mitigating the effects of climate change.

Climate finance focuses on reducing environmental and climate-related risks to economic development. Currently, the need for climate financing is recognized by nearly all countries.

The emergence of sustainable finance can be traced back to the Financial Initiative of the United Nations Environment Programme (UNEP FI) [41], which marked the beginning of a partnership between UNEP and the global financial sector. This initiative aimed to mobilize private financial resources for the Sustainable Development Goals (SDGs).

Sustainable finance, as a dynamic convergence of finance and sustainability, drives the transformation of the financial system towards a fairer and more responsible future [42].

In the context of EU policy, sustainable finance is defined as "financing to support economic growth while reducing environmental impacts, aimed at achieving the climate and environmental goals of the European Green Deal, taking into account social and governance aspects." Sustainable finance also involves transparency of risks related to environmental, social, and governance (ESG) factors, which may affect the financial system, as well as reducing such risks through proper management of financial and corporate entities [43].

Additionally, the International Institute for Sustainable Development (IISD) defines sustainable finance as "the provision of financial capital and risk management services in a manner that ensures economic growth, social equity, and environmental protection" [44].

Green finance, as a thematic direction within the concept of sustainable finance, encompasses activities related to:

- Addressing climate change and adapting to its impacts (climate finance);
- Preserving marine ecosystems (blue finance);
- Achieving other environmentally sustainable development goals (various areas of green finance).

The green finance direction forms the foundation of the sustainable finance system. Theoretically, this is justified by the hierarchy of values in sustainable development, where environmental goals must be given absolute priority, transforming social and economic values and models. From a practical standpoint, green finance acts as a driver of the green economy, shaping financial development trajectories and creating new challenges and solutions.

Currently, there is a significant increase in the study, practical application, and theoretical generalization of processes related to green finance. In economic literature, green finance is viewed as a fundamental condition for the transition to a green economy, green economic growth, and sustainable development. Simultaneously, green finance is associated with the challenge of building a new global financial system.

Modern scientific approaches study green finance as a macroeconomic phenomenon and a factor in macroeconomic development. For instance,

Bhatnagar and Sharma (2022) state that green finance encompasses all financial activities and initiatives aimed at environmental protection, climate change mitigation, and adaptation [45]. Bhattacharyya (2021) notes that the broader goal of green finance is to decouple inclusive economic growth from environmental degradation [46].

According to Tverezovska, O., & Hrytsenko, L. (2022), the essence of green finance can be described as the process of integrating the financial sector with transformative processes that promote sustainable development [47]. Broadly, green finance consists of environmentally responsible investments that require public funding support and active management of environmental risks throughout the financial system. In a narrow sense, green finance is defined as a set of financial instruments designed and applied to reduce negative environmental and climate risks.

According to the G20 Green Finance Synthesis Report (2016), green finance is defined as "financing of investments that provide environmental benefits within the broader context of environmentally sustainable development. These environmental benefits include reductions in air, water, and land pollution, greenhouse gas emissions, increased energy efficiency in the use of existing natural resources, as well as climate change mitigation and adaptation and their associated benefits" [48].

Researchers Razhees et al. (2023), who studied the role of green finance in fostering sustainable economic growth, found a significant positive impact of green loans and green bonds on long-term economic growth [49].

Green finance plays a critical role in directing funds towards environmentally safe initiatives, including renewable energy, energy efficiency, sustainable infrastructure, and climate change initiatives [50].

Moreover, econometric studies have emerged that examine the externalities of green finance, its parametrization within macroeconomic indicators, and other metrics and characteristics that enable the calculation of direct and indirect effects on the economy and society as a whole, as well as the prediction of potential environmental impacts of specific financial processes.

Figure 12 presents the basic elements for formulating green finance.

Thus, determining whether companies, projects, policies, or financial instruments qualify as "green" is based in each case on criteria established in regulatory frameworks.

Overall, "green finance" can be defined in both narrow and broad terms. In the narrow sense, green finance refers to financial instruments (such as bonds, loans, etc.) aimed at financing activities that ensure sustainable environmental development. The broader approach to defining green finance implies that it encompasses the entire range of economic

relationships associated with funding environmental protection activities, combating climate change, transitioning to a low-carbon and energy-efficient economy, effective management of environmental and climate risks, and financial oversight within the relevant areas of public relations.

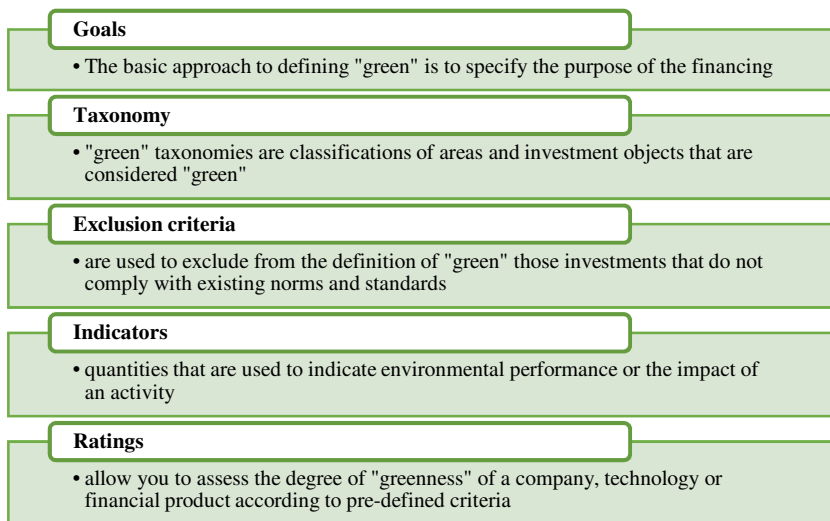


Figure 12. Basic elements for formulating green finance

Note - compiled by the authors

Green finance spans a wide array of financial institutions and asset classes and includes both public and private financing.

The main directions of green financing include maintaining biodiversity to protect ecosystems, creating an environmentally sustainable agricultural system in the EU, developing alternative energy sources, greening production cycles in industry, introducing new environmental standards in the construction sector, and promoting eco-friendly transportation.

Green finance exerts diverse macroeconomic impacts; various investment procedures, directions, and organizational forms of investment may have different macroeconomic effects and properties. Green financing often has a significant influence not only on specific industries or regions but also on global processes. The localization of investments (as green finance is predominantly directed towards solving local issues) is frequently linked to larger-scale mega-economic and mega-social consequences. Understanding how value is created and accumulated in the green economy

through green financing requires a new approach to defining the categories of value and utility. This new approach can only be formulated as a result of interdisciplinary exploration.

The mobilization of capital from financial institutions and private businesses to address climate change and preserve the environment is a priority for the economic policies of most countries around the world, as achieving the Sustainable Development Goals (SDGs) requires substantial funding volumes.

Green financial instruments are designed to finance projects related to the environment, ecology, and climate change.

Green financial instruments include green bonds, green loans, green mortgages, green indices, green investments, green insurance, green ETFs, green crowdfunding, and others. The green segments of financial markets are rapidly expanding, acting as a driving force for the transition to a new generation of financial systems. Many countries are actively implementing non-investment and blended forms of green financing. The largest users of green financing are sectors such as energy, industry, waste management, construction, transportation, agriculture, forestry, water, and ICT [51].

3.2 Trends and patterns in sustainable finance: a Scopus-based bibliometric analysis

Recognizing the crucial role of financing in achieving sustainable development goals, a significant portion of the literature is devoted to the study of sustainable finance and its components, including green finance and climate finance, as well as the impact of green finance on economic development. An important area of research is the identification of the characteristics and parameters of green finance in the countries of the European Union.

Within the framework of this study, a comprehensive literature review on sustainable finance, green finance, and climate finance in the context of the European Union was conducted using bibliometric analysis. Bibliometric analysis is an open-source tool designed to perform a comprehensive mapping of scientific sources, enabling a full range of publication analysis and result visualization.

The aim of this research is to identify key research directions and concepts related to green finance and its contribution to sustainable development within the European Union, as well as to uncover research gaps in the existing body of literature that could serve as a foundation for future studies.

To identify the main concepts and approaches to the study of green finance in European practice, the method of bibliometric analysis was chosen. Bibliometric analysis of existing scientific research uses quantitative approaches to evaluate and analyze scientific publications, their authors, journals, citation metrics, and other characteristics of academic work. By examining the features and trends of scientific literature, bibliometric analysis enables the identification of key topics and their interconnections, leading authors, as well as the main approaches and methods used in the field. It also helps determine directions for future research and assess the impact and significance of various scientific publications.

The study can reveal how green finance contributes to sustainable development, addresses environmental and social issues, and supports the development of human capital and innovation. Bibliometric analysis can also uncover research focused on economic policy and initiatives aimed at promoting green finance. One of the advantages of this method is that it allows for the inclusion of articles discussing various green finance instruments. This approach helps to identify keywords that, when combined, offer a high-level description of the content of scientific publications and the relationships between citations. Such a method provides a better understanding of the research approaches in the field of sustainable finance.

The study was conducted using the Scopus database in May 2025. Scopus is recognized as one of the primary and widely used bibliographic databases, offering a vast collection of research literature across various scientific disciplines. A four-stage process (Figure 13) was used to select the sample of articles from the Scopus database.

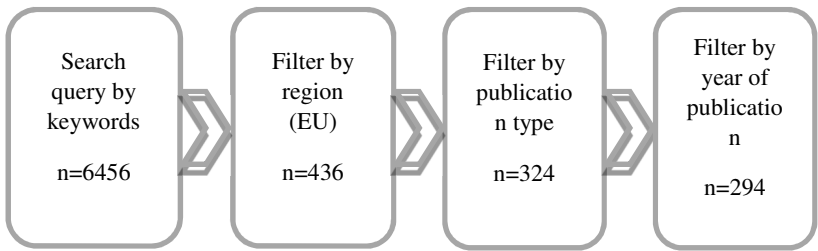


Figure 13. Stages of the scientific publication selection process
Note: compiled by the authors

In the first stage, a search query was performed using the keywords “green finance,” “sustainable finance,” and “climate finance” in accordance

with the research topic. In the second stage, publications relevant to the region—“European Union,” “EC,” “Europe,” “European”—were selected. The third stage involved filtering by publication type, selecting only journal articles and review papers. In the fourth stage, the final selection included studies published between 2020 and 2025.

The collected sample of scientific publications was analyzed using VOSviewer and Biblioshiny software, which offer a comprehensive toolkit for exploring scientific literature, including clustering, bibliographic coupling, and thematic mapping. The use of VOSviewer and Biblioshiny streamlines the bibliometric analysis process, enabling visualization of complex networks and clusters of related concepts. The resulting graphs and figures enhance understanding of important topics, key concepts, patterns, and emerging trends within the field. The keyword combinations displayed in the figures form thematic clusters and create bibliometric maps that show the strength of connections, the prominence of keywords, and associations between individual terms.

In the context of the growing volume of scientific publications, bibliometric literature analysis provides an opportunity for a broad overview of research contributions, significance, and impact of various academic works, as well as for identifying areas that warrant further investigation.

The topic of sustainable finance, green finance, and climate finance has been extensively studied by economists, especially in recent years. To identify the dynamics in the volume of knowledge in this area, data on annual scientific output, the most relevant sources, the most relevant institutions, co-occurrence networks, and bibliometric mapping were analyzed.

For the period from 2020 to 2025, a sample of 294 scientific publications across 191 sources was obtained. During this period, 694 authors published their research, 71 of whom were sole authors. Over 32% of the articles were published through international collaboration. The average number of citations was 14.13 per publication.

Figure 14 presents the annual volume of publications on the topic of investment impact on economic growth using modeling approaches.

A steady increase in scientific publications on this topic can be observed from 2020 to 2024, highlighting its growing relevance. The annual publication growth rate during this period was 22.31%. Between 2020 and 2024, the annual number of publications nearly doubled — from 19 in 2020 to 83 in 2024. The highest publication activity was recorded in 2024. The rising number of studies in the fields of sustainable, green and climate

finance reflects increasing challenges in financing sustainable development goals and the urgent need for a green transformation of the global economy.

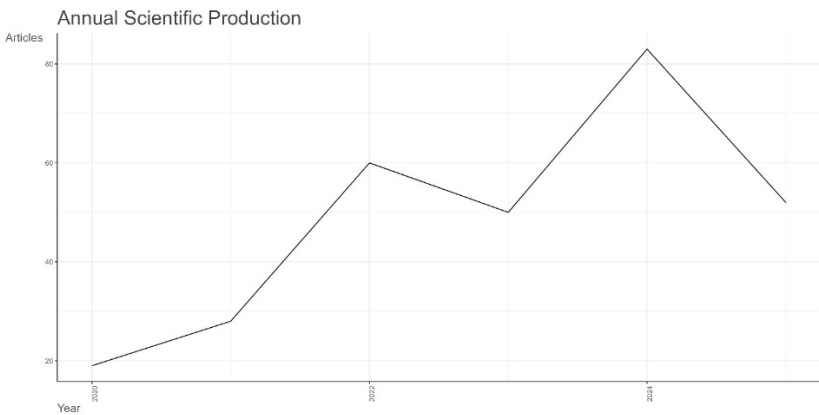


Figure 14. Number of scientific publications in the field of the sustainable, green and climate finance
Note: compiled by the authors using Biblioshiny

Table 4 provides data on the most highly cited scientific publications in the field of sustainable and green finance.

Table 4. Number of citation of publications from the Scopus database

Article Title	Authors	Year of Publication	Number of citation	Journal Title
1	2	3	4	5
Corporate green bonds	Flammer C.	2021	916	Journal of Financial Economics
The Influence of Firm Size on the ESG Scope: Corporate Sustainability Ratings Under Review	Drempetic S., Klein C., Zwergel B.	2020	753	Journal of Business Ethics

1	2	3	4	5
Sustainable solutions for green financing and investment in renewable energy projects	Taghizadeh-Hesary F., Yoshino N.	2020	380	Energies
Central bank mandates, sustainability objectives and promotion of green finance	Dikau S., Volz U.	2021	313	Ecological Economics
ESG Disclosure and Firm Performance: A bibliometric and meta analysis	Khan M.A.	2022	309	Research in International Business
A sustainable development pathway for climate action within the UN 2030 Agenda	Soergel et al	2021	300	Nature Climate Change
A step forward on sustainability: The nexus of environmental responsibility, green technology, green finance	Madaleno M., Dogan E., Taskin D.	2022	285	Energy Economics
The green bond market	Banga J.	2019	285	Journal of Sustainable Finance and Investment
Sustainable business model archetypes for the banking industry	Bocken N.M.P., Yip A.W.H.	2018	259	Journal of Cleaner Production
Equitable mitigation to achieve the Paris Agreement goals	Robiou Du Pont, Y. Jeffery, M.L. Gutschow, J. Rogelj, P. Christoff, M. Meinshausen	2017	228	Nature Climate Change
Note: compiled by the authors				

As shown in the table, the article on corporate green bonds had been cited in 916 publications at the time of this study, indicating strong research interest in this topic. Additionally, the most cited works address issues such as corporate sustainability, financing renewable energy projects, the role of central banks in promoting green finance, climate finance, and the development of sustainable business models for banks.

The relationship between the parameters of scientific publications is illustrated in Figure 15, which shows the interconnections between authors, countries, and keywords.

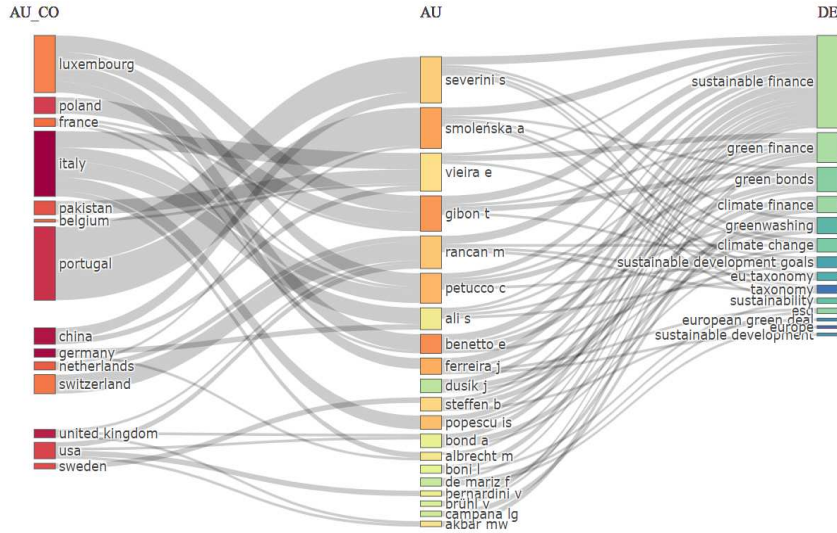


Figure 15. Three-fields plot

Note: compiled by the authors using Biblioshiny

Researchers from Luxembourg, Italy, and Portugal are among the most active contributors in the field of sustainable finance in recent years. Furthermore, sustainable development financing is actively studied not only in developed countries (the United Kingdom, the United States, France, Germany and others) but also in developing and transitional economies (Pakistan, China and others). The highest number of articles is focused on sustainable finance, as evidenced by the frequent use of related keywords in abstracts and article content. The most prolific authors in this field include

Benetto E., Smolenska A., Gibon N., Severini S., Petucco C., Rancan M., Vieira E., Ferreira J., Popescu I.S. and Steffen B.

Keywords were analyzed using the VOSviewer software, which made it possible to assess the strength of co-occurrence of selected terms. To create the bibliometric map, a specialized thesaurus and the most frequently used keywords were applied. The visualization of the results is presented in Figure 16, where the size of each element represents its total link strength, and the thickness of the connecting lines indicates the strength of the relationship between two terms. Keywords within a single cluster are more closely related to one another.

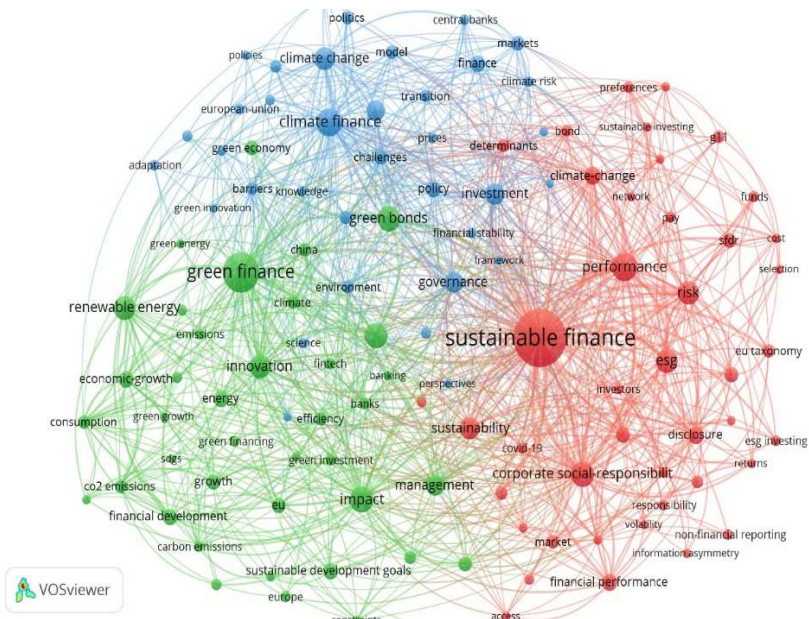


Figure 16. Bibliometric map of scientific publications in the field of the sustainable, green and climate finance

Note: compiled by the authors using VOSviewer

The publication mapping method uses different colors to represent multiple clusters (red, green, blue, and others). The interpretation of the clusters is based on the keywords they contain. This division is conditional, as the clusters and keywords are interconnected. The largest circles indicate

the central importance of the keywords “Sustainable finance”, “Green finance” and “Climate finance,” which are linked to elements on the map.

Table 5 presents the color-coded clusters and the keywords included within them.

Table 5. Clustering of Scientific Publications in the Field of Sustainable Finance

Cluster number	Cluster color	Number of terms	Most frequently used terms
1	red	33	Sustainability, corporate social responsibility, ESG, performance, EU taxonomy, financial performance, risk, funds, preferences
2	green	31	Renewable energy, innovation, emissions, impact, management, green bonds, green economy, economic growth
3	light blue	23	Climate change, transition, policy, governance, adaptation, investments, central banks, model, perspective, environment
Note: compiled by the authors using VOSviewer			

The bibliometric map of publications identified three main clusters, with the largest and most central being the red cluster labeled “Sustainable finance”. The next largest is the green cluster, centered around “Green finance”. The third cluster is light blue, with “Climate finance” as its core keyword. All three clusters are closely interconnected, indicating that most research studies examine these three areas in combination. Scientific publications typically use combinations of keywords from these clusters.

Academic publications also explore elements that are integral components of sustainable finance. These elements appear as network nodes on the scientometric map and include terms such «green bonds», «investment», «financial system», «carbon emission», «renewable energy», «taxonomy», «circular economy» and others. Each cluster contains a group of interrelated keywords that frequently co-occur in scientific literature. It is important to note that these concepts are among the most significant and widely discussed in the existing body of research on sustainable finance.

The terms «spatiotemporal analysis», «network models», «cost benefit analysis», «CGE modeling», «agent-based models», «linear probability model», «Markov-switching econometric methodology», «computable general equilibrium», which appear in the clusters, represent research

methods used to analyze the contribution of finance to achieving sustainable development goals. These methods are therefore applied by researchers to study this topic and are considered the most appropriate and relevant.

The development of thematic directions in the field of sustainable finance is presented in Figure 17. The chart illustrates themes using circular markers of various sizes, positioned within one of four areas: “basic themes”, “motor themes”, “niche themes” and “emerging or declining themes”.

