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REVIEW

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Sustainable development economy and the development of green economy in the European Union

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Abstract

Background This study aims to explain the policies implemented by the European Union in transitioning to a green economy. It examines the period from the adoption of sustainable development within the Union to the present, focusing on the EU's strategies for sustainable development and the green economy.

Main text The study reveals that the European Union has long recognized environmental problems and the impacts of climate change, starting from the 1990s. In response to the global crisis in 2008, the EU embraced the opportunity to build a dynamic, low-carbon, resource-efficient, knowledge-based, and socially inclusive society. Green investments were included in the EU's rescue plan, initiating the green transformation. The study explains the concepts of sustainable development, the green economy, and green growth. It discusses how the European Union implemented its green transformation, particularly through the examination of the European Green Deal. Furthermore, it explores the developments related to climate change and the green economy within the framework of the European 2020 strategy.

Conclusions The findings highlight the European Union's commitment to addressing environmental challenges and transitioning to a green economy. Future research should focus on assessing the effectiveness of implemented policies and strategies in achieving sustainable development goals. The EU allocated a substantial portion of its budget to support green investments, including green incentives during the 2008 financial crisis, and significant budgets from member states like Germany and France. The EU has set ambitious targets for reducing greenhouse gas emissions, aiming for at least a 40% reduction by 2030 compared to 1990 levels and becoming carbon-neutral by 2050. Future research should also explore the social and economic implications of the green transformation, including job creation and industry competitiveness, to provide valuable insights for policymakers and researchers. This will contribute to enhancing the EU's green policies and advancing the transition to a sustainable and environmentally conscious economy.

Keywords Sustainable development, Green economy, European Green Deal

Background

The Industrial Revolution, which emerged in the eighteenth century from a historical perspective, holds an important place in terms of the environment. In this century, the world population increased significantly, and the abundance of natural resources led people to a situation where they could not think about it. With the increasing production and consumption accompanying

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the Industrial Revolution, social life began to change, cities became crowded as a result of rural–urban migrations, new business lines and sections of society emerged [1]. This situation led to an increase in production and the rapid satisfaction of human needs. However, the changing forms of production and consumption with the Industrial Revolution accelerated the emergence of environmental problems. Moreover, environmental problems, which were previously perceived at the local level, have now reached global dimensions, and the developments experienced have led to the spread of the idea of nature conservation. Especially in Europe, the increasing deforestation activities have led scientists to take action to protect nature with the idea that it will pose a danger to future generations [2].

While these developments led to the development of sustainability thinking, they also contributed to the development of the idea of global sustainability among many ecological thinkers. One of these thinkers is Rachel Carson, who caused a sensation worldwide with her book "Silent Spring". In this book, published in 1962, Carson drew attention to the negative effects of industrialization on the environment and emphasized that humanity's intervention in natural life creates environmental problems. She also argued that the adverse effects of chemical products on agricultural areas caused many plant and animal species to start to become extinct and that the use of chemical pesticides would lead to an excessive increase in harmful insect species [3].

With the addition of environmental issues and the rise in oil and other commodity prices, debates regarding the natural limits of economic growth have gained momentum in this period. One important example of this is the Club of Rome, founded in 1968 