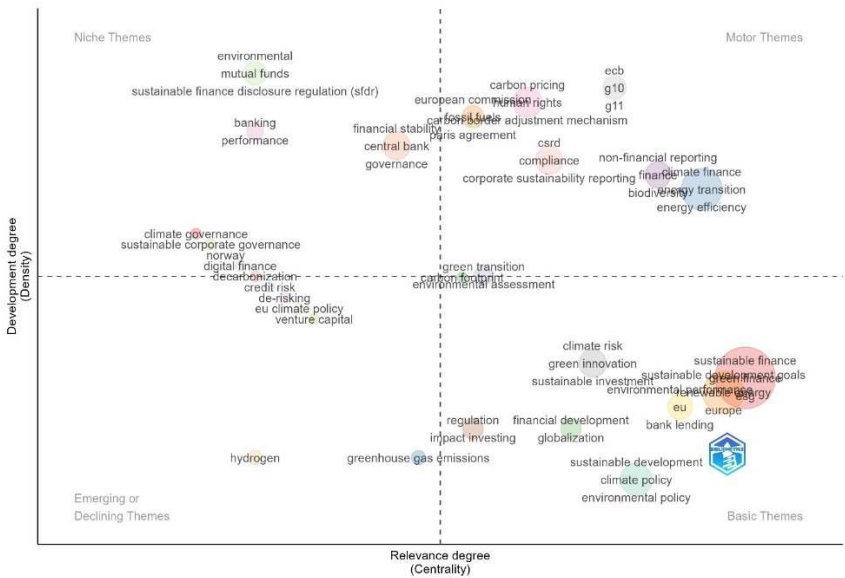


Figure 17. Bubble chart of publications in the field of the sustainable finance

Note: compiled by the authors using Biblioshiny

The basic research themes for the period 2020–2025 are “sustainable finance”, “sustainable development goals”, “green finance,” “green bonds”, “climate change”, “EU taxonomy”, “European Green Deal” and “greenwashing”. These topics dominate current research. Also considered basic themes are “financial development”, “climate risk”, “green innovation”, “environmental performance”, “renewable energy” and “climate policy” indicating that these concepts are closely linked to sustainable finance in the literature.

When analyzing scientific publications with time stamps, different colors were used to reflect the development of research over time. Darker-colored clusters represent older studies, while lighter-colored clusters indicate more recent research.

In studies conducted during 2020–2021, the main focus was on a combination of keywords such as corporate social responsibility, greenhouse gases, corporate governance, green economy, and others. For the period 2022–2023, research was characterized by topics related to renewable energy, impact, climate change, green bonds, and so on. It should be noted that scientific works published in 2024–2025 show a shift towards studying green development, decentralized finance, cost-benefit analysis, EU taxonomy, sustainable development goals, green innovation, consumption, and similar topics. This indicates a transition to more comprehensive and innovative themes that integrate environmental, economic, and technological aspects of sustainable development.

Thus, as a result of the bibliometric analysis, modern scientific directions and approaches to studying the financial aspects of sustainable development were identified. A sample of 294 publications on the topic was analyzed from the international Scopus database for the years 2020–2025. It was found that researchers' interest in sustainable finance significantly increased during this period. The key focus areas of these studies were sustainable, green, and climate finance.

3.3 Features of Investment Support for the European Green Deal and Digital Platforms for Sustainable Finance

The European Green Deal is a comprehensive package of long-term initiatives by the European Union aimed at its climate strategy. It serves as a roadmap for reducing carbon emissions by EU countries by 55% by 2030 and achieving carbon neutrality by 2050, which requires substantial capital investments [52].

According to estimates by the European Commission, the implementation of the European Green Deal (EGD) will require over €260 billion in additional investments annually. Significant expenditures will be needed to increase the share of renewable energy in the energy generation mix. It is also necessary to finance the electrification of transportation, enhance the energy efficiency of buildings and structures, and invest in low-carbon technologies.

To reduce greenhouse gas emissions and transition the EU towards a resource-efficient, low-carbon, and inclusive economy, substantial

investments are essential. In 2017, the mandate of the European Fund for Strategic Investments (EFSI) was expanded and extended, increasing the target funding amount. At least 40% of this fund’s resources must be allocated to infrastructure and innovative projects that contribute to the achievement of the Sustainable Development Goals (SDGs). Additionally, the capital of the European Investment Bank (EIB) was increased from €5 billion to €7.5 billion to enhance its capacity to attract investments up to €500 billion.

The European Investment Bank (EIB) has been designated as the climate bank of the European Union, tasked with promoting the goals of the European Green Deal both within Europe and beyond. Starting in 2021, all EIB operations must comply with the provisions of the Paris Climate Agreement of 2015, including the gradual phasing out of funding for projects related to fossil fuels. In line with this approach, one of the pillars of the EGD is the Investment Plan, which directly relies on the EU’s Cohesion Policy, allowing for the launch of co-financed projects involving EU member states [51].

The Investment Plan includes three main directions (Figure 19).

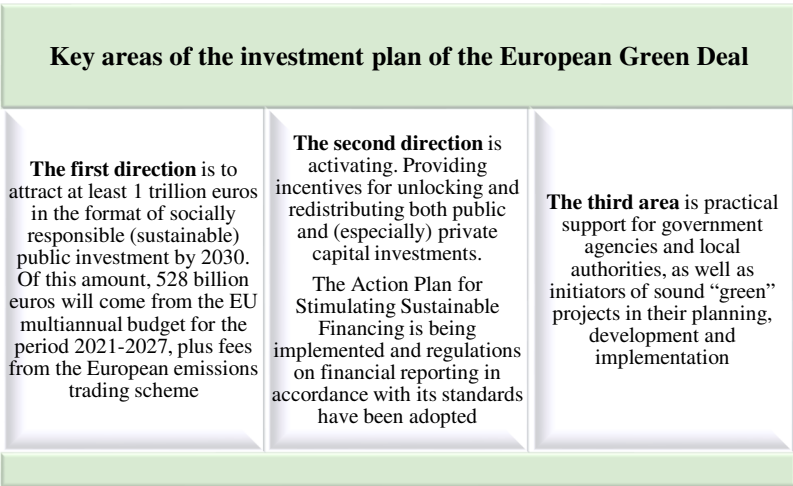


Figure 19. Directions of the European Green Deal Investment Plan
Note - Compiled based on [52]

The main tool of the Investment Plan is the Just Transition Mechanism (JTM). It aims to provide targeted support to regions and sectors facing the

most significant challenges during the accelerated transition to climate neutrality. The Just Transition Mechanism is based on three pillars:

1. Just Transition Fund, with a budget of €17.5 billion (€7.5 billion from the EU's multi-annual budget and €10 billion from the "Next Generation EU" program). The fund's resources are primarily allocated to communities and regions that are most affected by the adverse socio-economic impacts of the transition.

2. InvestEU program, aimed at mobilizing at least €650 billion in public and private investments from 2021 to 2027 for the sustainable recovery of the European economy. Of this amount, 30% is specifically allocated for climate-related goals (financing innovative initiatives with higher financial risks, backed by an EU budget guarantee of €26.2 billion).

3. Public Sector Loan Facility, a credit line to optimize public financing in targeted regions, provided through the EIB (grants from the EU combined with loans from the EIB for projects with no expected financial profit).

In the EU, climate action is integrated into all policies and programs funded by the EU budget and the "Next Generation EU" fund. Moreover, all such expenditures must align with European targets for achieving climate neutrality by 2050, climate goals for 2030, and must comply with the Paris Agreement and the "do no significant harm" principle outlined in the EU taxonomy regulation.

Many initiatives under the European Green Deal require the application of new technologies and the transformation of existing financial models. Research and development in this area are financed through the Horizon Europe budget program, enabling the EU to establish "green" partnerships involving various industrial sectors and EU member states. These partnerships focus on areas such as battery and accumulator production, renewable hydrogen, low-carbon steel, the creation of sustainable urban environments, and biodiversity conservation. The European Innovation Council has allocated €300 million from its own budget for "market-creating" innovations that will support the objectives of the European Green Deal.

The Just Transition Fund is subject to climate conditionality: for a country to access the fund, it must commit to achieving carbon neutrality by 2050. If a country fails to make this commitment, its share of funding from the Fund may be reduced by up to 50%.

Under the InvestEU scheme, a credit guarantee is provided from the EU budget for investors investing in locally initiated projects across four areas:

- Sustainable infrastructure;
- Research, innovation, and digitalization;

- Small and medium-sized enterprises (SMEs);
- Social investments and professional retraining.

Investment opportunities are provided by EU partners, including the European Investment Bank Group, the European Bank for Reconstruction and Development, and national development banks. To receive EU support, proposed projects must:

- Address market failures or capital shortfalls, be economically viable;
- Require initial support from the EU;
- Achieve a multiplier effect and, where possible, attract investments;
- Contribute to achieving EU policy objectives.

EU member states may (by agreement with the Commission, on a voluntary basis) invest in such projects using funds received through European structural funds or the Comprehensive Recovery Plan for the European Economy. In return, they gain access to the EU's high credit-rated budget guarantee.

InvestEU is a digital platform that connects investors and project developers on a unified pan-European platform, providing an accessible and convenient database of EU investment opportunities [53]. Overall, the InvestEU program aims to attract over €372 billion in 2021–2027.

The InvestEU platform offers features such as project pre-evaluation, a list of pre-screened high-quality projects, consulting services on sustainable development financing, and the selection of viable projects for funding. Key advantages for project developers include:

- The application process takes less than an hour;
- Projects can be published on the platform for up to three years;
- The InvestEU platform is free of charge;
- Access to a large pool of potential investors.

For investors, the advantages of the InvestEU platform include:

- A comprehensive database of European projects;
- Standardized project formats for investment;
- Filtering options based on preferences;
- Pitching events and personal meetings via the InvestEU platform;
- Direct contact through the InvestEU portal.

The InvestEU program website consists of three main sections:

1. Public section, providing general information, including a project map (interactive for registered users) and a catalog of projects grouped by country, industry, and other criteria.

2. Online platform for registered users (front office), allowing user registration and providing detailed information such as:

- A database of detailed project presentations (structured summaries available only to registered users);

- Dedicated areas for project developers and investors to submit projects online for publication on the InvestEU portal and to review published projects.

3. Internal platform (back office), used by Commission services for project verification and management.

The InvestEU portal is managed by the European Commission. The content on the portal is created by project developers, both private and public legal entities. To participate on the portal, users must accept the Terms, aimed at ensuring the quality of published information. However, the Commission cannot guarantee the accuracy of the published information, and potential investors must conduct their usual due diligence, including financial and other relevant aspects, before deciding to invest.

If project developers agree to have their projects reviewed based on eligibility criteria, the Commission conducts such a review. The projects must fall within one of the 25 sectors with high economic value-added. The list of sectors and eligibility criteria is provided in Appendix G. According to the eligibility criteria, a project must be located within the EU or in a territory associated with an EU member state. Some technical aspects of the review process may be outsourced to third parties.

Figure 20 shows statistical data on project categories and their geographical distribution as represented on the InvestEU portal.



Figure 20. Statistical data on projects on the InvestEU portal
Note - Compiled based on [53]

The InvestEU portal compiles a list of projects that meet the eligibility criteria and then forwards them to implementing partners (such as the European Investment Fund, national banks, international financial institutions, etc.), who will evaluate projects based on their geographic focus and area of activity.

For project developers and investors needing advisory support, the InvestEU Advisory Hub offers a consultation request feature. The advisory support does not require project developers to submit funding applications and does not guarantee financial assistance. The portal connects project developers with advisory partners to collaborate and help projects reach the funding stage.

Project developers will be denied publication of project information if it is found to be inaccurate. Project information is removed from the InvestEU portal if not updated by the developer within three years [54].

As an addition to the InvestEU portal, the European Commission, together with the European Investment Bank (EIB), decided to create the Green Gateway website [55], developed by Adelphi Consult GmbH (Berlin, Germany). The main page of the Green Gateway website offers two options:

1. Green products of the European Investment Bank;
2. Sustainable finance of the European Investment Fund [56].

In the first case, Green Gateway allows projects to be evaluated against the "green" criteria of the EIB using the Green Eligibility Checker program.

The Green Eligibility Checker supports financial intermediaries in attracting, assessing, and reporting on green investments [57]. It evaluates whether potential investments contribute to climate action and environmental sustainability in accordance with the EIB's criteria. Investments that receive a positive evaluation may qualify for placement within the "green windows" of the EIB's financial products. The results of the Green Eligibility Checker inform users about the projects' compliance with "green" eligibility criteria, the EU taxonomy principles, and the environmental impact of the projects.

In the second case, Green Gateway provides technical assistance to financial intermediaries and end recipients—representatives of small and medium-sized enterprises (SMEs), individuals, and other businesses with small and medium capital—through the InvestEU Sustainable Development Guarantee program of the European Investment Fund, known as the SG Tool [56].

The SG Tool helps financial intermediaries assess investment projects according to the eligibility criteria applicable under the InvestEU

Sustainable Development Guarantee portfolio product. The SG Tool can also be used by potential end recipients to evaluate whether their investments may qualify for support under the Sustainable Development Guarantee portfolio product of InvestEU.

The SG Tool is publicly accessible and can be used free of charge by any market participants.

Additionally, Green Gateway offers guidelines and case studies on "green" investment criteria, as well as access to interactive e-learning programs.

To attract private capital towards green investments, the EU initiated the creation of the International Platform on Sustainable Finance (IPSF). In 2020, 14 countries joined the IPSF, accounting for 50% of the world's population, 50% of GDP, and 55% of greenhouse gas emissions. The platform serves as a multilateral forum for dialogue between policymakers responsible for developing national sustainable development programs and major investors interested in implementing sustainable development concepts. The platform enables participants to share information and promote best practices, taking into account regional and national contexts, comparing various initiatives, and identifying potential obstacles in green finance [58].

The platform advises the Commission on the development, analysis, and revision of technical screening criteria, including the potential impact of such criteria on the assessment of assets classified as environmentally sustainable according to existing market practices [59]. The platform also informs the Commission on the suitability of the technical screening criteria for use in future EU policy initiatives aimed at promoting sustainable investments and the potential role of sustainable reporting and accounting standards in supporting the application of the technical screening criteria. The platform advises the Commission on further measures to improve data availability and quality, while considering the goal of avoiding excessive administrative burdens and addressing other sustainable development tasks.

Experts from the public sector include representatives from the European Environment Agency, ESA, the European Investment Bank, the European Investment Fund, and the EU Agency for Fundamental Rights. Private sector experts include representatives of financial and non-financial market participants, industry representatives, and individuals with experience in accounting and reporting. The platform also includes experts representing civil society, including specialists in environmental, social, labor, and governance issues, as well as experts from academia, including universities, research institutes, and other scientific organizations, including individuals with global experience [60].

The selection process aims to ensure a high level of expertise, geographic and gender balance, and a balanced representation of relevant knowledge in line with the platform's specific tasks. During the selection process, the Commission evaluates candidates according to these horizontal rules to determine if any potential conflicts of interest exist and must take appropriate measures to resolve any such conflicts.

The platform has an indefinite mandate, given the various tasks outlined in the Taxonomy Regulation. It operates based on plenary sessions involving all 57 members and 11 observers, supported by subgroups where technical work is conducted on opinions, reports, or recommendations (Figure 21). The plenary session serves as a forum for ensuring proper linkages between relevant subgroups and for formally approving the platform's recommendations and reports.

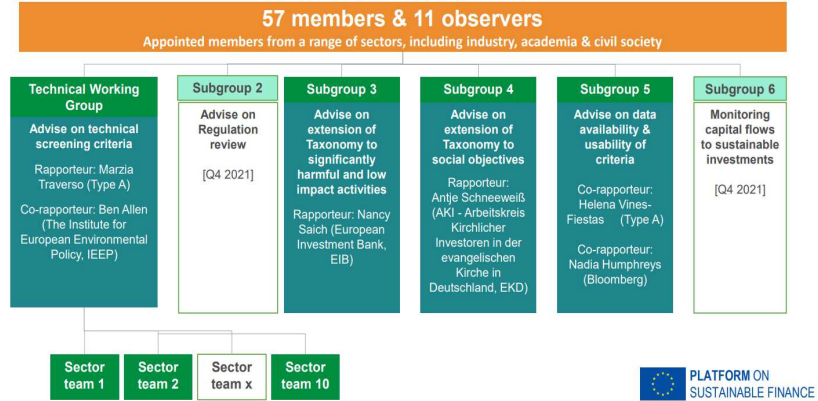


Figure 21. Organizational structure of the International Platform for Sustainable Development (IPSF)

Note - Compiled based on [60]

A broad and balanced representation of stakeholders, expertise, and perspectives enables the Platform to develop recommendations based on scientific data, knowledge, and extensive practical experience. The Platform advises on technical screening criteria for the EU taxonomy that are both applicable and aligned with the ambitions of the European Green Deal.

To visually present the content of the EU taxonomy, a Taxonomy Compass has been developed. Currently, it reflects the provisions of the Delegated Act on climate objectives adopted in June 2021. In the future, updates to the Compass are planned, including the incorporation of specific

regulatory acts that define the technical screening criteria for types of economic activities contributing significantly to the achievement of the climate and environmental objectives outlined in the Taxonomy Regulation.

The Compass is designed as a matrix displaying economic activities in relation to environmental objectives. The Taxonomy Compass aims to provide users with a convenient tool for checking various types of economic activities, identifying their significant contributions, and determining which criteria they must meet. For an economic activity to be considered aligned with the taxonomy, it must comply with minimum safeguards (social standards). These procedures must be implemented by the enterprise and adhere to the "do no significant harm" principle. Compliance with these indicators is essential to ensure alignment with the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights.

3.4 Green Bonds as a Tool in the Green Finance System

Currently, one of the most rapidly developing financial instruments is green bonds, aimed at funding environmental projects across various socio-economic activities. This financial instrument has both financial and social components, as a key criterion for granting a security the "green" status is its focus on reducing environmental risks for society as a whole. The important features of green securities include their high risk, substantial capital requirements, and low returns.

Green bonds are debt securities, with the proceeds from their issuance exclusively allocated to funding green projects. Initially, these were referred to as "climate protection bonds," later as "climate bonds," and since 2008, the umbrella term "green bonds" has been established. This term is not limited solely to climate-related projects but refers to financing initiatives aimed at addressing environmental issues in general [61].

One of the clear competitive advantages of green bonds is their high investment ratings, predominantly rated A or higher. This is attributed to the status of the issuers (many of whom are supranational financial institutions) and the support provided by governments.

It is well known that the quality of securities and their corresponding ratings are inversely proportional to their risk level; therefore, the returns on such financial instruments cannot be high. This fully applies to green bonds. As a result, not all investors consider green bonds suitable for investment, as unlike pension funds, many institutional investors seek to maximize returns.

Another feature of green bonds is their long duration, which is explained by the timeframes required for project implementation. This factor can be seen as favorable for attracting strategic investors, such as pension funds. More than half of the issued green bonds have a duration exceeding ten years, while only about 5% of bonds are issued with a term of 3-5 years.

A current trend in the development of the green finance market is a shift in the motivation of participants. In the past, the main reasons for investors using green bonds were, firstly, the diversification motive, i.e., constructing a portfolio based on a variety of included securities, which also serve as tools for reducing portfolio risk, and secondly, the reputational motive—the desire to present themselves positively by participating in environmental projects. Over time, financial market participants have become increasingly aligned with the ideas of environmental protection.

The Green Bond Principles (GBP) were established in 2014 by a consortium of investment banks in collaboration with the International Capital Market Association (ICMA) to standardize approaches for developing the green bond issuance market, focused on enhancing environmental sustainability. The ongoing monitoring and development of guidelines were subsequently transferred to an independent secretariat based within ICMA [62].

Adherence to the GBP provides investors with assurance that the issuer complies with certain standards regarding the allocation of bond proceeds, the selection of projects, and the reporting provided to investors. The GBP emphasizes the required transparency, accuracy, and integrity of the information disclosed and communicated by issuers to stakeholders. The principles of green bonds are illustrated in Figure 22.

Green Bond Principles			
using debt from bonds to finance green projects and activities that bring environmental benefits	a process for evaluating and selecting projects that ensures transparency in the relationship between investors and issuers regarding the financing of green projects	green bond management in terms of fund distribution and methods of internal monitoring by a third party or auditor for transparency purposes	reporting on the use of proceeds. Information on the amounts allocated and the expected environmental impact of the green project should be updated regularly or until fully allocated

Figure 22. Green Bond Principles
 Note - Compiled based on [63]

It is important to note that the issuer must go through a procedure to determine whether the projects meet the criteria for "green" projects. The projects will also be evaluated for compliance with other eligibility criteria and may be subject to additional processes for final selection.

Green projects typically fall into the following categories: renewable energy; energy efficiency; pollution prevention and control; environmentally sustainable management of natural resources and land use; conservation of terrestrial and aquatic biodiversity; clean transportation; efficient water and wastewater management; climate change adaptation; environmentally efficient and/or circular economy products, production technologies, and processes; and green buildings.

To issue green bonds, the issuer must demonstrate how its strategy aligns with the environmental objectives of the countries involved and provide detailed information about the intended use of the raised funds. It is expected that the introduction of unified standards for green securities will enable issuers to attract capital at a lower cost, while allowing investors to choose genuinely green bonds. This, in turn, will significantly contribute to the development of the financial infrastructure in this area and increase investor interest in this asset class.

Currently, the range of available instruments in the field of sustainable bonds is expanding significantly. There are three main categories of bonds: green, social, and hybrid, often referred to by the acronym GSS (Green, Social, Sustainability). In addition to these three core instruments, sustainable securitized products are also developing actively. These products not only use financing for green and social projects but are also backed by "sustainable" collateral, such as a portfolio of green loans. Another interesting instrument is the Sustainability-Linked Bond (SLB). The terms of these bonds are tied to specific sustainability-related KPIs (e.g., greenhouse gas emissions targets).

Transition bonds have also seen widespread development. These bonds are designed for companies operating in the most carbon-intensive industries (such as coal, metallurgy, and oil and gas). While these companies may not currently meet strict green criteria, they are focused on a "green" transition, which requires substantial financial resources.

Figure 23 illustrates the volumes of GSS+ bonds, including green, social, sustainable, transition, and Sustainability-Linked Bonds.

The cumulative volume of sustainable bonds exceeded \$4.4 trillion in 2023. The largest share is attributed to green bonds, amounting to \$2.8 trillion. A total of 96 countries participated in the issuance of green bonds, demonstrating the significant interest of nations in green finance instruments.

Aligned GSS+ scorecard					
	 Green	 Social	 Sustainability	 SLB	 Aligned GSS+
Total size of market (cumulative)	USD2.8tn	USD821bn	USD768bn	USD48.6	USD4.4tn
Number of countries	96	49	69	23	106
Number of currencies	53	46	43	12	64

Figure 23. Global sustainable bond volumes in 2023

Note - compiled from the source Climate bonds Initiative [64]

The dynamics of green bonds and GSSS (Green, Social, Sustainability, and Sustainability-Linked Bonds) volumes are shown in Figure 24.

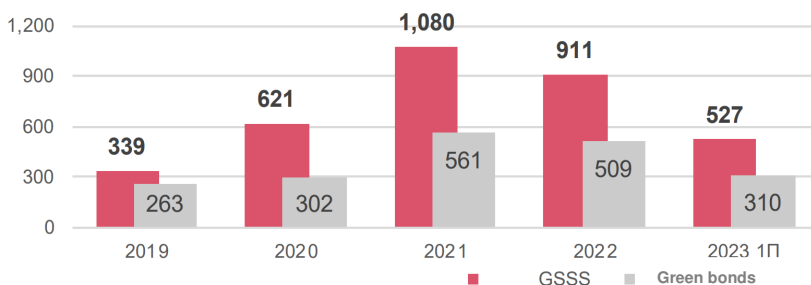


Figure 24. Volume of green bonds issued worldwide, in billions of US dollars

Note - compiled from the source PwC [65]

Since the first issuance of green bonds by the World Bank, the volume of this market has grown at a significant pace. The market downturn occurred for the first time in February 2022 due to the energy crisis,

geopolitical tensions, rising inflation, and increased interest rates. The issuance of GSSS (Green, Social, Sustainability, and Sustainability-Linked Bonds) decreased by 24%, while green bonds experienced a 16% decline compared to 2021.

In the early stages of market development, simple instruments are typically issued, primarily diversified by issuers [66]. Unlike other bonds, green bonds are distinguished by their targeted use of financial resources for "green" projects. Notably, payments on such bonds are not tied to the performance of the projects themselves, meaning investors are not exposed to project risks.

As the instruments evolved, more complex green bonds began to emerge, transforming into project bonds. These bonds still offer a fixed income and serve as a means to attract financial resources (either in full or partially) for a specific infrastructure project, which is more cost-effective for the issuer than bank financing. Investors relied on a stable cash flow due to the issuer's long-term obligations, making it a generally acceptable investment method. However, when these cash flows are guaranteed solely by the revenue from the sale of goods and services generated by the project—as is the case with structured green bonds—the limited recourse rights increase investor risks. This is because their ability to claim owed funds is limited only to the green assets provided as collateral.

The features of the international green bond market are illustrated in Figure 25.

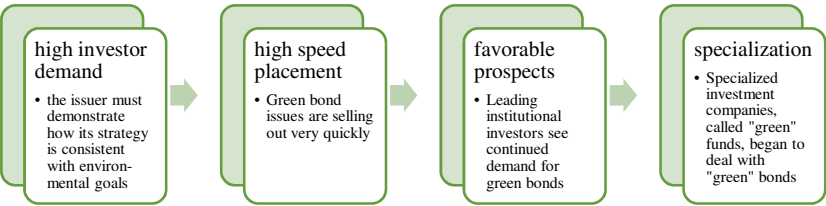


Figure 25. Features of the international green bond market
Note - Compiled based on [67]

To mitigate risks, issuers employ securitization mechanisms, including both on-balance-sheet and off-balance-sheet securitization, as well as traditional and synthetic securitization. They often create special purpose vehicles (SPVs), and rating agencies evaluate the specific asset pool rather than the issuer itself. In the event of default, recovery may be sought from the collateral assets, but this will still be limited. This increases risks on the

one hand but, on the other hand, leads to higher yields for green bonds, attracting institutional investors who are interested in less liquid assets.

Given the favorable outlook, specialized investment companies known as green funds have emerged, focusing on green bonds. These funds are created by institutional investors active in this market, allocating resources primarily for investments in green bonds.

The further development of the green bond market is moving towards the digitalization of the global economy and the use of digital currencies, which will contribute to an increase in the issuance of digital green bonds.

3.5 Modern Trends in the Development and Standardization of Green Bonds in the EU

The consolidation of political efforts among EU member states aimed at developing a unified sustainable development strategy, along with active public support for environmental initiatives and the creation of common green bond standards across the EU, has enabled the formation of effective measures for standardizing green finance. A significant advantage of the European green finance model is the strong role of private initiative: the state provides the legal framework for the functioning of this market but is not the primary issuer.

The European Union is the leading region in green bond issuance. From 2014 to 2022, Europe accounted for 46% (\$405 billion) of the total volume of GSS+ bond issuance [68].

Figure 26 shows the volumes of green bonds by regions of the world.

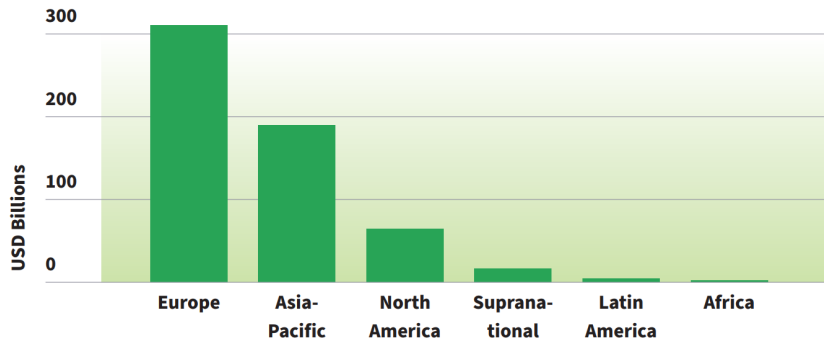


Figure 26. Green bond volumes by world region in 2023, US\$ billion
Note - Compiled based on [68]

The European Union leads in the cumulative volume of green bonds. As of the end of 2023, the volume of green bonds in the EU exceeded \$300 billion.

Table 6 presents information on the current trends in the development of the green bond market in the EU.

Table 6. Current trends in the EU green bond market

Current status	Drivers	Barriers	Prospects
- volume of issuance in 2023 – over \$300 billion; - diversified green investment market with high level of private capital activity; - existence of voluntary European green bond standard	- a single economic zone; - a highly developed legal infrastructure for the green bond market; - a high level of investor confidence in green bonds of European companies; - active participation in the exchange of best practices in the field of green financing	- economic instability of individual EU member states	- the active development of the green bond market in the EU is predicted with the active participation of private capital investments; - the main volume of green bond issues will be accounted for by a small number of the most developed countries
Note - Compiled based on [69]			

To regulate and standardize green financial instruments, the European Commission established the Technical Expert Group on Sustainable Finance (TEG) in 2018. The group's tasks include developing a unified classification system for sustainable economic activities, approving the European green bond standard, and setting benchmarks for low-carbon investment strategies. Based on expert assessments and feedback from international organizations, TEG published guidelines for the voluntary use of the European Green Bond Standard in 2020 [70].

In 2019, the European Parliament and EU member states reached an agreement on the adoption of new "Disclosure Requirements Rules for Sustainable Investments and Sustainability Risks through Disclosure Regulation." These rules are based on three fundamental principles:

- **Elimination of greenwashing:** Companies must not make false or misleading claims about the sustainability characteristics and benefits of an investment product. The disclosure regulation aims to eliminate greenwashing while increasing financial market awareness of sustainability.

- **Regulatory neutrality:** The regulation provides a disclosure framework that should be applied equally by different financial market operators. The European Banking Authority, the European Securities and Markets Authority, the European Insurance and Occupational Pensions Authority, and the Joint Committee of European Supervisory Authorities will monitor the harmonization of disclosures across all relevant sectors.

- **Level playing field:** Disclosure rules apply to investment funds, insurance investment products, private and professional pension funds, individual portfolio management, insurance companies, and investment funds.

As the number and scale of green bond issuances increased, professional financial market participants began to consider the possibility of pooling such bonds, which required issuance standards and mechanisms for trading and redemption. While the yield on these securities was deemed acceptable by professional investors, non-speculative investors were more focused on selecting securities with an effective mechanism for controlling the cash flows generated by these financial instruments.

The standardization of green bonds was undertaken by the international nonprofit organization Climate Bonds Initiative (CBI), founded in 2010. The key activities of CBI include: analyzing and researching the green bond market, developing standards and a certification system for green bonds, and reviewing legislative initiatives at the national level aimed at promoting green finance.

In late 2011, CBI published the first voluntary climate bond standard and an accompanying certification scheme, primarily for financing wind energy projects. Subsequently, the scope of the standards was expanded to cover the most investment-attractive sectors, including solar energy, clean public transportation, and energy-efficient buildings. From 2012 to 2015, four additional sectoral standards were developed and approved for projects related to solar energy, low-carbon public transportation, and energy-efficient buildings. Furthermore, sectoral standards were created for issuing bonds aimed at financing projects in wind energy, tidal energy, and geothermal energy.

In 2017, these standards were updated to expand the range of eligible debt instruments that could be certified for green bond issuance. The new version of the standards placed greater emphasis on the certification process, with clearer requirements for participants involved in issuing and

trading green bonds, particularly for issuers and infrastructure organizations facilitating the trading of these securities. Issuers are required to obtain a compliance certificate from a third party, confirming that the securities meet all the criteria set by the Climate Bonds Initiative. This procedure is not part of, nor a substitute for, the classification process for green bonds, which is conducted by a second party — specifically invited experts.

Notably, the Climate Bonds Initiative is not an official international organization, and compliance with its standards is voluntary. Issuers are not obligated to undergo certification, and having a certificate did not initially affect the ratings of these securities or their classification as "green" or "climate" bonds.

In 2014, the International Capital Market Association (ICMA) joined the conceptual and methodological work in the field of green bonds, focusing on the following key areas in green finance:

- Developing and updating the Green Bond Principles (GBP), which establish uniform standards for transparency, disclosure, and reporting;
- Engaging with governments, regulatory bodies, central banks, and stock exchanges, both nationally and internationally, to enhance financial regulation of the green bond market;
- Facilitating the exchange of experience and information among association members and other market participants on the development of green bonds.

In 2014, a consortium of investment banks developed the Green Bond Principles (GBP), which have become the accepted benchmark followed by most global green bond issuers. The GBP are international principles. Additionally, there are national and regional principles and rules established based on regulatory frameworks [71].

The framework of the "Green Bond Principles" (GBP) can be represented in the form of five models for responsible bond issuance as outlined by ICMA (Figure 27).

The first model, green bonds, assumes that the proceeds from the issuance of green bonds are used exclusively for the financing and/or refinancing, either partially or fully, of new and/or existing green projects. It is important to note that certain green projects may also generate additional social benefits, so the qualification of bonds as green should be determined by the issuer based on the main objectives of the projects. If the bond issuance is simultaneously targeted towards environmental and social projects, they are labeled as Sustainability Bonds, with their issuance process governed by a separate guideline. The key requirement for classification as green bonds is compliance with the four ICMA principles:

use of proceeds, project evaluation and selection process, management of proceeds, and reporting.

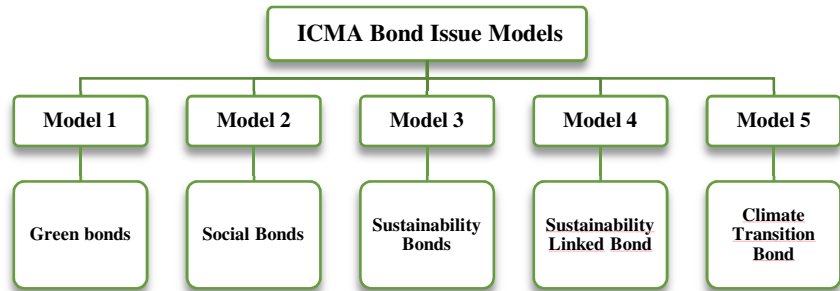


Figure 27. ICMA Responsible Bond Issuance Models
Note - Compiled based on [71]

The second model, social bonds, involves directing the proceeds exclusively towards the financing and/or refinancing, either partially or fully, of new and/or existing social projects. The issuance of social bonds also requires adherence to the four GBP principles, and the borrower’s business must align with the Social Bond Principles (SBP).

The third model, Sustainability Bonds, directs the proceeds exclusively towards financing and/or refinancing a combination of green and social projects. Compliance with both the four principles of GBP and the Social Bond Principles (SBP) is required.

The fourth model, Sustainability-Linked Bonds (SLB), uses the proceeds raised for general corporate purposes, with a mechanism for adjusting the financial or structural characteristics of the issuance in the event of a trigger event, typically associated with the failure to meet key sustainability performance indicators. Compliance with GBP/SBP and SLBP (Sustainability-Linked Bond Principles) is required. In general, any type of bond instrument linked to key sustainability performance indicators falls under this model. The financial and/or structural characteristics of the bond may vary depending on whether the issuer meets the pre-determined sustainability goals. Thus, issuers explicitly commit (including in the bond documentation) to improve their sustainability performance within specified timeframes. Accordingly, Sustainability-Linked Bonds are instruments aimed at achieving specific, pre-set goals, which are measured using defined key performance indicators and evaluated based on established corporate Sustainability Performance Targets (SPTs).

The fifth model, Climate Transition Bonds, is issued by companies with high carbon emissions to finance and/or refinance projects that support low-carbon or net-zero transition goals. Compliance with GBP/SLBP and the Climate Transition Finance Handbook (CTFH) is required. Disclosure recommendations during the capital-raising process include four key elements that must be reflected in the issuance documentation: the issuer's strategy for transitioning to a low-carbon economy and related management practices; the relevance of the business model for environmental protection; the scientific basis of the low-carbon transition strategy, including its goals and pathways; and transparency of information on the implementation of the strategy. Disclosure must be provided for any issuance of bonds with targeted capital use or bonds linked to sustainability. Relevant information may be included in the annual report, framework document, or company investment presentation, provided these documents are publicly accessible to investors. At the same time, independent assessment, assurance, and verification can either be included in the issuance documentation as a second opinion or presented within the issuer's ESG reporting, especially for the verification of environmental data.

The European Green Bond Standard (EU GBS) was developed in line with the EU Sustainability Taxonomy and is based on the work of international organizations like CBI and ICMA. The Green Bond Standard was introduced to enhance transparency, integrity, and consistency of green bond characteristics in the European market. The Standard specifies three requirements for green bonds:

Proceeds from green bonds must be used exclusively for financing or refinancing green projects in accordance with the EU Sustainability Taxonomy.

The bond issuance documentation must comply with the four Green Bond Principles. The alignment with the four GBP components must be verified by an independent accredited external reviewer.

According to the EU GBS, the following barriers hinder the development of the green bond market:

- Issuers find it challenging to assess the economic benefits of green bonds, as internal costs related to additional process management and reporting requirements are significant compared to standard bonds.
- The pricing advantages of green bond issuance appear minor and inconsistent.
- External review procedures seem complex and costly, subject to conflicts and quality control issues.

Enhanced reporting requirements for projects and activities financed by such bonds make green bonds labor-intensive and less attractive for issuers,

as information must be provided annually until all proceeds are fully allocated, as well as on non-financial aspects.

There is some uncertainty about the types of assets and expenditures that can be financed through green bonds.

Table 7 outlines several recommendations based on the EU Green Bond Standard to address existing challenges and promote the growth of the green bond market in the EU.

Table 7. Possible solutions to existing problems for the growth of the EU green bond market

Barriers to the Development of the Green Bond Market	Recommendations for removing barriers
Insufficient number of green projects	Complementing policies that directly increase investment in green assets in the real economy
Issuers' concerns about reputational risks	Reducing reputational risks through a robust external auditor accreditation scheme
Lack of clear economic benefits for issuers	Developing measures to facilitate the issuance and circulation of green bonds; subsidies to offset additional costs associated with external audits
Complex, expensive reporting and external control procedures	Standardization and simplification of the verification process, reduction of costs for external verifications
Time-consuming reporting procedures	Standardization of reporting requirements, simplification of the process and differentiation of reports
Uncertainty about the type of assets and expenditures that can be financed through green finance	Expanding the scope of eligible expenditure on funds borrowed for green bonds
Note - Compiled based on [71]	

Thus, promoting the development of the green finance market in the EU is based on regulating this field through specific methodological guidelines. Issuers of green bonds are advised to undergo an independent external assessment of the green bond issuance to verify its compliance with certain standards. Although such assessments are voluntary in most cases, they are strongly recommended. External assessments are conducted by independent experts who evaluate the green bond issuance for its adherence to standards

or guidelines, such as the Green Bond Principles (GBP), Climate Bonds Standards (CBS), ASEAN Green Bond Standards, and others.

The issuer may seek the services of external consultants or institutions with the necessary expertise in green projects. The evaluation process helps assess the project's risks and the quality of the issuer's actions in raising funds through the issuance of bonds. On average, over 80% of green bonds have undergone independent consultant evaluations. Assessments for green bonds provide investors, governments, and shareholders with assurance about the targeted nature of green financing, as well as access to a comprehensive disclosure system for the project.

The types of external assessments for green bond issuance are shown in Figure 28.

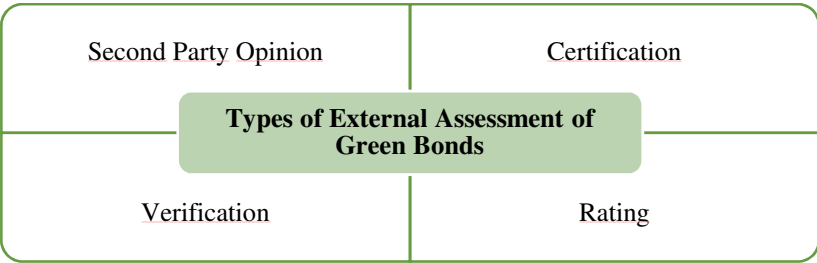


Figure 28. Types of external evaluation of green bond issues
Note - Compiled based on [72]

The conclusion of external expert organizations, known as a second party opinion, is an assessment provided by an expert company that evaluates the project's risks and the credit quality of the issuer for raising funds through bond issuance.

Green bond ratings may be assigned to individual issues as well as to entire securities programs. For example, the international rating agency Moody's has developed the Green Bonds Assessment (GBA), which focuses on the issuer's adherence to the principle of targeted use of proceeds, as well as the quality of project management and reporting.

If a company plans to obtain a Climate Bond Initiative (CBI) certificate for issuing green bonds, it is necessary to involve accredited verifiers for the verification process. These verifiers include consulting and auditing firms (such as Deloitte, KPMG, and others), certification agencies, and consulting firms specializing in responsible investing and green finance. Currently, the Climate Bond Initiative has the most developed methodology for certifying green bonds, which is based on the principles of green bonds.

The Centre for International Climate and Environmental Research (CICERO, Norway) holds the largest market share for external assessments of green bonds: the company has issued 2,500 opinions, representing 70% of the market. The next largest company by market share is Sustainalytics (Netherlands), which has issued 262 external assessments, accounting for 7% of the market. Sustainalytics provides consulting services, strategy development for responsible investing, climate risk management for asset managers, ESG rating development, and analysis of investment portfolios for compliance with responsible investment principles.

One of the main objectives of the actively implemented Climate Bonds Standard is to build confidence among investors and governments that the proceeds from bond issuance are being used in a targeted manner to implement environmentally sustainable projects in the context of climate change adaptation.

3.6 The Role of Green Loans in Achieving Environmental Sustainability

One of the key instruments in the green finance market is green loans, which have been developing rapidly in recent years and possess significant potential. Green loans are a type of loan provided exclusively for the financing or refinancing, either fully or partially, of new or existing environmentally friendly projects.

Many studies highlight that green loans serve as a link between environmental industries and financial organizations, while green financing as a whole is seen as a solution for addressing environmental issues and resource management.

The official launch of the green lending market occurred in 2005 by American financial organizations. In the subsequent years, this financial instrument gained widespread popularity. However, a trend of declining volumes in sustainable lending is expected in 2024 compared to 2023 (Figure 29).

The decline in the volume of sustainable lending is attributed to the strict requirements for green projects, which are still not offset by the broader application of Sustainability-Linked Loans (SLLs) across many industries.



Figure 29. Global sustainable lending volumes, US\$ billion
Note - Compiled based on [73]

The key players in the sustainable lending market are the United States and Germany (Figure 30). Germany shows an increase in the volume of sustainable lending in 2024 compared to 2023, while the United States experiences a decline. Growth in 2024 is also observed in Switzerland, Singapore, Italy, the UAE, Taiwan, and China.

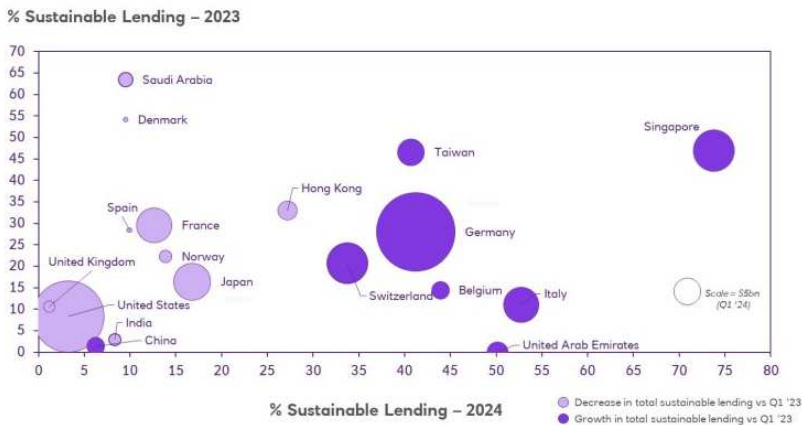


Figure 30. Share of sustainable lending – key markets (in %)
Note - Compiled based on [73]

The growth of sustainable lending in Germany is primarily driven by syndicated deals in the industrial segment. In Singapore, there is a significant increase in sustainable lending, supported by the Singapore

Sustainable Finance Association. The UAE has shown a growing interest in sustainable lending.

The share of sustainable lending by sector is shown in Figure 31.

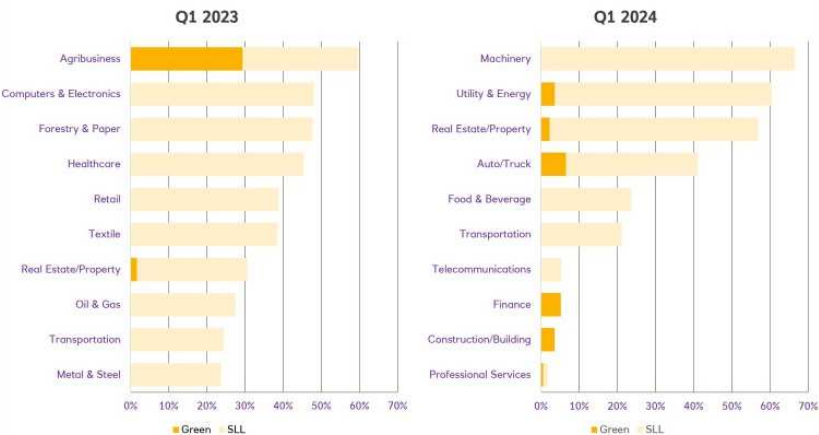


Figure 31. Share of sustainable lending in the main sectors of the global economy (in %)
Note - Compiled based on [73]

In 2024, global sustainable lending was primarily concentrated in the engineering, energy, real estate, and utilities sectors. Engineering accounted for the largest share of sustainable lending (over 65%) due to the prevalence of Sustainability-Linked Loans (SLLs). The highest share of green lending was observed in the transportation, financial, energy, and construction sectors.

Credit relationships based on green lending are attractive to many borrowers and lenders (Figure 32).

Analyzing the benefits of green loans for financial institutions, it is evident that green lending facilitates the enhancement of environmental risk management processes within banks and the integration of innovative banking services, contributing to the transformation of the banking business model towards sustainable development. For banks, the provision of green loans is not merely an act of corporate social responsibility or a response to public policy; it serves as a strategic tool for boosting competitiveness. The efficient deployment of green lending mitigates environmental risks,

broadens the scope of financial instruments, and fosters sustainable economic growth.



Figure 32. Benefits of green loans for financial institutions

Note - compiled by the authors

For borrower organizations, securing green loans enhances corporate reputation: a robust reputation for social and environmental responsibility has a favorable impact on the company's valuation. Public discourse frequently emphasizes environmental concerns, creating a "halo effect" for companies that can demonstrate strong environmental credentials or a commitment to sustainable practices. Furthermore, even if a company opts to disregard reputational issues, it remains bound by the expectations of its shareholders and regulatory frameworks. This trend is particularly pronounced in Europe, where major corporations are mandated to disclose sustainability performance as part of their annual reporting obligations.

As the market for green loans continues to mature, integrating these loans into pooled asset funds (e.g., through securitization) is becoming increasingly feasible. The widespread adoption of the LMA Green Loan Principles would contribute to the growth of the green finance market by promoting standardization in green lending practices and enabling investors to assess the legitimacy of capital market instruments.

Many creditors assert that firms operating on a sustainable basis are more likely to exhibit superior strategic leadership and robust management practices. An additional advantage is the external verification process: sustainable debt typically requires the borrower's operations to undergo review or certification by third-party sustainability experts. This certification process ensures that the borrower's corporate governance and

internal operations meet specific standards. Consequently, companies with green credit obligations are expected to have superior risk management capabilities overall, reducing credit risk and justifying the more favorable pricing typically associated with well-defined sustainability criteria.

The theoretical analysis of the benefits and drawbacks of green loans for the parties involved in credit relationships can serve as a basis for developing financial documentation and specialized credit products tailored by financial institutions.

In 2018, the Loan Market Association, together with leading financial institutions, introduced the Green Loan Principles (GLP), which are modeled after the widely recognized Green Bond Principles. The GLP delineate criteria for identifying a loan as "green." Compliance with these principles assists regulatory and supervisory authorities in applying eligibility criteria for providing incentives (such as grants or tax relief), thereby facilitating access to more cost-effective financing for environmentally sustainable projects. The GLP are designed to enhance the green finance market by ensuring consistency within the green lending sector.

Overall, the framework of green loan principles is anchored in fundamental components illustrated in Figure 33.

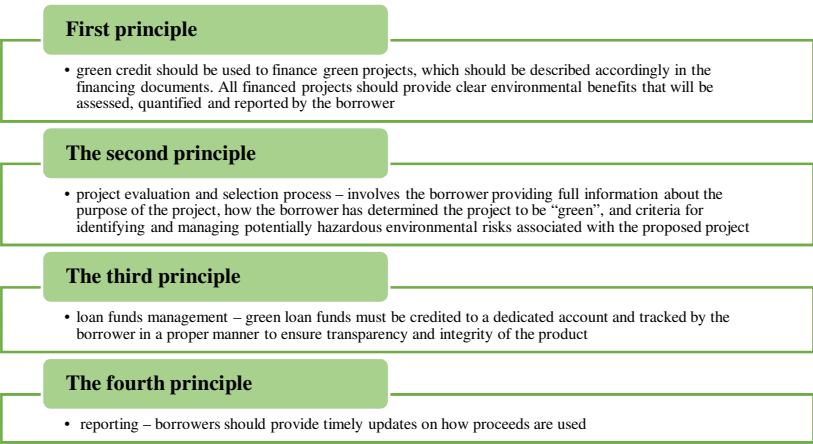


Figure 33. Principles of green lending
Note - compiled from the source [74]

The first principle stipulates that the loan must be used to finance green projects, which should be appropriately described in the financial

documents. All projects financed must deliver clear environmental benefits, which should be evaluated (where possible), quantified, and reported by the borrower.

The second principle, the project evaluation and selection process, requires the borrower to provide comprehensive information on the project's objectives, how the borrower classified the project as "green," as well as criteria for identifying and managing potential environmental risks associated with the proposed project.

The third principle, the management of proceeds, states that the funds from the green loan should be credited to a designated account and monitored by the borrower in an appropriate manner to ensure transparency and integrity of the product. If the green loan takes the form of a credit line with multiple tranches, each tranche of the green loan must be clearly designated. The proceeds from these tranches must be credited to a separate account and monitored by the borrower accordingly. Borrowers are encouraged to establish an internal process for managing and tracking the allocation of funds to green projects.

The fourth principle, reporting, advises borrowers to provide timely updates on the use of proceeds. In cases where confidentiality agreements, competitive considerations, or a large number of underlying projects limit the level of detail that can be provided, the Green Loan Principles (GLP) recommend reporting in general terms or on a portfolio basis. Information should only be shared with institutions participating in the credit relationship.

Transparency is particularly important in disclosing the expected outcomes of the project. The GLP recommend using both qualitative and quantitative performance indicators (e.g., energy efficiency, electricity generation, greenhouse gas emission reductions) and disclosing the key methodology for their calculation. Borrowers who have the capability to track achieved outcomes are encouraged to include them in regular reports.

External evaluation of the project and support in developing the green lending process are recommended when necessary. This service may include consulting, verification, certification, and rating assessment. When receiving consulting services, the borrower can obtain advice from an institution recognized for its expertise in environmental protection, sustainability, or other aspects of green loan administration. During verification, the structure of the green loan, including both the participants and the object of the loan, may be reviewed by independent qualified parties such as auditors or independent ESG rating representatives. Unlike certification, verification may focus on alignment with internal standards or borrower requirements.

A borrower may have a green loan or a corresponding green credit card certified according to an external green assessment standard. The assessment standard defines the criteria, and compliance with these criteria is verified by qualified third-party certifiers. Additionally, the borrower may obtain a green loan evaluated by qualified third parties, such as specialized rating agencies.

The following requirements apply to the credit agreement:

- Purpose: The use of proceeds section should specify that the loan funds will be applied to achieve objectives consistent with the Green Loan Principles (GLP) of the LMA. This approach is similar to the one used for green bonds. One of its advantages is simplicity. However, while it is suitable for term loans, it may not be appropriate for revolving financing mechanisms (e.g., supply chain finance).

- Margin adjustment: In this case, the margin depends on a rating based on sustainability criteria rather than creditworthiness. In most green loans, margin adjustments are binary (i.e., if the targets are met, the margin decreases; if not, it increases). The rating is based on various factors such as environment, health, safety, clients, suppliers, and staff, where the margin varies depending on the company's performance across several criteria. The level of margin adjustment is not always significant—in some transactions, it is only a few basis points, but in others (especially in more recent deals), the margin may fluctuate much more.

- Green asset ratio: The borrower must ensure that the value of its investments in green assets is not less than the amount of its green debt. This is necessary to realize the benefits of a targeted approach. However, it is acknowledged that a company may not always demonstrate that the loan was directly applied for green purposes.

- Third-party verification: Although the LMA Green Loan Principles theoretically allow borrowers to self-certify their compliance with sustainability criteria, adherence to these criteria usually depends on certification or verification by third-party experts. A key challenge for the development of the green lending market is to build trust in third-party verification by ensuring standard compliance and consistent application across transactions.

Green banking instruments in the retail segment include green credit cards, green auto loans, green mortgages, and green home equity loans [75]. Green credit cards allow the cardholder to donate 0.1-1% of the purchase or transaction amount to nonprofit organizations involved in environmental activities. Green auto loans offer a lower interest rate (at least 0.25% lower) compared to standard auto loans. The interest rate on green auto loans varies based on different indicators, such as CO2 emission intensity and fuel

efficiency. Lower CO₂ emissions and higher fuel economy result in a lower interest rate.

Green mortgage loans are offered to borrowers at a lower interest rate compared to market rates. Homes purchased or upgraded with these mortgages are more energy efficient. Obtaining a green mortgage ensures an environmentally friendly living space and reduces housing costs. A key requirement for green mortgage loans is the availability of documents proving the energy efficiency of the property. For example, in the Netherlands, standards for green mortgages have been established. Under this project, homebuyers receive special certificates for purchasing and upgrading homes. These certificates can be used to obtain loans on more favorable terms.

In international practice, green loans are classified based on various characteristics. Table 8 presents the types of green loans offered by commercial banks.

Table 8. Classification of Green Loans

Category	Subcategory
Green loans to borrowers in specific industries	Green agricultural loans, industrial energy, green forestry projects, etc.
	Environmental protection, ecological restoration and disaster prevention projects
	Resource recycling projects
	Waste Removal and Pollution Prevention Projects
Renewable Energy Credits	Solar energy projects, wind projects, biomass power projects, hydropower projects, etc.
Loans for rural and urban water supply	Drinking water safety engineering projects, water conservation projects, urban water conservation projects
Loans for energy saving and green building	Green transformation of existing construction projects, green construction, development, operation and maintenance projects
Loans for green transport projects	Rail transport projects, waterway management and vessel procurement projects, urban public transport projects, environmental transport projects
Loans for the development of energy-saving and environmental services	Energy saving services, environmental protection services, water management services, circular economy services
Note - compiled from the source [76]	

Green home equity loans are aimed at upgrading homes with energy-efficient and conservation technologies. The interest rates for these loans are typically 0.33-1% lower than for standard loans. The loan funds are generally used for installing solar and wind energy systems, energy-efficient windows, furnace and heating system replacements, roofing, new insulation systems, and more. The development of such financing in Europe is supported by the Energy Efficient Mortgages Initiative (EEMI) [77].

The EEMI is a global market initiative aimed at mobilizing capital markets and implementing best practices to achieve sustainable development goals in the financial sector, while also supporting the objectives of the European Green Deal and the Renovation Wave Strategy. The EEMI focuses on building a new ecosystem that involves collaboration among all stakeholders and provides macroprudential frameworks for financing energy-efficient buildings and implementing energy-saving home renovation solutions.

The cost of borrowing under green lending programs is often lower than that of traditional credit instruments, as these loans are considered less risky for banks for at least two reasons. First, more environmentally friendly and energy-efficient housing reduces utility expenses, thereby increasing the borrower's ability to make timely loan payments. Second, such housing is more attractive and typically has a higher market value compared to similar buildings without green features. In the event of a sale of energy-efficient homes or apartments, banks can achieve a higher financial return.

When analyzing the sectoral structure of the green lending market, it is notable that over 90% of borrowed funds are directed toward financing green infrastructure projects with an average repayment term of over 15 years. This can be attributed to relatively low credit risks: green infrastructure projects have a default risk of 5.7%, compared to a default risk of 8.5% for non-green infrastructure projects. The next main area of green project financing involves the development of renewable energy sources and the activities of energy-generating companies.

Easing the credit policies of banks to expand the share of green loans is the most significant challenge and a key factor in achieving the goals of the green economy and green finance.

Chapter 4. Analysis of Trends in Sustainable Finance Regulation and Prospects for Green Transformation in Kazakhstan

- 4.1 Green Budgeting and Green Tax Policy in European Countries
- 4.2 Green Tax Policy in European Countries
- 4.3 Regulation of Financial Institutions in the Context of Green Transformation
- 4.4 Implementation of ESG Strategies in the Practices of European Banks
- 4.5 Current Trends in Green Financing in the Republic of Kazakhstan

4.1 Green Budgeting and Green Tax Policy in European Countries

The development of green finance is achievable with active state participation, through the formulation and implementation of green policies. Many countries utilize taxes, subsidies, budgetary funds, and other financial instruments to address environmental issues, making a substantial contribution to the expansion of green finance.

Currently, budgetary funds are one of the primary sources for financing environmentally focused projects. A modern trend in greening the financial system is the adoption of green budgeting in developed countries, which has led to significant changes in budgetary policy, redirecting it towards achieving environmental and climate goals. Through this tool, governments identify, measure, and monitor public expenditures aimed at achieving the Sustainable Development Goals (SDGs) and environmental projects. This facilitates informed budgetary decisions and the mobilization of additional resources. Budget tagging based on SDGs and green labeling helps enhance the transparency and accountability of government expenditures allocated to SDGs and green projects, fostering public and expert discussions.

Over the past decade, most countries worldwide have developed modern budget management systems capable of creating a favorable environment for integrating green budgeting tools into the budget process. Key characteristics of this favorable environment include:

- The application of strategic public management principles;
- Transition to medium-term budgeting and the development of medium- and long-term budget forecasts;
- The use of program-target management methodology and the formation of government budgets in a program format;
- Close cooperation between government agencies, parliamentary bodies, and civil society institutions.

Budget financing for environmental projects is grounded in a framework of legal and regulatory documents:

- Budget laws that determine the volume of budgetary financing for the fiscal year;
- Government programs outlining priority areas and basic conditions for financing activities related to sustainable development and environmental problem-solving.

One of the foundational documents that served as a basis for developing methodological guidelines for green budgeting was the OECD's Budgeting for Cooperation Initiative, dated 2017. According to the OECD's approach, green budgeting refers to the reorientation of budgetary policy towards achieving sustainable environmental and climate goals. This involves assessing the environmental impacts of budgetary and tax policy measures as part of fulfilling international commitments and national environmental legislation requirements [79].

The tools of green budgeting include national projects and programs aimed at achieving green economy goals, tax instruments (environmental taxes, ecological fees, progressive tax rates, etc.), green financial instruments such as government climate and green bonds, subsidies for priority projects in the green agenda, analytical documents for analyzing, monitoring, and evaluating budget spending on national economic goals related to ecology and climate change mitigation; classification (tagging, labeling) of budget revenues and expenditures to assess their impact on environmental indicators; performance metrics; environmental budget reporting, and others [80].

The integration of green budgeting tools into the budget process has received strong support from influential international financial institutions. In addition to the OECD, the World Bank and IMF have been actively involved in this initiative. Alongside other international organizations, such as the Global Initiative for Fiscal Transparency (GIFT) and the Open Government Partnership, significant progress has been made in developing and promoting universal international norms and commitments related to green budgeting.

Various countries have gradually begun integrating the principles and tools of green budgeting into their budget processes. SDG budget tagging has already been implemented in Mexico and Nepal. Green labeling and green budget formulation are being carried out in France, Ireland, Italy, Germany, the United Kingdom, Colombia, Armenia, Canada, and other countries. Figure 34 shows the Green Budget Index of OECD countries.

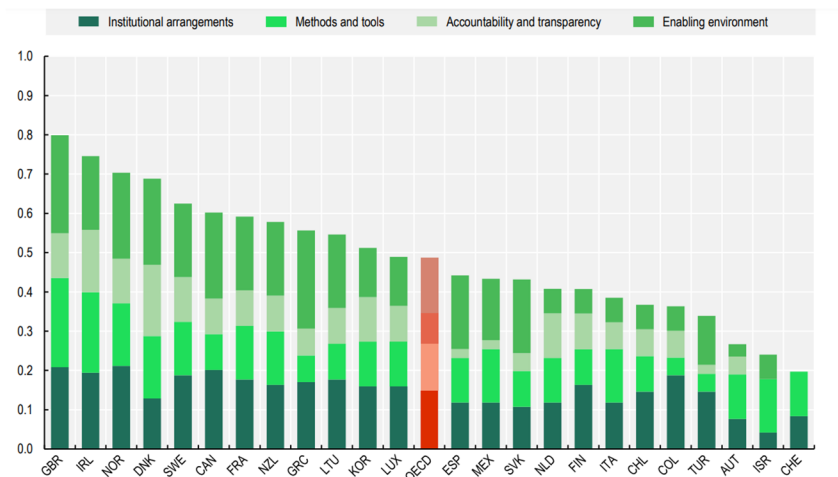


Figure 34. OECD Green Budgeting Index 2023

Note - compiled from the source [79]

The implementation of green budgeting mechanisms is a complex process, whose effectiveness depends on the current level of development of the budgetary process (availability of reporting, budget formulation analysis, evaluation systems, etc.), the government's commitment to environmental goals and obligations, the presence of accountability systems, qualified personnel, and other factors.

Making informed budgetary decisions aimed at expanding green budgeting practices requires analysis and systematic evaluation of the environmental outcomes of implemented budget policies within the framework of achieving national strategic priorities for sustainable development. For this purpose, the following set of green budgeting tools is recommended:

- Development of strategic documents on environmental protection and climate change;
- Ex-ante analysis of budget revenues and expenditures to assess their impact on the environment and the achievement of strategic environmental goals;
- Analysis of budget costs and expenditure efficiency with respect to their environmental impact;
- Green budget tagging (identifying budget expenditure items by type of environmental impact and degree of influence);

- Development of target performance indicators for environmental spending, integrating environmental indicators into a results-oriented budgeting system;
- Monitoring the effectiveness of budget spending and interim assessments of progress toward environmental goals;
- Ex-post analysis of environmental goal achievements compared with actual budget expenditures, and evaluation of spending efficiency (systems for reporting on environmental finance—CPEIR and PEIR);
- Audit of the effectiveness of budget expenditures on environmental goals.

Among the advantages of classifying the budget by its impact on ecology and climate are the following:

- Enhanced awareness of how budget decisions align with national goals;
- Provision of information that can be used to increase the effectiveness of government actions in achieving national objectives;
- Green budget tagging can assist in resource mobilization and increase transparency and accountability of public policy by improving monitoring and reporting;
- Helps countries make progress toward fulfilling their international commitments, including under the Paris Agreement.

One of the key tools in green budgeting is the green tagging of budget items, which involves identifying expenditure items that affect environmental goals [81]. The unique feature of the green budget tagging method lies in classifying budget expenditures based on their impact on ecology and climate (biodiversity, air and water issues, etc.). It is important to recognize that challenges may arise in determining the environmental impact of various budget items, as some are easy to classify, while others are more complex.

The difficulties that may arise when implementing green tagging principles in budget practices include:

- Determining the level of detail for tagged expenditures. Different activities within a single budget item may have varying impacts on green goals, and the absence of tagging can reduce the actual efforts aimed at achieving green objectives. Conversely, detailing budget expenditures for tagging requires additional resources, including time. One solution is "weighting" the item, i.e., considering only a portion of the budget item as green spending;
- Assessing expenditures related to disaster risk management is challenging in terms of their impact on environmental goals. For instance, flood control measures may negatively affect biodiversity conservation and

lead to ecosystem changes. Therefore, it is necessary to account for the potential environmental damage, which may require additional restoration expenditures;

- Evaluating the negative impact of budget expenditures on the environment is an important factor, as the volume of subsidies detrimental to green goals may exceed the volume of environmentally beneficial budget expenditures;

- Reaching consensus among stakeholders is crucial for understanding how certain budget expenditures impact green objectives. Since decisions regarding budget tagging are subjective and influenced by national goals and characteristics, achieving alignment in tagging helps make informed decisions;

- Balancing social and economic goals when pursuing green objectives. Green goals may have both positive and negative correlations with social and economic objectives, which must be considered when tagging budget expenditures. For example, social subsidies may negatively impact green objectives (e.g., subsidies for transportation), while increasing taxes on non-eco-friendly fuels may adversely affect social goals (e.g., higher prices for low-income groups) [82].

The necessity for countries to meet their commitments under the 2030 Agenda, which includes a substantial block of specialized environmental indicators, has become a significant driver for reorienting the budget process towards green formats.

Environmental tagging was first implemented in Nepal in 2012, followed by over 20 (mostly developing) countries developing their own tagging methodologies. The first OECD country to implement environmental tagging was Ireland in 2018. In 2020, France introduced the world's first comprehensive green budget as an annex to the 2021 Finance Act.

As previously mentioned, France was the first country to publicly announce its transition to a green budget format, fundamentally restructuring the budget process by implementing a full set of green budgeting tools. In 2020, the French government published its first green budget as an annex to the 2021 Finance Act [83]. This was preceded by a major transformation of the country's budgetary process over the past 70 years. In 2021, all types of French budget expenditures were analyzed for their potential impact on the environment. According to this analysis, of the €574.2 billion, nearly 9.2% (€52.8 billion) had a direct impact on climate and the environment.

In implementing the principles of green budgeting, France actively uses green tagging of expenditures, practically linking all budgetary expenditures

to the strategic priorities of the state in sustainable development. Under this tagging, all government expenditures are divided into three categories: purely green (beneficial), mixed, and unfavorable (Table 9). This classification is based on their impact across six environmental objectives: climate change mitigation, climate adaptation, water resource management, circular economy and waste management, pollution control, and biodiversity conservation and sustainable land use.

Table 9. Categories of Green Budget Expenditures in France

Categories of budget expenditures	Description of budget expenditures
Purely "green" (favorable) expenses	Expenditures that are environmentally beneficial according to at least one environmental criterion; in relation to other criteria, these expenditures must be (at least) neutral
"Mixed" expenses	Expenditures that have a favourable effect on one or more environmental criteria but an adverse effect on others
Unfavorable expenses	Expenditures that are unfavourable for at least one environmental criterion and do not have any positive impact on the remaining criteria
Note - compiled from the source [84]	

Between 2020 and 2021, these environmentally sustainable expenditures increased by €8.5 billion, indicating the French government's strong commitment to ecological transformation (Figure 35).

In 2021, the share of "mixed" expenditures amounted to €4.7 billion. These funds were primarily allocated for the development of transport infrastructure, mainly railways. Additionally, the 2021 budget included €10 billion of "unfavorable" expenditures, the majority of which (€7.2 billion) represented lost revenues due to tax exemptions and reduced tax rates, including consumption taxes on fuel and energy products. It is worth noting as a positive outcome that in 2021, the amount of unfavorable expenditures decreased by €1 billion.

To better integrate environmental considerations into public policy management, the French "green budget" serves as a new tool that will be updated and expanded each year throughout the budget cycle. An analysis of the French budget demonstrated that green budgeting tools provide

evidence of the extent and nature of the impact of budgetary policy measures and expenditures on achieving environmental and climate goals. The implementation of green budgeting supports transparency and accountability measures, enabling oversight of the impact of budget policy on national climate and environmental targets.

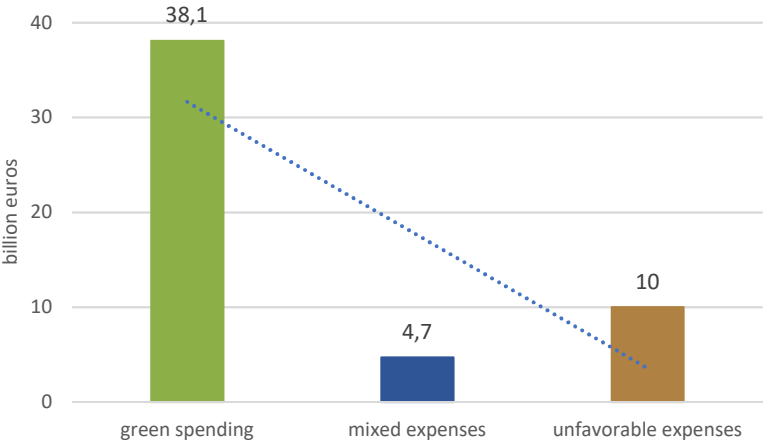


Figure 35. Distribution of expenditure in the French budget in 2021
Note - compiled from the source [85]

In 2023, France implemented its third green budget, with the expenditures presented in Figure 36.

An analysis of the expenditure dynamics of France’s green budget indicates a growth in favorable (effective) spending. At the same time, in 2023, there was a sharp increase in unfavorable (ineffective) expenditures, primarily due to the need to mitigate the rapid rise in energy prices.

Although the tagging of the green budget highlights budgetary measures that have a positive impact on socio-economic and environmental development, special attention should be given to budgetary measures that negatively affect greening efforts. Reducing the negative impact on the environment and natural surroundings is a more effective method than merely supporting and developing positive budgetary measures. It also has a significant impact on the social sphere.

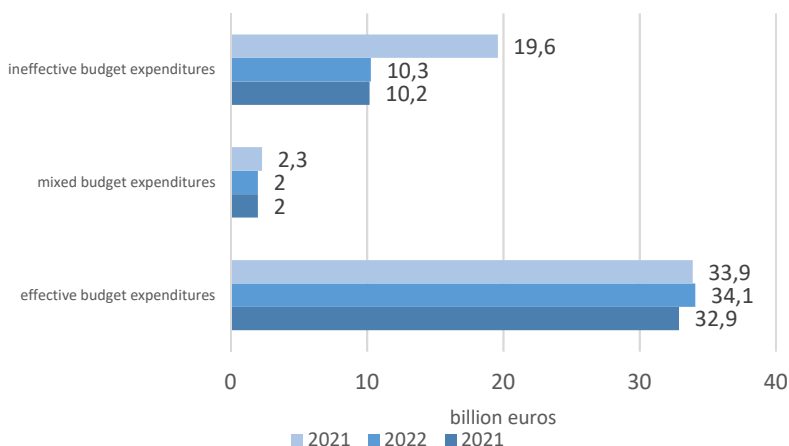


Figure 36. Expenditures of the French green budget in 2023, without support and incentive measures aimed at combating rising energy prices
 Note - compiled from the source [85]

To ensure substantial progress in the application of green budgeting tools, it is necessary to:

- Integrate green innovations into the budget process as outlined in the OECD methodology (especially the tagging of budget expenditures and measures);
- Adopt a unified format for national goals and indicators for achieving environmental and climate objectives;
- Conduct green classification of budget policy measures and expenditures based on the nature of their impact (positive or negative) on achieving environmental and climate targets;
- Evaluate the effectiveness of budget expenditures from a green perspective and set specific performance goals aligned with national sustainable development targets [86].

The formation and implementation of a new green public financial policy and green budget, comprising comprehensive measures and an effective mechanism tailored to modern trends and conditions, is of utmost priority. This approach will drive the country's development and elevate it to a new level of socio-economic progress. In the context of globalization and the evolving global community, where the threat to financial security is increasing, the role of the state in mitigating such risks is undeniably significant.

4.2 Green Tax Policy in European Countries

One of the most effective economic tools for ensuring sustainable natural resource use, environmental protection, and the implementation of "green" economy principles is tax policy. It is realized through the integration of environmental factors into the general taxation system.

The main idea behind using tax instruments is to establish a link between the amounts of contributions made by enterprises to budgets and the extent of environmental harm caused by these enterprises. Environmental charges serve as fiscal instruments, primarily aimed at increasing budget revenues. It is important to note that taxes also have a stimulating function, encouraging changes in the behavior of economic entities that cause environmental harm. These tools should be applied as charges, with the revenue generated used to incentivize behavior change through subsidies for environmental investments. Thus, environmental taxes play both a protective and compensatory role. They can act as a stimulus for reducing the negative impact on the environment while also providing compensation for environmental and economic damage. This dual role highlights their uniqueness as instruments for reducing environmental pressure and fostering the development of a green economy.

An environmental tax is defined as a tax whose tax base is a physical unit (or an indirect measure of a physical unit) that has been proven to cause specific negative impacts on the environment [87].

According to OECD reports, environmental regulations governing production should adhere to the following principles:

- Green taxes should target activities that pollute the environment;
- The tax rate should be proportional to the level of environmental damage caused;
- The tax should be reliable, with a predictable rate to encourage behavior that supports environmental protection;
- Environmental taxes may need to be combined with other environmental policy instruments to address specific issues [88].

Environmental taxes are widely used in many countries around the world. A notable example is the European Union, where environmental taxes are classified into four distinct categories based on their application areas: energy, transport, pollution, and resources (Figure 37).

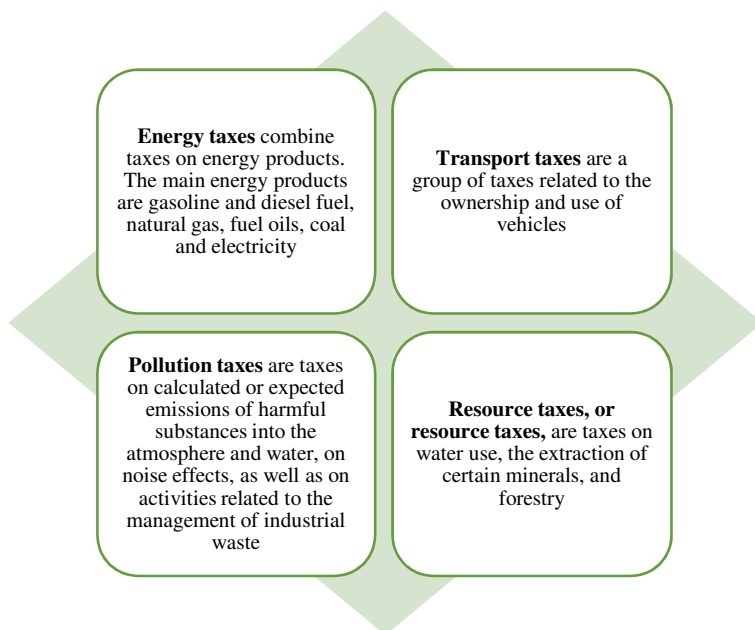


Figure 37. Types of environmental taxes

Note - compiled from the source [87]

Energy taxes encompass taxes on energy products used both for transportation and stationary purposes. The primary energy products for transportation purposes include gasoline and diesel fuel. Stationary energy products include natural gas, fuel oils, coal, and electricity.

It is noteworthy that taxes on carbon dioxide (CO₂) emissions are categorized as energy taxes rather than pollution taxes. This classification is due to several reasons. Firstly, CO₂ taxes often cannot be separately identified in tax statistics, as they are integrated with energy taxes, for example, through differentiated oil tax rates. Additionally, they are sometimes introduced as a substitute for other energy taxes, and the revenue generated from these taxes is often substantial compared to pollution taxes. As a result, international comparisons may be distorted. Carbon taxes play a crucial role in reducing greenhouse gas emissions, particularly in sectors not covered by the European Emissions Trading System (ETS). It should be noted that carbon taxes, due to their fiscal specificity, have a much stronger impact on fuel demand than a mere increase in prices.

Energy taxes are classified into the following types:

- Taxes on motor fuels;
- Taxes on energy fuels;
- Taxes on electricity.

For instance, in the United Kingdom, energy taxation is primarily based on excise duties on hydrocarbon oils. The taxable items are numerous but can be grouped into four categories: light oils, crude oil, biofuels, and gas used as fuel. In Germany, the main energy tax is on petroleum products.

The types of transport fuel include diesel, leaded and unleaded gasoline, as well as alternatives like natural gas and liquefied petroleum gas.

Energy taxes constitute the largest share of total revenue from environmental taxes, accounting for slightly over 76% of the overall volume. In countries like the Czech Republic, Lithuania, Luxembourg, and Romania, they represent more than 0.9 of total environmental tax revenues. Conversely, in Malta (51.3%), Norway (55.4%), Denmark (55.5%), and the Netherlands (55.9%), energy taxes make up just over half of environmental tax revenues. Over the past decade, there has been a slight increase in revenue from energy taxes, largely due to energy consumption, rising energy prices, and energy efficiency policies.

Governments offer tax incentives to encourage businesses and individuals to invest in technologies and practices that reduce energy consumption. This includes improving building insulation, using more fuel-efficient vehicles, and implementing more energy-efficient production processes.

Transport taxes are a category of taxes associated with the ownership and use of vehicles. Importantly, taxes on gasoline, diesel, and other transportation fuels are included in energy taxes rather than transport taxes.

Transport taxes can be divided into one-time and periodic taxes. One-time transport taxes are related to the import or sale of equipment, while periodic transport taxes include annual road taxes.

Transport taxes include charges such as:

- Distance-based taxes;
- Annual vehicle ownership taxes;
- Excise duties on vehicle purchases.

Among environmental taxes, transport taxes generate the second-largest share of revenue, accounting for about 20% of total environmental tax revenues. There is a steady trend of increasing revenue from transport taxes, largely driven by the growing number of vehicles. The relative importance of transport taxes is significantly higher in Austria (35.5% of all environmental tax revenues), Ireland (38%), Denmark (38.7%), Malta (40.3%), and Norway (40.6%). The lowest share of transport taxes in total

environmental tax revenues is observed in Estonia (2.2%) and Lithuania (2.5%).

Pollution taxes are levied on calculated or estimated emissions of harmful substances into the air and water, noise pollution, and activities related to waste management. However, CO₂ taxes are classified under energy taxes, while taxes on SO₂ emissions are included in this group.

Imposing pollution charges also stimulates innovation and a constant search for new technologies, as businesses start looking for more environmentally friendly alternatives. For example, in Sweden, the introduction of a tax on nitrogen oxide emissions led to a significant increase in the use of emission reduction technologies: before the tax, only 7% of companies used such technologies, but a year after its implementation, the figure rose to 62%.

To make pollution charges a reliable source of budget revenue, the taxable base must be stable enough to ensure predictable revenue streams. The burden of payments should be either widely distributed or concentrated on regulated entities that benefit most from the collected revenues, while administrative costs should be kept low. Since it is challenging to meet these conditions in a pollution charge system, especially one covering a wide range of pollutants, OECD countries generally consider it an inefficient source of earmarked revenues.

Resource taxes, or taxes on resources, are levied on water use, the extraction of certain minerals, and forestry activities. Thus, resource taxes are applied when exploiting natural resources, including water, minerals (excluding oil and gas), and forests for commercial purposes.

Environmental taxes are primarily composed of energy taxes (around 60%), followed by transport taxes (around 30%), with the remaining categories accounting for about 4% of the total environmental tax revenue (Figure 38).

The use of economic tax instruments for environmental protection is reflected in the 8th EU Environmental Action Programme up to 2030, the EU Sustainable Development Goals, and the "Europe 2030" strategy.

In addition, environmental taxes can be divided into two major categories:

1. "Polluter pays" taxes, levied on the producer or consumer at the point of pollution.
2. "User pays" taxes, imposed on the extraction or utilization of natural resources.

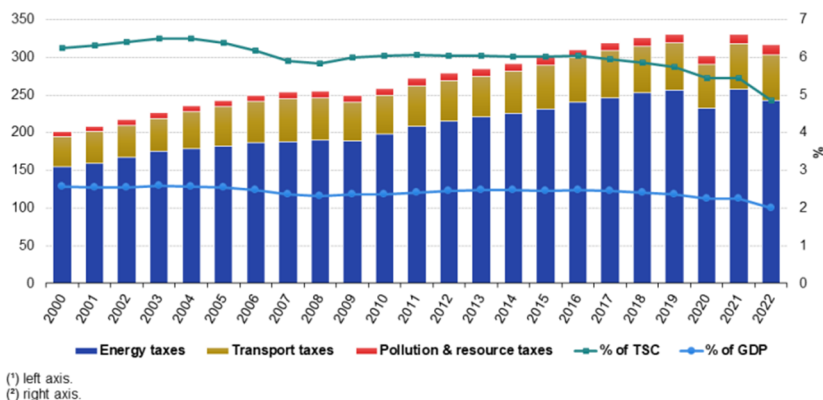


Figure 38. EU environmental tax revenues 2000-2022
(EUR billion, % of TSC, % of GDP)

Note - compiled from the source [89]

Based on the purpose of introduction, environmental taxes are classified into three groups:

1. Cost-covering charges: The earliest examples of environmental taxes arose from traditional regulatory environmental policies. This category of environmental taxes involves covering the costs where users of the environment contribute to or cover the expenses associated with monitoring or controlling their use of environmental resources. Cost-covering charges can be of two types:

- Usage fees, charged for a specific environmental service (e.g., wastewater treatment or waste disposal).
- Targeted levies or deferred payments, where revenues are allocated towards relevant environmental goals without directly providing a service to the payer (e.g., funds for waste recycling services).

2. Incentive taxes: An environmental tax may be introduced solely to alter environmentally harmful behavior without any intention of increasing revenue. Such a tax can serve a purely incentivizing role. The level of the incentive tax can be determined based on estimates of the environmental damage costs or the necessary price signal required to achieve environmental objectives. The revenues from such taxes are often used to further promote behavior changes through grants or tax reliefs. An example is the tax on NO_x emissions in Sweden or the toxic waste charge in Germany.

3. Fiscal environmental taxes: These include energy taxes and a variety of other non-energy taxes, such as taxes on waste, wastewater, pesticides, fertilizers, sulfur, etc. Examples include CO₂ taxes in Sweden and Norway.

It is evident that these three types of environmental taxes are not mutually exclusive: cost-covering charges may have incentivizing effects, and revenues from fiscal environmental taxes may be partially allocated to relevant environmental goals. This classification by primary intention aids in assessing the effectiveness of environmental taxes.

Regulatory or incentivizing environmental taxes are primarily designed to alter taxpayer behavior that harms the environment without the intent to generate revenue for the state budget. Moreover, fixed-rate payments often decrease if the tax is effective, as does the tax base.

Environmental taxes, as a source of budget revenue, can also influence behavior while generating significant income for the state budget, which often far exceeds the costs of tax collection. Environmental taxes can serve as a revenue source for targeted environmental programs.

It is important to note that environmental taxes are an integral tool of the state's environmental policy. However, regardless of the goal of introducing or revising a system of pollution charges, it must aim to achieve specific environmental policy objectives.

A particularly interesting example is the gradual increase in the carbon tax in Sweden, which allowed taxpayers to adapt to the changes. The carbon tax has been in place in Sweden since 1991, contributing to the goal of becoming a CO₂-neutral country by 2045. The increase in energy and carbon taxes was combined with reductions in other taxes to avoid an overall rise in the tax burden. This was supported by a flexible system of distribution and measures to stimulate employment growth. Sweden has the highest standard carbon tax rate in the world. In 2024, the carbon tax rate in Sweden increased to 1,450 Swedish kronor (125 euros) per ton of fuel with 100% fossil content, such as natural gas or coals for the carbon tax include importers, distributors, and large consumers of fossil fuels. For example, the tax on gas supplied to gas stations is already collected at the level of the importer or distributor, meaning there is no need to collect the tax from the gas station operator or end consumer. In practice, the tax amount is passed along the supply chain, either fully or partially. The carbon tax amount is not itemized in the fuel price. These rules simplify administration, as the number of taxpayers is significantly limited.

Although the carbon tax in Sweden does not apply to fossil fuels burned for electricity production, this exception is limited, as Sweden's electricity sector relies on nuclear and hydroelectric power, resulting in low emissions [90].

The basis of the carbon taxation system was achieving a balance between environmental and economic principles (i.e., meeting environmental goals should not lead to reduced competitiveness in certain economic sectors or increase the financial burden on citizens). Consequently, the introduction of the carbon tax did not face public resistance and enabled the achievement of both sustainable resource use and environmental protection goals while maintaining economic stability at both micro and macro levels.

Sweden's experience demonstrates that emission reductions can coexist with economic growth. The taxation system, combined with other climate and energy policy tools, can yield effective results [91].

One of the most significant initiatives of the European Union is the introduction of the Carbon Border Adjustment Mechanism (CBAM), designed to prevent carbon leakage. This mechanism aims to tax imports of products from countries with lower environmental standards than those in the EU. The objective of this carbon border tax is to prevent "environmental dumping" while encouraging the EU's trading partners to adopt stricter environmental policies. Thus, CBAM ensures a level playing field for businesses within the EU and those outside its borders.

Initially, CBAM applies to six sectors: cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen. These sectors are characterized by high emission intensity and are most vulnerable to carbon leakage. Following the transition period, the scope of the tax may be expanded.

The transitional phase of the Carbon Border Adjustment Mechanism will last until December 31, 2025, with full implementation expected in 2026. The introduction of the carbon tax requires importers to purchase and surrender carbon certificates based on the emissions generated during the import process. The price of these certificates will be linked to the European Emissions Trading System (ETS). If a producer from a non-EU country can demonstrate that they have already paid a carbon price for the emissions produced during the manufacturing of imported goods in the third country, the corresponding cost may be fully deducted for the EU importer. CBAM is designed to protect EU domestic production and create a level playing field in terms of carbon regulation [92].

One of the main challenges facing the EU is the harmonization of environmental taxes among its member states. The rates of environmental taxes vary significantly across countries, which can distort competition. It is crucial to enhance tax consistency among EU member states and ensure a coordinated ecological transition.

4.3 Regulation of Financial Institutions in the Context of Green Transformation

The transition from extensive, resource-intensive economic growth to sustainable development and a "green" economy requires substantial financial investment. Experts estimate that the cost of accelerating access to the Sustainable Development Goals (SDGs) by 2030 could reach up to \$6.4 trillion annually. To secure this level of funding, an active government policy is essential for coordinating, incentivizing, and monitoring activities in the field of "green" finance. Figure 39 illustrates the required financing volume across seven key sustainable development areas.

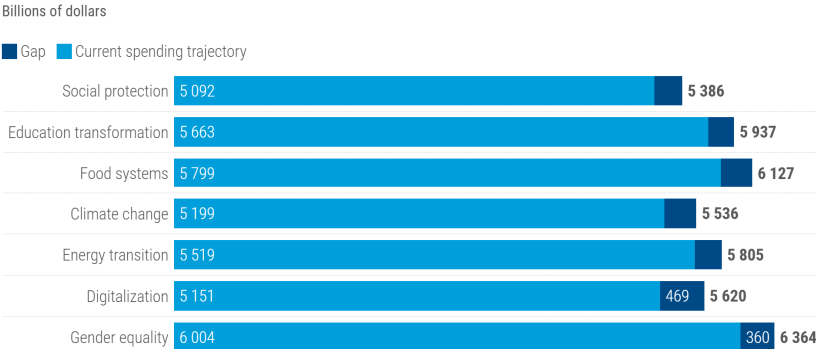


Figure 39. The volume of necessary financing in the areas of transition to the SDGs

Note - compiled based on data [93]

According to UNCTAD estimates, when covering all developing economies and using the median per capita cost across 48 developing countries included in the study, the total annual needs from 2023 to 2030 will range from USD 6.9 trillion to USD 7.6 trillion.

At the national level, the policy aimed at achieving the Sustainable Development Goals (SDGs) should also focus on creating conditions for the growth of "green" financing. In this regard, many countries utilize government subsidies, tax incentives, preferential tariffs, and other economic policy tools. However, to significantly expand green financing, tax incentives alone are insufficient. Regulatory and incentive measures are needed to increase the contribution of financial organizations to addressing environmental challenges and developing green financing.

Currently, financial market regulators face several objectives related to developing rules for forming and operating an internal environmental and climate risk management system for financial organizations, establishing requirements for climate-related financial information disclosure, setting standards for assessing the compliance of financial market participants with these requirements, promoting climate-responsible behavior among financial institutions, and developing and implementing methodologies for identifying and monitoring climate risks in the financial market.

The initiatives of greening the financial sector are presented in Table 10.

Table 10. Initiatives in the Field of Greening the Financial Sector

Initiative	Description
Principles of Responsible Investment	Considering ESG factors when making investment decisions
Sustainable Stock Exchanges Initiative	Cooperation of stock exchanges and investors, issuer companies, regulators, international organizations on ESG issues and promotion of sustainable investments, financing of SDGs
Global Alliance for Banking Values	Using finance for economic, social and environmental development
Climate Bond Standard and Certification Scheme	Criteria and requirements for climate bonds
Network for Sustainable Banking	Association of banking regulators and banking associations of private financial institutions
Green Bond Principles	Definition of Green Bond Components and Criteria
Center for Green Finance and Investment	Implementing effective policies, creating institutions and instruments for financing the green economy
Network of central banks and financial supervisors to green the financial system	Concentration of finance for the development of ecology and the implementation of climate risk management in the financial market
Bringing together international financial centres to support the	Supporting the development and application of sustainable finance

development of sustainable finance	
Principles of Responsible Banking	Sets global benchmarks for sustainable banking
Green Bond Initiative	Investing in projects and assets needed for a rapid transition to a low-carbon and sustainable economy and its adaptation to climate change
Taxonomy in Green Finance	Establishing criteria for determining the “greenness” of financial instruments
Note - compiled from the source [95]	

The emergence of sustainable finance can be traced back to the United Nations Environment Programme Finance Initiative (UNEP FI, 1992), which marked the beginning of a partnership between UNEP and the global financial sector aimed at mobilizing private financial resources to support the Sustainable Development Goals (SDGs). In 2006, the United Nations introduced a global initiative known as the Principles of Responsible Investment (PRI), where the term ESG (Environmental, Social, and Governance) first appeared as a comprehensive set of factors to be considered in order to minimize long-term investment risks.

The Principles of Responsible Investment represent a set of voluntary commitments to integrate social, environmental, and governance factors into investment strategies with the aim of minimizing long-term investment risks. PRI is based on the premise that institutional investors and asset managers are obligated to act in the best long-term interests of their investors and, therefore, must adequately consider how ESG issues may affect the performance of investment portfolios.

The financial sector has seen the following notable trends:

Firstly, the principles of responsible investment are being integrated into the decision-making process for business investments and financing. In particular, ESG principles are being adapted for traditional financial instruments, while new financial instruments are being introduced that focus on ESG criteria in investment decision-making.

Secondly, institutional conditions for the sustainable financial services market are being formed, including the modernization of financial institutions aimed at achieving sustainable development goals and developing standards for the provision of sustainable financial services [95].

Adhering to the principles of responsible investment enables financial organizations to more effectively manage reputational and regulatory

business risks, better diversify their investment portfolios, and achieve the same financial benefits in their activities as non-financial companies.

One significant initiative in the field of sustainable development and green investment is the Central Banks and Supervisors Network for Greening the Financial System (NGFS), established in December 2017 at the One Planet Summit in Paris. Its goal is to promote the implementation of measures necessary to achieve the goals of the Paris Agreement, develop a climate risk management system for the financial market, and mobilize capital for environmentally friendly and low-carbon resources. In recent years, the NGFS has brought together central banks and regulators from more than 50 countries and 12 international organizations, including the central banks of Germany, the United Kingdom, Finland, France, and others. The member countries of the NGFS represent 44% of global GDP, 31% of the population, and two-thirds of globally systemically important banks and insurance companies. The NGFS aims to encourage central banks and regulators to take action to develop a green financial system.

One of the key and widely recognized standards in green financing is the Equator Principles (EPs), which provide a set of guidelines for managing environmental and social risks in project financing and lending. The Equator Principles can be applied to project financing (valued at USD 10 million and above), advisory services for project financing, corporate loans linked to projects, and bridge loans [96]. The Equator Principles are based on standards developed by the International Finance Corporation in the field of environmental and social sustainability.

Financial institutions adhering to the Equator Principles (EPFI) must classify projects according to their category. There are three main project categories:

Category A: Projects with potentially significant environmental and social risks and/or negative impacts that are irreversible.

Category B: Projects with potentially limited environmental and social risks and/or negative impacts that are localized and easily reversible.

Category C: Projects with minimal social and environmental risks and negligible or no negative impacts.

The subsequent actions taken with each project depend on the category it has been assigned [97].

Disclosure requirements for Equator Principles Financial Institutions (EPFI) include:

- The number of advisory services for project financing;
- The number of project finance loans and corporate loans linked to projects, broken down by sector and geographic region;

- Implementation reporting, including responsibilities, staffing, the role of senior management, and the integration of the principles into credit and risk management policies and procedures.

As noted by Finger et al. (2018), adherence to the Equator Principles has become a long-term strategic decision for banks in developing countries [98].

The Equator Principles represent an international initiative that has brought together 105 banks and investment companies from 38 countries. These institutions have agreed upon conditions for monitoring the "environmental friendliness" of investment projects worth over USD 10 million and have collectively pledged to refrain from financing and investing in large projects that pose significant environmental risks. However, their scope mainly covers substantial projects.

At the same time, the day-to-day operations of a financial organization should ideally also have sustainable characteristics and be aimed at minimizing potential environmental and social risks. In this regard, it is worthwhile to examine the experience of European Union regulators, who in recent years have implemented several measures to strengthen the focus on sustainable development within financial institutions.

The work of Pianta et al. (2020) provides a detailed assessment of current EU actions in promoting sustainable growth, including financing programs, budgetary rules, competition policy, and the activities of the European Investment Bank [99].

In March 2018, the "Action Plan: Financing Sustainable Growth" was published, aimed at: "redirecting capital flows towards sustainable investments to achieve sustainable and inclusive growth; managing financial risks related to climate change, resource depletion, environmental degradation, and social issues; and promoting transparency and long-term sustainability in financial and economic activities" [100].

In December 2019, the European Banking Authority (EBA) adopted the EBA Action Plan on Sustainable Finance. The primary objectives of this document include:

- Improving the regulatory framework to encourage financial institutions to develop in line with sustainability principles;
- Incorporating sustainability provisions into the development strategies and risk management of financial institutions;
- Providing regulatory authorities with a comprehensive set of tools for monitoring and assessing social, governance, and environmental risks that financial institutions may face.

The Action Plan on Sustainable Finance outlines not only the main areas of work in sustainable finance and its authority within the current legislative

framework but also a roadmap for the adoption of regulatory documents on sustainable finance covering the period from Q4 2019 to the first half of 2025. Based on this document, the European Banking Authority published a Discussion Paper on Management and Supervision of ESG Risks for Credit Institutions and Investment Firms, which describes how social, environmental, and governance risks can be incorporated into the regulatory framework.

In turn, the European Union has developed directives in the field of sustainable finance, which are presented in Table 11.

Table 11. Regulation of Sustainable Finance in the EU

Indicators	CSRD proposal	SFDR	EU Taxonomy Regulation
Requirements	The CSRD extends the scope of disclosure obligations under the mandatory EU standards on sustainability reporting	SFDR requirements for content, methodologies and presentation of information (on major adverse effects, products) for financial market participants and financial advisers at the organization, service and product level	A classification that provides companies, investors and policymakers with a list of environmentally sustainable economic activities
Scope of application	All major companies and all companies publicly listed on EU financial markets	Financial market participants and financial consultants at the level of organizations, services and products	Financial market participants; all companies in accordance with CSRD
Note - compiled from the source [100]			

In alignment with the European Commission's Action Plan on Financing Sustainable Growth, the European Central Bank (ECB) developed the Guide on Climate-Related and Environmental Risks: Supervisory Expectations Relating to Risk Management and Disclosure, with the latest version published in November 2020. This document serves as a recommendation, describing current regulatory practices for environmental and climate risks, providing classifications, and detailing their impact on traditional banking risks.

The EU Action Plan on Sustainable Finance represents a broad strategy designed by the EU to support sustainable investments across the 27 EU member states. In addition to the Sustainable Finance Disclosure Regulation (SFDR), the plan includes the EU Taxonomy and EU benchmarks.

In recent years, there has been growing interest worldwide in systematizing and standardizing approaches to projects that align with the Sustainable Development Goals (SDGs), including green projects. For an objective comparative analysis of projects and to assess the extent to which they improve environmental and resource efficiency, reduce negative environmental impacts, and lower greenhouse gas emissions, it is essential to have clear and measurable criteria. Using assessments based on the degree of corporate transparency does not allow for well-founded conclusions regarding the "greenness" of projects. The development of green project taxonomies and the application of expert evaluation approaches for making investment decisions are evidence of the need to create a set of criteria for the informed selection of projects deserving priority attention.

The EU Taxonomy came into effect in 2020 [101]. It serves as a classification system for environmentally sustainable financial activities. The taxonomy provides a list of clear definitions to help investors, policymakers, and companies identify which economic activities are sustainable and green.

The taxonomy of green projects was recommended by the International Organization for Standardization in the document – the ISO 14030-3 standard group, titled "Environmental Performance Evaluation. Green Debt Instruments. Part 3. Taxonomy" (ISO 14030-3). The title of this standard group, "Environmental Performance Evaluation," reflects its purpose of establishing a reliable evaluation system for projects claiming green status.

The commonly accepted classification criteria for green projects are presented in Figure 40.

A particularly noteworthy aspect of the ISO 14030-3 standard is the definition of Best Available Techniques (BAT), which is independent of environmental permits: BAT refers to economically viable solutions that

help reduce negative environmental impacts, including greenhouse gas emissions.

The distinct feature of the taxonomy described in ISO 14030-3 is that when achieving a positive effect according to one of the criteria, it is necessary to demonstrate the absence of negative effects on the remaining five criteria. Priority should be given to projects that create a synergistic effect — improving performance across multiple criteria.

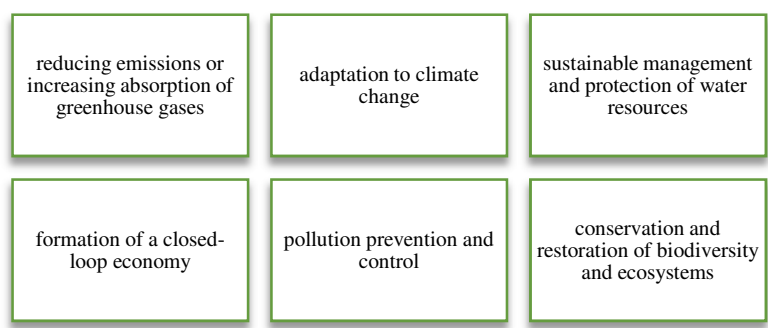


Figure 40. Criteria for classifying green projects
Note - compiled from the source [102]

Thus, the ISO 14030-3 document, "Environmental Performance Evaluation. Green Debt Instruments. Part 3. Taxonomy," provides recommendations whose practical application will help establish a unified and consistent foundation for developing green standards taxonomies for different countries and regions. The prioritization of project selection for preferential financing, such as low-interest loans, directly depends on the goals of industrial, environmental, and climate policies.

Currently, taxonomies developed by CBI (Climate Bonds Initiative), ICMA (International Capital Market Association), and IDFC (International Development Finance Club) are also being applied, providing detailed criteria for identifying green investment projects.

To accelerate the transition to environmentally sustainable investments, the European Parliament and the Council of the European Union approved the Regulation (EU) 2020/852 in 2020, known as the Taxonomy Regulation. This regulation establishes a framework to facilitate sustainable investments and defines which economic activities should be considered environmentally sustainable. The regulation sets a unified classification system across the European Union, providing clarity for businesses and

investors and encouraging increased private sector financing to achieve climate neutrality while maintaining social sustainability.

The regulation defines six environmental objectives:

- Mitigation of climate change;
- Adaptation to climate change;
- Sustainable use and protection of water and marine resources;
- Transition to a circular economy;
- Prevention and control of pollution;
- Protection and restoration of biodiversity and ecosystems.

These objectives guide the development of the green economy and the tasks for the transition period towards a carbon-neutral format.

According to the regulation, an economic activity qualifies as environmentally sustainable if it:

- Makes a substantial contribution to one or more of the specified environmental objectives;
- Does not cause significant harm to any of the specified environmental objectives;
- Is conducted in accordance with minimum safeguards (procedures implemented by the company conducting the economic activity to ensure compliance with the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights);
- Meets the technical screening criteria set by the European Commission.

The technical screening criteria must:

- Identify the most substantial potential contribution to achieving the specified environmental objective, adhering to the principle of technology neutrality and considering both short-term and long-term impacts of the economic activity;
- Specify minimum requirements to avoid significant harm to any relevant environmental objective, taking into account both short-term and long-term impacts of the economic activity;
- Be quantitative and include threshold values whenever possible; otherwise, they should be qualitative;
- Be based, when necessary, on EU labeling and certification schemes, EU methodologies for environmental impact assessment, and EU statistical classification systems, while also considering any relevant existing Union legislation;
- Utilize sustainability indicators, as outlined in Article 4(6) of Regulation (EU) 2019/2088, whenever possible;
- Be grounded in robust scientific evidence and the precautionary principle;

- Consider the lifecycle impact, including data from existing lifecycle assessments, by examining the environmental impact of both the economic activity itself and the products and services it provides, specifically through the consideration of their production, use, and end-of-life stages;
- Take into account the nature and scale of the economic activity;
- Consider potential market consequences of the transition to a more sustainable economy, including the risk of stranded assets and the creation of inconsistent incentives for sustainable investment;
- Cover all relevant types of economic activities within a specific sector and ensure equal treatment of these activities if they equally contribute to achieving environmental objectives;
- Be user-friendly and established in a way that facilitates compliance verification.

The technical screening criteria must also include requirements for activities related to the transition to clean energy, aligning with the pathway to limit global temperature rise to 1.5°C above pre-industrial levels, particularly focusing on energy efficiency and renewable energy sources, to the extent that such activities make a significant contribution to any of the environmental objectives [102].

The technical screening criteria must ensure that electricity generation activities using solid fossil fuels are not classified as environmentally sustainable economic activities.

The technical screening criteria should also include guidelines for activities related to the transition to environmentally friendly or climate-neutral mobility. This includes changes in transport modes, efficiency measures, and alternative fuels, as long as these activities significantly contribute to any of the environmental objectives.

Thus, the technical screening criteria for determining whether an economic activity makes a substantial contribution to climate change mitigation or adaptation must ensure that the activity has a positive impact on the climate goal or reduces its negative effects. Consequently, these technical screening criteria should relate to threshold values or performance levels that economic activities must achieve to be considered as making a significant contribution to one of these climate objectives. The "do no significant harm" technical screening criteria must ensure that economic activities do not have a significant negative impact on the environment. Therefore, these criteria should define the minimum requirements that an economic activity must meet to qualify as environmentally sustainable.

The Commission regularly reviews the technical screening criteria and, if necessary, amends the delegated acts adopted under this Regulation based on scientific and technological developments. In this context, before making

amendments or replacing a delegated act, the Commission must assess the fulfillment of these criteria, taking into account the results of their application by financial market participants and their impact on capital markets, including the direction of investments towards environmentally sustainable economic activities. The Commission should review the technical screening criteria for these activities at least once every three years.

"Environmentally sustainable investments" refer to investments in one or more types of economic activities that qualify as environmentally sustainable.

In 2021, the Commission Delegated Regulation (EU) 2021/2139 was approved, supplementing Regulation (EU) 2020/852. This regulation applies to measures taken by the EU or member states that set requirements for financial market participants or issuers of financial products or corporate bonds labeled as environmentally sustainable, for financial market participants providing financial products, and for companies obligated to publish non-financial reports.

It is important to note that the EU's taxonomy can be used as a basis for its development at the national level, but the principle of respecting national specificities prevails.

Further development of the sustainable financial services market will involve the creation and implementation of taxonomies in other thematic areas of sustainable finance. Additionally, the practice of producing non-financial reporting and other relevant information on funded projects and companies is expanding in formats such as ESG indices, ratings, and others, tailored to the demands of green investors. International cooperation on these issues will help reduce information asymmetry, harmonize regulatory approaches, and mitigate significant conflicts.

4.4 Implementation of ESG Strategies in the Practices of European Banks

In 2019, researchers from the European Institute of Economics and the Environment found that due to climate change, the frequency of banking crises is expected to increase from 26% to 248% [65]. Rescuing insolvent banks will create an additional fiscal burden of 5-15% of GDP per year and double the ratio of public debt to GDP. This raises concerns about the adequacy of measures taken by the banking system and the level of awareness regarding climate change issues. Kalfaoglou (2021) notes that banking organizations are now encountering "green swans," extreme events

caused by climate change. Green swans lead to a climate crisis that not only has irreversible consequences but also presents causes that are difficult to reverse. He suggests viewing financial stability and climate stability as interchangeable public goods [103].

Current trends are influencing the operations of financial institutions, which are now expected to become more effective, stable, and inclusive of environmental and social issues. Two notable trends have emerged:

Firstly, ESG principles or responsible investing are becoming increasingly integrated into the decision-making process for business investments and financing. ESG principles are being adapted for traditional financial instruments, while new financial instruments focused on ESG criteria for investment decisions are being introduced simultaneously.

Secondly, institutional conditions for the functioning of the sustainable financial services market are being established, including the modernization of financial institutions to meet sustainable development goals, as well as the development of standards for the provision of sustainable financial services.

One of the directions in greening the banking system is the development of sustainable banking or ESG banking, which involves organizing banking activities in accordance with the principles of environmental, social, and corporate responsibility in the interests of current and future generations. It also includes banks' participation in achieving sustainable development goals.

Currently, ESG banking issues are attracting significant attention from researchers. However, there is no universally accepted definition of ESG banking in global practice. Deloitte reports define it as follows: "ESG banking is a banking concept based on the principles of environmental, social, and corporate responsibility in the interest of current and future generations, as well as on the practical implementation of initiatives to achieve the SDGs and other socially significant values" [104].

The Principles of Responsible Investment (PRI), as a global UN initiative, were introduced to the public in 2006. This was the first appearance of the term ESG (Environmental, Social, Corporate Governance), referring to a set of factors to be considered in order to minimize long-term investment risks. The PRI is based on the premise that institutional investors and asset managers must act in the best long-term interests of their investors and, therefore, must properly consider how ESG issues may affect the performance of investment portfolios. Thus, the principles of responsible investment represent a set of voluntary commitments to integrate social, environmental, and governance factors into investment strategies to minimize long-term investment risks.

A significant event in 2019 was the launch of the Principles for Responsible Banking (PRB), established by UNEP FI and signed by more than 270 banks worldwide. The Principles for Responsible Banking complement the PRI and were designed to align banking strategies and activities in lending and underwriting with the Sustainable Development Goals and the Paris Climate Agreement (Table 12).

Table 12. Principles for Responsible Banking

Principles of Responsible Banking	Description of the principles of responsible banking
Coherence	The business strategies of signatory banks must be aligned with the needs of citizens and society as reflected in the SDGs and the Paris Climate Agreement, as well as in national and regional documents
Defining Impact and Setting Goals	Banking businesses should set and publish targets to enhance positive and reduce negative impacts on the environment and people, consistently managing the risks arising from their activities, and orienting clients towards ESG products and services
Clients and customers	The banking community must work responsibly with clients and counterparties, encouraging sustainable development practices in economic activity aimed at the prosperity of current and future generations
Stakeholders	Signatory banks shall actively consult, facilitate interaction and cooperation between all stakeholders to achieve the development goals of society
Management and Culture	Commitment to the goals and principles will be confirmed by the strategy of effective management policy and responsible banking culture
Transparency and accountability	Signatory banks commit to being transparent and accountable, to disclosing information on the progress made in implementing these principles, to assessing the negative and positive impact of their own activities and their contribution to achieving the goals of society
Note - compiled from the source [105]	

By joining UNEP FI, a bank publicly commits to the Principles for Responsible Banking (PRB). Membership in the UNEP FI community and

the adoption of PRB commitments to align its business with the Sustainable Development Goals (SDGs) simultaneously provide the following benefits:

- Access to sustainable development tools and training on a preferential basis;
- The opportunity to learn from the experience of other sustainable banks and collaborate on green initiatives;
- Participation in expert working groups, international research, and expert consultations.

ESG factors have become a subject of extensive research in the banking sector. These factors are considered in two contexts:

- In a narrow sense, ESG principles refer to changes in business processes within banks and financial institutions, particularly in the operational models of risk management.
- In a broader sense, the implementation of ESG principles means the "greening" of investment policies at the regional and national levels, becoming a prerequisite for the inclusion of companies and corporations in global value chains.

Research results show both positive and negative effects of ESG on banks' profitability and performance. Many researchers (Brogi and Lagasio, 2018; Tommaso and Thornton, 2020; Maama, 2021; Menicucci and Paolucci, 2022; Nguyen, 2024) have found a positive relationship between ESG ratings and financial performance of banks [106, 107, 108, 109, 110]. At the same time, some studies have concluded that the impact of ESG on bank operations depends on various factors and can increase costs and reduce profitability [111].

Researchers Bouattour et al. (2024) analyzed the relationship between ESG ratings and bank stability in the digital age. They found that higher ESG scores are associated with a lower risk of bank insolvency, aligning with stakeholder theory. Additionally, their findings suggest that European banks with weak ESG ratings will not be able to avoid the fragility caused by investments in technological infrastructure [112]. The study by Cao et al. (2024) also confirms that banks with higher ESG investments are more efficient [113]. Analyzing European banks, Chiamonte et al. (2022) revealed that ESG strategies can reduce the vulnerability of banks during financial distress [114].

In recent years, banks have actively adopted ESG principles in their operations. The assets of ESG funds worldwide have grown significantly, reaching USD 480 billion in 2023 [115]. ESG factors cover a wide range of sustainability criteria, with environmental issues remaining the primary drivers of ESG investing.

ESG ratings measure banks' commitment to managing long-term environmental, social, and governance risks. Figure 41 presents the ESG rating of the 15 largest banks in the world by market capitalization in 2024.

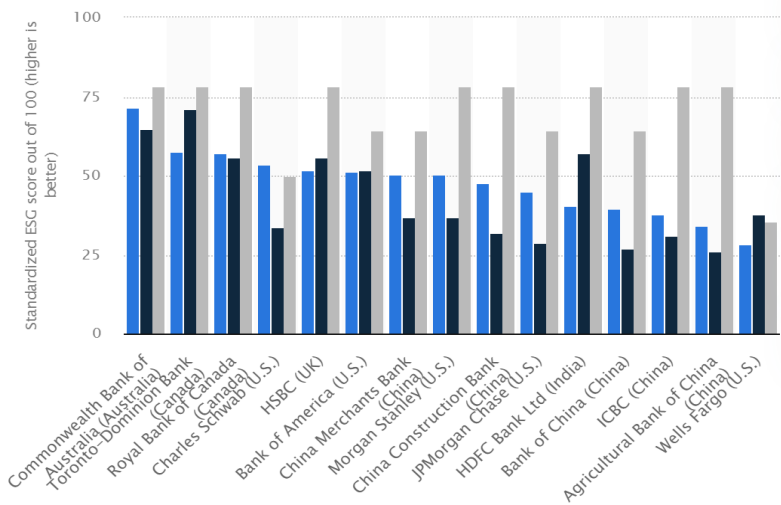


Figure 41. Comparison of ESG ratings of the 15 largest banks in the world by market capitalization in 2024

Note - compiled based on data [116]

In 2024, the ESG ratings of the world's largest banks varied significantly according to different rating agencies. For instance, JPMorgan Chase, the largest bank globally by market capitalization, showed a wide range of scores: on a standardized scale of 100, the highest rating was assigned by MSCI (64.3), while the lowest rating came from S&P Global (29). The score from Sustainalytics was 45. Despite having issued only one green bond since December 2020, JPMorgan Chase ranked tenth among the world's leading banks in terms of green bond issuance volume.

In developed economies, major banks are the primary drivers of ESG transformation in national economies. They achieve this by financing and lending to business projects and initiatives aimed at transitioning to a green economy and reducing the share of companies with a high carbon footprint in their credit portfolios.

The forms of implementation of ESG strategies in the banking sector are presented in Table 13.

Table 13. Formation and Implementation of ESG Strategies in the Banking Sector

Criteria	ESG strategies in banking
Sources of motivation for the implementation of ESG strategies	- allocation of a new segment of the financial market – green finance; - shortage of long-term capital for financing infrastructure and environmental projects; - attracting public attention to environmental issues; - tightening environmental standards for international trade and business; - the need to comply with international norms and conventions
Mechanisms for implementing ESG strategies of banks	- green financing occurs within the framework of industry financial and industrial groups or the issue of green bonds with an open right of purchase; - green financing is distributed by the state regulator among trusted state banks or funds managed by private banks; - green financing is allocated by the Institute for Sustainable Development on a competitive basis
ESG Finance Business Models	- limited partners – banks create special target ESG funds under their own management; - general partners – banks create, on behalf of the state regulator, a special target ESG financing fund, which is managed by the project curator; - stock exchange model – a special segment is created on the stock market for quoting green securities; - portfolio model – a bank or a consortium of banks creates an independent fund for collective ESG investments, formed through contributions from businesses, and managed by a board of managing partners
Objectives of ESG financing	- increasing the competitive position of banks in the international capital market; - obtaining preferences from state regulators; - strengthening the resource base of banks through the management of ESG funds created at the expense of the budget; - obtaining access to financing of state sustainable development programs
Note - compiled by the authors	

The opportunities presented for ESG strategies in banking encompass the reasons for implementing ESG practices in banking activities, goals, mechanisms for implementation, and ESG financing business models. The choice of a particular strategy has a decisive influence on banks' policies regarding the provision of ESG financing, as well as the selection of tools for its execution.

ESG banking expands the range of risks considered by banks (environmental, social, and governance) and extends the planning horizon in the interests of both current and future generations. The expansion of risk scope and horizon requires additional costs but allows for considering a wider range of alternatives and instruments and adapting more quickly to continuous changes during ongoing crises.

The growing interest in ESG is driven by the clear expectations of major institutional investors that companies adhere strictly to ESG criteria. Commercial banks will be able to continue collaborating with partners who have committed to integrating ESG factors into their financial obligations or will refrain from financing certain types of activities.

By incorporating ESG principles into their operations, banks contribute to the formation of a "sustainable business mindset" among borrowers by offering green financial products and providing consultation on the greening of the economy. This also helps improve the bank's image and business reputation. Although banks themselves have a relatively small carbon footprint, they can positively impact the environment on a national scale, contribute to decarbonization, and reduce greenhouse gas emissions through the provision of ESG services (green lending, issuance of social and green bonds, advising clients on sustainable development, etc.).

The process of greening commercial banks' loan portfolios is gradual, starting with surveys on clients' exposure to ESG risks, followed by the introduction of requirements and assessments in credit scoring models.

From an environmental perspective, issuing green loans significantly influences the overall competitiveness of banks, increases the profitability of interest-bearing assets, and thus improves their financial performance. The use of artificial intelligence and big data can help commercial banks verify the goals of green lending, thereby aiding in the achievement of climate objectives and enhancing the ESG performance of commercial banks [117].

Adherence to responsible investment principles enables financial organizations to more effectively manage ESG risks, better diversify their investment and credit portfolios. The increasing importance of ESG risks requires extending the timeframe for their identification, assessment, and incorporation into the transmission of traditional banking risks. Tasks,

responsibilities, and timelines for identifying, evaluating, managing, monitoring, and reporting ESG risks should be integrated into known risk types within the bank's risk management system. This can be done through risk mapping, scenario analysis, and stress testing, based on standards, external databases, recommendations, and publications [118]. ESG risks influence and must be considered in the assessment of credit, market, operational, and other types of risks covered by the bank's risk management system.

The European Central Bank (ECB) set a deadline for eurozone banks (end of 2024) to assess and include climate and environmental risks in their management plans, strategies, and risk management frameworks [119]. ECB assessments revealed that banks continue to underestimate the breadth and scale of climate and environmental risks, with over 95% of European banks having blind spots in their identification. In the first phase, the ECB expects banks to adequately classify climate and environmental risks and conduct a comprehensive assessment of their impact on banking activities. In the second phase, the ECB expects banks to integrate climate and environmental risks into their governance and strategy. In the final phase, banks are expected to meet all remaining supervisory expectations regarding climate and environmental risks, including full integration into the Internal Capital Adequacy Assessment Process (ICAAP) and stress testing.

When lending, ESG risks are considered at all stages of the credit process, including risk profiling of sectors and geographical areas, risk classification procedures, and collateral evaluation. This may involve assessing default probabilities, portfolio analysis regarding sectoral/geographical concentrations, impact limits, borrowing strategies, scenario analysis, and/or stress testing. Loan interest rates should reflect various risks and costs associated with climate and environmental risks through different cost factors (capital cost, green bond financing, and credit risk).

Operational risk management should evaluate the impact of ESG risks on business continuity, timely restoration of physical assets, the location of financial institutions, etc. Market risk management involves using expert assessments and stress testing of ESG risks, assessing the impact on current market positions and future investments. Similarly to other types of risks, banks should assess risk concentration, ESG factors, time horizons, measures for effective ESG risk management, and interaction with stakeholders.

Managing ESG risks can involve negative, positive, and integrated screening based on ESG criteria, taxonomies, and international standards;

incorporating ESG conditions and commitments into contracts; and other forms of dialogue with clients and partners [120]. Procedures and methods for identifying, assessing, managing, monitoring, and reporting ESG risks should be reviewed regularly, including considering the composition, volume, and quality of the initial data and the methods of processing it.

Banks worldwide are increasingly recognizing the importance of sustainable development in their operations. In 2021, the United Nations created the Net-Zero Banking Alliance, uniting banks to achieve the ambitious goal of net-zero emissions by 2050. As of September 2024, the Net-Zero Banking Alliance expanded to include 144 banks, most of which are based in Europe [120]. This initiative demonstrates the banking sector's commitment to aligning its activities with reducing greenhouse gas emissions. Members of the Net-Zero Banking Alliance are required to set interim targets and provide annual progress reports, reflecting a shift towards more transparent and accountable sustainable practices in the banking sector.

Thus, the banking sector serves as a driver of environmental transformation in the economy, stimulating and guiding clients and borrowers towards reducing negative environmental impacts and preserving ecosystems.

4.5 Current Trends in Green Financing in the Republic of Kazakhstan

The concept of sustainable development, as outlined in UN documents, is also reflected in Kazakhstan's development strategies. Kazakhstan's monitoring system for achieving the Sustainable Development Goals (SDGs) includes 280 indicators, of which 205 are global and 75 are national indicators. It is worth noting that Kazakhstan is still at the beginning of its journey towards sustainable development.

One of the first regulatory documents in Kazakhstan addressing sustainable development and environmental initiatives was the Concept for Transition to a Green Economy (2013-2050). This concept laid the foundation for systemic transformations in Kazakhstan's economy, aimed at improving the well-being and quality of life of the population while minimizing environmental impact and natural resource degradation. The implementation of the key directions of the Concept for Transition to a Green Economy planned to attract investments of USD 3.3 billion annually (approximately USD 119 billion in total until 2050) [121].

In November 2022, Kazakhstan signed a strategic partnership agreement with the EU to promote sustainable value chains for raw materials, renewable hydrogen, and batteries that Europe needs to build green energy infrastructure.

In line with the SDGs, at the 2020 Climate Ambition Summit, Kazakhstan committed to a full transformation of its oil and gas-dependent energy sector into a carbon-neutral economy by 2060. This commitment became an integral part of national climate policy, highlighting the prioritization of sustainable development goals and the conditions set by the Paris Agreement.

In early 2023, Kazakhstan adopted the Strategy for Achieving Carbon Neutrality by 2060, developed in line with global climate trends and in fulfillment of relevant international obligations [122]. The strategy outlines nationwide approaches and the strategic course of state policy for the gradual transformation of the economy to ensure well-being, sustainable economic growth, and fair social progress. Additionally, by 2030, the country aims to achieve a 15% reduction in greenhouse gas emissions compared to 1990 levels.

To achieve carbon neutrality by 2060, Kazakhstan requires investments totaling over USD 600 billion, with an investment need of USD 10 billion by 2030, and the remaining USD 600 billion to be invested by the end of 2060 [123].

The analysis of current trends in sustainable financing in Kazakhstan indicates an increasing interest from financial institutions and private businesses in sustainable financial instruments. Figure 42 presents data on the volumes of sustainable financing in Kazakhstan for the period 2020–2022.

Analyzing the trends in sustainable financing in Kazakhstan, it can be noted that the largest share within the structure of sustainable financing is held by green bonds, accounting for 61.5% of the total volume of sustainable financing in 2023, while the share of social bonds was 38.4%. In 2023, there is no information on the provision of green loans, although in 2021 they accounted for 25.8% of the total sustainable financing. The volume of social bonds, after a decline in 2022, increased significantly to 34.8 billion tenge. The most active issuers of green bonds in 2023 included the Development Bank of Kazakhstan, the Asian Development Bank, KazWind Energy, Jet Group, and Black Biotechnology. Social bonds were issued by MFO OnlineKazFinance, the Asian Development Bank and MFO Arnur Credit. It can be observed that at the current stage of development, the predominant instrument is the issuance of green and social bonds

through Kazakhstan's stock exchanges. However, the number of such securities issuances remains quite limited.

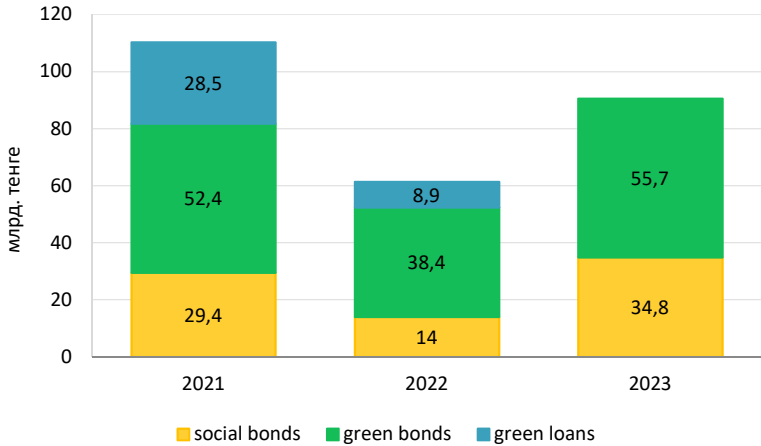


Figure 42. Volumes of sustainable financing in Kazakhstan for the period 2021-2023 (in billion tenge)

Note - compiled based on data [124]

To support the development and promotion of green finance, a specialized organization, the AIFC Green Finance Center (the Center), was established in 2018. The Center facilitates the attraction of investments for the implementation of environmentally friendly, energy-efficient, and low-carbon projects in Kazakhstan and Central Asia. Special attention is given to developing instruments such as green bonds, concessional lending, and subsidies for green projects. The main functions of the Center include providing advisory support to green bond issuers, covering part of the expenses for external review of issuers during green bond issuance, conducting research, and more.

In 2021, the AIFC Green Finance Center introduced several initiatives in the field of sustainable financing, such as the AIFC Statement on Commitment to Sustainable Finance Principles, a voluntary ESG reporting system for companies listed on the Astana International Exchange (AIX), and the establishment of a regional office for the Green Investment Principles for the Belt and Road Initiative in Central Asia.

Additionally, the Center, in collaboration with the International Center for Green Technologies and Investment Projects, developed the Kazakhstan Green Project Taxonomy, which is a "unified classification system for economic activities, project categories, and assets aimed at enhancing the efficiency of existing natural resource use, reducing negative environmental impacts, and improving energy efficiency" [125]. The green taxonomy is applied in green financing, particularly in the issuance of green bonds, provision of green loans, green insurance, equity financing, and similar areas. The Kazakhstan Green Taxonomy includes a strategic goal, environmental objectives, definitions of concepts, and participants in the green financing process. Thus, the green taxonomy can be used as a guide and methodological framework for identifying eligible projects as environmentally sustainable and aligned with the SDGs.

According to researchers Khudyakova and Urumov (2021), at the current stage, Kazakhstan's green taxonomy envisions a gradual transition to a low-carbon and circular economy. It includes a transitional category such as "low-emission energy" [126].

The AIFC Green Finance Center is included in the ICMA registry as a verifier for green, social, and sustainability bond issuances, confirming that its methodology and approaches align with ICMA principles for independent verifiers and international industry standards. The external reviews provided by the Center are recognized by the London Stock Exchange for bonds traded in the green bond segment. Thus, the AIFC Green Finance Center has made a significant contribution to the development of Kazakhstan's regulatory environment and policy framework in the area of green growth.

At the same time, in The Green Future Index 2023, Kazakhstan's position declined from 46th place in 2022 to 54th place in 2023. Kazakhstan ranked 54th out of 76 countries, with an overall score of 4.13 [127]. This index measures the progress of green economy development based on investments in renewable energy, innovations, and green financing. Within the index, Kazakhstan received high scores in the "Climate policy" component (44th place) and the "Carbon emissions" component (49th place). However, Kazakhstan scored poorly in the "Clean innovation," "Energy transition," and "Green society" components.

Kazakhstan's position remains relatively low in the CCPI-2024 (Climate Change Performance Index), ranking 60th due to very low scores in greenhouse gas emissions and energy use [128]. As a result, Kazakhstan remains among countries with poor performance indicators. Although Kazakhstan has updated its national targets in recent years, aiming for carbon neutrality by 2060, the country still lacks a transparent greenhouse

gas accounting system and sector-specific short-term targets. Additionally, action plans remain unclear, including phased coal phase-out, climate adaptation measures, and a transition to a green economy.

The instability of Kazakhstan's ESG policy is evidenced by its low ranking in the Global SDG Achievement Index. In 2024, Kazakhstan ranked 66th in the SDG Index-2024 [129].

The transition to sustainable development and a green economy requires substantial financial investment to transform economic sectors and create green technologies, processes, and innovations. In Kazakhstan, public budget funds continue to be the primary source of financing for environmental and climate-related initiatives and projects. However, the budget alone is insufficient to fund large-scale environmental and social projects. Several key issues continue to hinder the development of green financing in Kazakhstan:

- Low investor interest in funding social and environmental projects due to high associated risks and limited motivation among economic entities to develop and implement social and green projects because of restricted access to financing;

- Gaps in the regulatory framework for supporting and regulating ESG initiatives; lack of clear guidelines for applying international ESG standards in non-financial reporting; insufficient data and transparency;

- The dominance of short-term goals over long-term objectives impedes the attraction of private capital; green projects face weak competitive positions compared to "brown" projects in terms of the speed of return on investment;

- Lack of incentives and compensatory measures to support investments in green economy projects; absence of a coherent green and climate policy in the country's regions; ineffective mechanisms for involving SMEs in the implementation of long-term green projects;

- Ongoing subsidies for the existing energy sector and inadequate funding for climate adaptation projects;

- Limited set of green financing instruments and unstable trading volumes on the stock market, influenced by internal and external factors;

- Low resource potential of the banking sector, which restricts its contribution to financing the green economy;

- Absence of clear regulations for second-tier banks and financial organizations in implementing green financing policies and an effective system for evaluating their results.

The expansion of green financing potential in Kazakhstan, as noted by researchers Kuur et al. (2021), depends on specific factors. They identify the following key factors for successful promotion of environmentally

responsible investment in Kazakhstan: legal, organizational, and financial support for the green transformation of the economy by the state; improvement of the regulatory framework and standardization of approaches; establishment of an effective ESG disclosure system; creation and strengthening of green development institutions and funds; utilization of public-private partnership (PPP) mechanisms; reduction of green financing risks; development of green financial instruments and their legal framework; and the reform of the country's financial market in line with green priorities [130].

In the study by Doszhan R.D. et al. (2022), it was found that the demand for green financial instruments in Kazakhstan is substantial and continues to grow consistently. However, the development of the green finance market requires both legislative and financial support from the government [131]. Similarly, the research by Berstembaeva and Nurumov (2024) emphasizes that financial support for green projects in Kazakhstan is predominantly provided by international organizations, which facilitate joint issuances of green bonds, investment in green projects, and the development of blended finance instruments [132].

To meet the strategic objectives for the development of sustainable finance, it is essential to implement effective measures capable of addressing the aforementioned challenges. The following directions can be considered for the further realization of sustainable finance policies:

- The establishment of infrastructure and a regulatory environment that promotes sustainable finance, including the introduction of transparent and harmonized ESG reporting standards;
- Genuine support from the government for green projects;
- The implementation and development of digital tools for green financing;
- The creation of a "sustainable bank" based on the Development Bank of Kazakhstan, drawing on the positive experience of the European Investment Bank (EIB), which serves as the EU's climate bank and works to promote the Green Deal goals both within Europe and globally;
- Reduction of risks through collective financing of green projects and ensuring institutional investors' access to financing for sustainable development projects;
- The development of specific public-private investment schemes for sustainable development projects;
- Preventing greenwashing and green bubbles (excessive investments in renewable energy that do not align with the debt levels of many clean-tech companies);

- Expanding the carbon tax to sectors with indirect greenhouse gas emissions;
- Strengthening the protection of the rights of entities purchasing green bonds, and increasing awareness about the benefits and significance of ESG investing;
- The development of a "sustainable guarantee" system, and the creation of a centralized guarantee fund for green loans;
- The introduction and expansion of green, climate, social, transition, and other bonds focused on sustainable development, along with green loans, green funds, green insurance, and green crowdfunding;
- Creating favorable conditions for attracting green investments and stimulating the influx of green financial resources into the regions of Kazakhstan;
- Enhancing partnerships and cooperation with international organizations and financial institutions for the exchange of best practices and resources.

Thus, Kazakhstan is pursuing state policy aimed at achieving carbon neutrality, increasing the volume of sustainable finance, and establishing a regulatory framework for ESG investing. However, there remains a need to bolster the country's investment potential in order to finance green initiatives and sustainable development programs effectively.

CONCLUSION

The analysis of European sustainable development practices demonstrates that the EU has developed a multidimensional and integrated approach to managing the green transformation. The combination of social, environmental, and financial instruments ensures that sustainability is not treated as a standalone policy, but as a strategic priority embedded across all sectors. This model has allowed the European Union to position itself as a global leader in climate action, ecological modernization, and responsible governance.

The first chapter revealed that social instruments — including corporate social responsibility, sustainable consumption, and public awareness — serve as the foundation for cultural and institutional shifts toward sustainability. The EU actively engages civil society, educational systems, and the private sector to create shared responsibility in achieving green goals. This participatory model of governance ensures legitimacy, accountability, and long-term commitment across all levels of society.

The second chapter demonstrated the EU's advanced progress in environmental policy and climate action. From strict emission regulations and ambitious decarbonization targets to the development of renewable energy and circular economy strategies, the EU's environmental agenda sets benchmarks for global standards. Moreover, its efforts to protect biodiversity and manage ecosystems holistically reinforce the ecological integrity of the European continent and its partners.

The third chapter highlighted the growing importance of green finance as a key enabler of sustainable development. The EU's financial architecture — encompassing green bonds, green loans, and sustainable investment platforms — is supported by rigorous regulatory frameworks and transparent standards. The integration of finance with sustainability goals ensures the mobilization of capital in ways that directly contribute to environmental and social impact, while fostering innovation and resilience in the financial sector.

Chapter four brought the focus to Kazakhstan, offering a comparative perspective and outlining pathways for aligning national sustainability efforts with European practices. While Kazakhstan is still in the early stages of its green transformation, emerging trends in green budgeting, ESG integration, and sustainable finance indicate a readiness to adopt and adapt successful EU strategies. The chapter emphasizes the importance of international cooperation, knowledge exchange, and institutional reform in shaping Kazakhstan's green future.

The monograph affirms that the European experience provides valuable lessons for countries pursuing sustainable development. While each country operates in a unique socio-economic and political context, the EU model demonstrates how coherent policies, inclusive governance, and innovative financing can collectively drive a successful green transformation. As global challenges intensify, the principles of sustainability must become central to decision-making at all levels — and the European case serves as a practical and inspiring guide toward that end.

The European Union continues to solidify its position as a global leader in sustainable development management, and the coming years hold promising prospects for advancing the green transformation agenda. One of the key directions is the deepening integration of sustainability principles into all sectors of economic policy — from agriculture and transport to industrial production and urban planning. The European Green Deal serves not only as a roadmap but as a framework for embedding climate and environmental goals into the core of socio-economic development, ensuring a just and inclusive transition for all member states.

Another significant perspective lies in the digitalization of sustainability management. The EU is investing in digital tools such as smart data platforms, AI-based environmental monitoring, and blockchain for green finance tracking. These technologies will enhance transparency, accountability, and real-time decision-making in sustainability governance. The continued development of SupTech and RegTech solutions will further modernize regulatory approaches, making environmental compliance and financial oversight more efficient and adaptive to complex global challenges.

The growing focus on sustainable finance opens new horizons for mobilizing private and institutional capital toward green goals. The EU Taxonomy for sustainable activities, together with the Green Bond Standard and mandatory ESG reporting, will strengthen investor confidence and guide capital flows into sustainable projects. As financial institutions align their strategies with ESG principles, green finance will become a systemic driver of both economic growth and environmental protection.

The EU's commitment to international cooperation and knowledge transfer will expand its influence beyond Europe. By supporting green transformation in neighboring regions and developing countries, the EU contributes to building global resilience against climate change. The export of regulatory frameworks, environmental standards, and technological solutions will help shape a more sustainable global economy, positioning the EU not only as a policy innovator but also as a normative power in the field of sustainable development.

References

1. The European environment — state and outlook 2015 — synthesis report. <https://www.eea.europa.eu/soer/2015> (accessed: 26.03.2025).
2. European Commission. Carbon Border Adjustment Mechanism (CBAM) – Putting a price on carbon imports. Brussels, 2023. URL: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en (accessed: 26.03.2025).
3. Eurostat. 23% of energy consumed in 2022 came from renewables. Eurostat News Release, 22 December 2023. URL: <https://ec.europa.eu/eurostat/> (accessed: 20.03.2025).
4. Benefits of EU environmental and climate action. EP Think Tank: [official website of the European Parliament's research service]. 28.11.2017. URL: <https://epthinktank.eu/2017/11/28/benefits-of-eu-environmental-and-climate-action/> (accessed: 26.03.2025).
5. EU aims to cut transport greenhouse gas emissions by 2030. World Economic Forum: [official website]. 09.2022. URL: <https://www.weforum.org/stories/2022/09/eu-greenhouse-gas-emissions-transport/> (accessed: 20.03.2025).
6. EU beats 2020 renewable energy goal, France lags behind – Eurostat. Reuters: [news agency]. 19.01.2022. URL: <https://www.reuters.com/markets/commodities/eu-beats-2020-renewable-energy-goal-france-lags-behind-eurostat-2022-01-19/> (accessed: 21.03.2025).
7. Khomenko S., Cirach M., Pereira-Barboza E. et al. Health impacts of air pollution in Europe: burden of disease estimates for nine risk factors. Scientific Reports. 2021. Vol. 11, Article number: 20282. DOI: 10.1038/s41598-021-01802-5. URL: <https://www.nature.com/articles/s41598-021-01802-5> (accessed: 21.03.2025).
8. Sustainability – at a glance. European Environment Agency (EEA): [official website]. URL: <https://www.eea.europa.eu/en/topics/at-a-glance/sustainability> (accessed: 21.03.2025).
9. Total greenhouse gas emission trends in Europe. European Environment Agency (EEA): [official website]. URL: <https://www.eea.europa.eu/en/analysis/indicators/total-greenhouse-gas-emission-trends> (accessed: 21.03.2025).
10. EU Biodiversity Strategy for 2030. Brussels, 2020. URL: https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en (accessed: 26.03.2025).

11. EU lifts green investment target by EUR 260 billion per year by 2030. Balkan Green Energy News: [information portal]. 13.02.2023. URL: <https://balkangreenenergynews.com/eu-lifts-green-investment-target-by-eur-260-billion-per-year-by-2030/> (accessed: 21.05.2025).
12. Achieving climate neutrality by 2050 requires a system change – CEFIC climate law position explained. European Chemical Industry Council (CEFIC): [official website]. 10.03.2021. URL: <https://cefic.org/news/achieving-climate-neutrality-by-2050-requires-a-system-change-cefic-climate-law-position-explained/> (accessed: 21.05.2025).
13. Sustainability – at a glance. European Environment Agency (EEA): [official website]. URL: <https://www.eea.europa.eu/en/topics/at-a-glance/sustainability> (accessed: 21.05.2025).
14. European Commission. (n.d.). Climate action. CLIMATE.EC.EUROPA.EU. Retrieved September 24, 2025, from <https://climate.ec.europa.eu>
15. OECD. What to expect from the EU Carbon Border Adjustment Mechanism? OECD Policy Brief, 13 March 2025. URL: <https://www.oecd.org/.../what-to-expect-from-the-eu-cbam-2025.pdf> (accessed: 26.03.2025).
16. Cornago E., Berg A. Learning from CBAM's transitional phase: Early impacts on trade and climate efforts. Centre for European Reform, Dec. 2024. URL: <https://www.cer.eu/publications/> (accessed: 26.03.2025).
17. UNCTAD. A European Union Carbon Border Adjustment Mechanism: Implications for developing countries. UNCTAD Study, 2021. URL: <https://unctad.org/publication/> (accessed: 26.03.2025).
18. Maliszewska M. et al. CBAM's impact on exports to the EU – Relative CBAM Exposure Index. World Bank Blogs, 04.12.2023. URL: <https://blogs.worldbank.org/trade/cbam-impact-exports> (accessed: 26.03.2025).
19. SEI. Consumption-based emissions: a new frontier for EU climate policy. Stockholm Environment Institute, Report, June 2024. URL: <https://www.sei.org/.../sei-report-eu-consumption-emissions-june-2024.pdf> (accessed: 26.03.2025).
20. TIPS. The European Green Deal and its implications for Africa. Trade & Industrial Policy Strategies, Policy Brief, 2023. URL: https://www.tips.org.za/.../EGD_Africa_policy_brief_2023.pdf (accessed: 26.03.2025).
21. ECFR. The geopolitics of the European Green Deal. European Council on Foreign Relations, Policy Brief, 2021. URL:

<https://ecfr.eu/publication/the-geopolitics-of-the-european-green-deal/>
(accessed: 26.03.2025).

22. E3G. The state of the Union's climate diplomacy 2023. E3G Blog, 07.09.2023. URL: <https://www.e3g.org/news/the-state-of-the-unions-climate-diplomacy-2023/> (accessed: 26.03.2025).

23. European Commission. Sustainable development in EU trade agreements – TSD 2022 Review. Brussels, 22.06.2022. URL: https://policy.trade.ec.europa.eu/.../sustainable-development-eu-trade-agreements_en (accessed: 26.03.2025).

24. PubAffairs Bruxelles. EU and New Zealand sign ambitious free trade agreement. 09.07.2023. URL: <https://www.pubaffairsbruxelles.eu/.../eu-and-new-zealand-sign-ambitious-free-trade-agreement/> (accessed: 26.03.2025).

25. College of Europe. The Effects of EU Free Trade Agreements: environmental perspective. EU Diplomacy Paper 5/2024, Bruges, 2024. URL: https://coleurope.eu/.../EDP_5_2024_Peridy.pdf (accessed: 26.03.2025).

26. WTO. Climate change in regional trade agreements. WTO Environmental Database, 2021. URL: https://www.wto.org/english/news_e/news21_e/clim_03nov21-2_e.pdf (accessed: 26.03.2025).

27. European Commission. Circular Economy Action Plan (CEAP). Brussels, 2020. URL: <https://ec.europa.eu/environment/circular-economy/> (accessed: 26.03.2025).

28. Eurostat. Waste statistics – municipal waste. URL: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics (accessed: 26.03.2025).

29. European Environment Agency (EEA). The EU Circular Economy Policy: Main elements. URL: <https://www.eea.europa.eu/themes/waste/resource-efficiency/the-eu-circular-economy-policy> (accessed: 26.03.2025).

30. Ellen MacArthur Foundation. Towards the Circular Economy: Economic and business rationale for an accelerated transition. Report, 2023. URL: <https://ellenmacarthurfoundation.org/> (accessed: 26.03.2025).

31. European Commission. Global Gateway Strategy – Sustainable Infrastructure. Brussels, 2022. URL: https://ec.europa.eu/info/strategy/global-gateway_en (accessed: 26.03.2025).

32. European Commission. Impacts of Circular Economy Policies on Labour Market and Economic Growth. Brussels, 2023. URL:

<https://ec.europa.eu/info/sites/default/files/circular-economy-labour-market.pdf> (accessed: 26.03.2025).

33. European Parliament. Renewable Energy Directive: Achievements and Perspectives. Brussels, 2023. URL: <https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/> (accessed: 26.03.2025).

34. European Commission. Hydrogen Strategy for a Climate-Neutral Europe. Brussels, 2022. URL: https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf (accessed: 26.03.2025).

35. Natura 2000 Network – Status and Expansion. EEA Report, 2023. URL: <https://www.eea.europa.eu/publications/natura-2000-network-2023> (accessed: 26.03.2025).

36. European Forest Strategy 2030. European Commission, 2021. URL: https://ec.europa.eu/environment/forests/strategy_en (accessed: 26.03.2025).

37. CEPS. EU Climate Diplomacy in a Changing World: Towards COP-28. Brussels, 2023. URL: <https://www.ceps.eu/publications/eu-climate-diplomacy-changing-world> (accessed: 26.03.2025).

38. UNFCCC COP-27 and COP-28 outcomes and analysis. URL: <https://unfccc.int/cop-28-outcomes> (accessed: 26.03.2025).

39. Pearce D. (1989). Green Economics. *Environmental Values*, 1. 3-13. https://www.environmentandsociety.org/sites/default/files/key_docs/pearce_1_1.pdf

40. United Nations. (1999). Environment and human settlements: report of the Secretary-General. <https://digitallibrary.un.org/record/262644?ln=en&v=pdf>

41. UNEP FI. (1992). <https://www.unepfi.org/about/about-us/history/>

42. Taneja S., Bhatnagar M., Ozen E. (2023). Greening the economy: Harnessing the power of sustainable finance. *Reference Module in Social Sciences*, <https://doi.org/10.1016/B978-0-44-313776-1.00150-1>

43. European Commission. What is Sustainable finance? https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en

44. International Institute for Sustainable Development. (2023). Sustainable finance. <https://www.iisd.org/topics/sustainable-finance>

45. Bhatnagar S. and Sharma D. (2022). Evolution of green finance and its enablers: A bibliometric analysis. *Renewable and Sustainable Energy Reviews*, 162. <https://doi.org/10.1016/j.rser.2022.112405>

46. Bhattacharyya R. (2021). Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges. *Green Finance*, 4(1). 1-35. <https://doi.org/10.3934/GF.2022001>
47. Tverezovska, O., & Hrytsenko, L. (2022). The Role of Green Project Financing in the Economic Development of Ukraine. *Financial and Credit Activity Problems of Theory and Practice*, 6(47). 124–138. <https://doi.org/10.55643/fcaptop.6.47.2022.3933>
48. G20 Green Finance Study Group. (2016). G20 Green Finance Synthesis Report. https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/green-finance-community-of-practice/documents.entry.html/2018/08/25/g20_green_finances-5qSy.html
49. Rasheed K., Saad S. and Ammad S. (2023). Green Financing for Sustainable Economic Growth: Exploring Critical Factors Towards Resilient Economies. *2023 International Conference on Sustainable Islamic Business and Finance (SIBF)*, Bahrain. 2023. 104-111. <https://doi.org/10.1109/SIBF60067.2023.10379984>
50. Ali E., Anshari M., Hamdan M., Ahmad N. and Surieshtino Y. (2023). Green Finance for Sustainable Development: A Bibliographic Analysis. *2023 International Conference on Sustainable Islamic Business and Finance (SIBF)*, Bahrain. 46-49. <https://doi.org/10.1109/SIBF60067.2023.10379915>
51. European Commission. A European Green Deal, 2019. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
52. Financial Stability, Financial Services and Capital Markets Union. The European Green Deal Investment Plan and Just Transition Mechanism, 2020. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_17
53. Portal InvestEU. - https://investeu.europa.eu/index_en
54. Technical characteristics of the Portal InvestEU. - <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021D0626&from=EN>
55. Green Gateway Digital Platform. - <https://greengateway.eib.org/>
56. Financing sustainable businesses and green investments – check the eligibility. - <https://sustainabilityguarantee.eif.org/>
57. Green Eligibility Checker. - <https://greenchecker.eib.org/>
58. Green Transition Scoreboard Report 2019-2020. - <https://www.ethicalmarkets.com/wp-content/uploads/2019/05/2019-2020-GTS-Full-Report.pdf>

59. International Platform on Sustainable Finance. Annual report, 2020.

https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/international-platform-sustainable-finance-annualreport-2020_en.pdf

60. European Commission. Platform on Sustainable Finance. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance/platform-sustainable-finance_en

61. Climate Bonds Initiative (2024). Green Bond Market Summary. https://www.climatebonds.net/files/reports/2019_annual_highlights-final.pdf

62. Berrou R., Ciampoli N., Marini V. (2019). Defining Green Finance: Exciting Standards and Main Challenges / Migliorelli V., Dessertine P. (eds). The Rise of Green Finance in Europe. Palgrave Macmillan, 31–51. <https://doi.org/10.1007/978-3-030-22510-0>

63. Climate Bonds Initiative. The Green bond market in Europe, 2018. https://www.climatebonds.net/files/reports/the_green_bond_market_in_europe.pdf

64. Climate bonds Initiative. (2023). Sustainable Debt. Global State of the Market. https://www.climatebonds.net/files/reports/cbi_sotm23_02h.pdf

65. PwC. (2024). Sustainable Finance Market Entry Strategy. <https://www.pwc.com/kz/en/esg/pwc-green-bonds-ru.pdf>

66. Banga J. (2019). The green bond market: a potential source of climate finance for developing countries. *Journal of Sustainable Finance and Investment*, 9(1), 17–32. <https://doi.org/10.1080/20430795.2018.1498617>

67. IMF (2019). Global Financial Stability Report: Lower for longer. Washington. <https://www.imf.org/en/Publications/GFSR/Issues/2019/10/01/global-financial-stability-report-october-2019>.

68. European green bond standard. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/european-green-bond-standard_en

69. EU Technical expert group on sustainable finance. Report on EU Green bond Standard, 2019. https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf

70. ICMA. Green Bond Principles (GBP). - <https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Translations/2018/RussianGBP2020-06-280920.pdf>

71. ICMA. Principles of social bonds (SBP). - <https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Translations/2020/RussianSBP2020-06-021120.pdf>
72. Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on Sustainability-Related Disclosures in the Financial Services Sector (Text with EEA Relevance). - <https://eur-lex.europa.eu/eli/reg/2019/2088/oj>
73. Bank of England (2019). Financial Stability Report. July. <https://www.bankofengland.co.uk/>
74. Haque R., Ahmad F. Backdrop in green loans contributes to lower sustainable lending volumes. <https://www.natwest.com/corporates/insights/sustainability/private-finance-esg-monthly/private-finance-sustainability-monthly-apr-2024.html>
75. Loan Market Association (2018). Green Loan Principles. https://www.lma.eu.com/application/files/9115/4452/5458/741_LM_Green_Loan_Principles_Booklet_V8.pdf
76. SPD Bank Corporate Social Responsibility Report (2015–2016) / compiled by the authors based on SPD Bank Corporate Social Responsibility Report (2015–2016).
77. Luo, C., Fan, S., Zhang, Q. (2017) Investigating the Influence of Green Credit on Operational Efficiency and Financial Performance Based on Hybrid Econometric Models. *International Journal of Financial Studies*, 5(4). 27. - <https://doi.org/10.3390/ijfs5040027>
78. World Green Building Council. Energy efficient mortgages initiative. What are green mortgages and how will they revolutionise home energy efficiency? <https://www.worldgbc.org/news-media/what-are-green-mortgages-how-will-they-revolutionise-home-energy-efficiency>
79. OECD. (2024). Green Budgeting in OECD countries. https://www.oecd.org/en/publications/green-budgeting-in-oecd-countries-2024_9aea61f0-en.html
80. OECD Library. (2024). Green Budgeting. <https://www.oecd-ilibrary.org/docserver/2f80b7b0-en.pdf?expires=1730959661&id=id&accname=guest&checksum=030C69E75F0FD008001DD6F8D5E50EFB>
81. World Bank (2021). Climate Change Budget Tagging: A Review of International Experience. EFI Insight-Governance. Washington, DC: - <http://creativecommons.org/licenses/by/30/igo>
82. Anikina I.D. (2023). Green instruments of public finance: global experience. *Bulletin of the Altai Academy of Economics and Law*, 11(2). 161-166. <https://doi.org/10.17513/vaael.3069>

83. Paris Collaborative on Green Budgeting. OECD. - <https://www.oecd.org/environment/green-budgeting/>
84. <https://www.economie.gouv.fr/budget-vert-france-1er-pays-monde-mesurer-impact-budget-etat-environnement#>
85. OECD-Green-Budgeting-Framework-Highlights. - <http://www.oecd.org/environment/green-budgeting/OECD-Green-Budgeting-Framework-Highlights.pdf>
86. European Environment Agency. Market-based instruments for environmental policy in Europe. 2005. - https://www.eea.europa.eu/publications/technical_report_2005_8
87. OECD. Guidelines for Reforming Environmental Charges Policy. https://www.oecd.org/content/dam/oecd/ru/publications/reports/2019/07/ad-dressing-industrial-air-pollution-in-kazakhstan_07b38a87/4a86e63d-ru.pdf
88. Eurostat. (2024) Environmental tax statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:ETEA24S-F01-v02-Environmental_tax_revenue_by_type_and_total_environmental_taxes.png
89. Government Offices of Sweden. (2024). Sweden's carbon tax. <https://www.government.se/carbontax>
90. OECD. (2019). Tax Energy Use 2019: Using Taxes for Climate Action. <https://doi.org/10.1787/058ca239-en>
91. Criqui P., Jaccard M., Sterner N. (2019). Carbon taxation: A tale of the countries. *Sustainability*, 11(6280). 1-21. <https://doi.org/10.3390/su11226280>
92. European Commission. (2021). Carbon Border Adjustment Mechanism: Questions and Answers. - https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3661
93. UNCTAD. (2023). The costs of achieving the SDFs. <https://unctad.org/sdg-costing/about>
94. Discussion paper on management and supervision of ESG risks for credit institutions and investment firms (EBA/DP/2020/03). The European Banking Authority. - <https://www.eba.europa.eu/calendar/discussion-papermanagement-and-supervision-esg-risks-credit-institutions-and-investment>
95. Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on Sustainability-Related Disclosures in the Financial Services Sector (Text with EEA Relevance). - <https://eur-lex.europa.eu/eli/reg/2019/2088/oj>
96. Agency of the Republic of Kazakhstan for Regulation and Development of the Financial Market. (2023). Environmental, Social and Corporate Governance Disclosure Guidelines for Banks.

https://www.gov.kz/uploads/2023/6/6/3c7112396b0eec5334aae3b8a39d4dca_original.860906.pdf?ysclid=lnltmhg9zr804883571

97. The Equator principles. – <https://equator-principles.com/about/>
98. Finger M., Gavius I., Manos R. (2018). Environmental risk management and financial performance in the banking industry: a cross-country comparison. *Journal Int Finan Markets Inst Money*, 52. 240-261. <https://doi.org/10.1016/j.intfin.2017.09.019>
99. Pianta Mario, Lucchese Matteo, Nascia Leopoldo. (2020). The policy space for a novel industrial policy in Europe. *Industrial and Corporate Change*, 29(3). 779–795. <https://doi.org/10.1093/icc/dtz075>
100. EBA Action Plan on Sustainable Finance. Explaining The EU Action Plan for Financing Sustainable Growth. <https://www.unpri.org/sustainable-financial-system/explaining-the-eu-action-plan-for-financing-sustainable-growth/3000.article>
101. EU taxonomy for sustainable activities. European Commission. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en#compass
102. Dorosko K. (2021). Sustainable Finance and Climate Change Prospects. - <https://ecolomist.kz/perspektivy-ustojchivogo-finansirovanija-i-izmenenija-klimata/>
103. Kalfaoglou F. (2021). ESG risks: A new source of risks for the banking sector. *Bank of Greece Economic Bulletin*, 53. 83-112. <https://doi.org/10.52903/econbull20215305>
104. Deloitte. (2023). Do sustainable banks outperform? Driving value creation through ESG practices. <https://www.deloitte.com/lu/en/Industries/banking-capital-markets/research/driving-value-creation-through-esg-practices.html>
105. UNEP FI/ Principles for Responsible Banking. <https://www.unepfi.org/banking/bankingprinciples/>
106. Brogi M., Lagasio V. (2018). Environmental, social, and governance and company profitability: are financial intermediaries different? *Corporate Social Responsibility and Environmental Management*, 26(3). 576-587. <https://doi.org/10.1002/csr.1704>
107. Tommaso C.D., Thornton J. (2020). Do ESG scores effect bank risk taking and value? Evidence from European banks. *Corporate Social Responsibility and Environmental Management*, 27(5). 2286-2298. <https://doi.org/10.1002/csr.1964>
108. Maama H. (2021). Achieving financial sustainability in Ghana's banking sector: is environmental, social, and governance reporting contributive? *Global Business Review*. <https://doi.org/10.1177/09721509211044300>

109. Menicucci E., Paolucci G. (2022). ESG dimensions and bank performance: an empirical investigation in Italy. *Corporate Governance: The International Journal of Business in Society*, 23(3), 563-586. <https://doi.org/10.1108/cg-03-2022-0094>
110. Nguyen Ngan Bich. (2024). Impact of ESG performance on the Profitability of ASEAN-6 commercial banks in the context of digital transformation. *Global Business & Finance Review*, 29(5). 60-71. <https://doi.org/10.17549/gbfr.2024.29.5.60>
111. Yuen M.K., Ngo T., Le T., Ho T.H. (2022). The environment, social, and governance (ESG) activities and profitability under Covid-19: evidence from the global banking sector. *Journal of Economics and Development*, 24(4), 345-364. <https://doi.org/10.1108/jed-08-2022-0136>
112. Bouattour A., Kalai M., Helali K. (2024). The non-linear relationship between ESG performance and bank stability in the digital era: new evidence from a regime-switching approach. *Humanities and Social Sciences Communications*, 22. <https://doi.org/10.1057/s41599-024-03876-8>
113. Cao Q., Zhu T., Yu W. (2024). ESG investment and bank efficiency: Evidence from China. *Energy Economics*, 133. <https://doi.org/10.1016/j.eneco.2024.107516>
114. Chiaramonte L., Dreassi A., Girardone C., Pisera S. (2022). Do ESG strategies enhance bank stability during financial turmoil? Evidence from Europe. *European Journal of Finance*, 28. 1173-1211. <https://doi.org/10.1080/1351847X.2021.1964556>
115. Statista. 2024. Green Banking. <https://www.statista.com/topics/9069/green-banking/>
116. Statista. 2024. Comparison of ESG scores of the 15 largest banks. <https://www.statista.com/statistics/1272380/comparison-esg-scores-largest-banks-worldwide/>
117. Zhu Y. and Jin Sh. (2023). How does the Digital transformation of banks improve efficiency and environmental, social, and governance performance? *Systems*, 11(7). 328. <https://doi.org/10.3390/systems11070328>
118. Porter M., Serafeim G., Kramer M. Where ESG fails. *Institutional Investor*. 2019
119. ECB (2022). Sets deadlines for banks to deal with climate risks. <https://www.bankingsupervision.europa.eu/press/pr/date/2022/html/ssm.pr21102~2f7070c567.en.html>
120. Bernow S., Nuttall R., Brown S. (2020). Why ESG is here to stay. McKinsey. <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/why-esg-is-here-to-stay#/>

121. Concept for the transition of the Republic of Kazakhstan to a green economy. - <https://adilet.zan.kz/rus/docs/U1300000577>
122. Strategy for achieving carbon neutrality of the Republic of Kazakhstan until 2060, approved by the Decree of the President of the Republic of Kazakhstan dated February 2, 2023 No. 121. <https://adilet.zan.kz/rus/docs/U2300000121>
123. KASE. - <https://kase.kz/ru/esg/bonds/>
124. AIFC Green Finance Centre. (2024). Sustainable Finance Analytics. - <https://gfc.aifc.kz/ru/sustainable-finance-analytics/>
125. Classification (taxonomy) of “green” projects subject to financing through “green” bonds and “green” loans, approved by the Decree of the Government of the Republic of Kazakhstan dated 31.12.2021 No. 996. - <https://adilet.zan.kz/rus/docs/P2100000996>
126. Khudyakova L., Urumov T. (2021). Kazakhstan: Towards Greening the Financial System. 183-199. <https://www.imemo.ru/publications/periodical/RNSE/archive/2021/iv-iiii/environmental-policy/kazakhstan-on-the-way-to-greening-the-financial-system>
127. The Green Future Index 2023. <https://www.technologyreview.com/2023/04/05/1070581/the-green-future-index-2023/>
128. CCPI-2024: Ranking and Results. <https://ccpi.org/country/kaz/>
129. Sustainable Development Report. 2024. The SDG Index. <https://dashboards.sdgindex.org/chapters/part-2-the-sdg-index-and-dashboards>
130. Kuur O.V., Varavin E.V., Kozlova M.V. (2024). ESG Transformation Factors of Kazakhstan's Economy in the Context of Sustainable Development. *Economy: Strategy and Practice*, 19(2). 20-40. <https://doi.org/10.51176/1997-9967-2024-2-20-40>
131. Doszhan R.D., Sabidullina A.E., Nurmagambetova A.Z., Kozhakhmetova A.K. (2022). Green financing in Kazakhstan: current status and prospects. *Economy: Strategy and Practice*, 17(4). 170-184
132. Berstembayeva R.K., Nurumov A.A. (2024). Problems of Financing the Green Economy in the Republic of Kazakhstan. Collection of materials from the international scientific and practical conference "Financial System in the Context of Creating a Model of Sustainable Economic Development of Kazakhstan". <https://rep.enu.kz/bitstream/handle/enu/13545/Merged-20240425-175033.pdf?sequence=1&isAllowed=y>

Assanova M.A., Glazunova S.B., Kalkabayeva G.M.

**European practice of sustainable development management
towards green transformation**

Monograph

Отпечатано с авторского оригинала

Подписано в печать 28.10.2025 г.

Формат бумаги 60x84 1/16. Бумага офсетная. Гарнитура Times.

Объем 11 п.л. Тираж 500 экз. Заказ № 358

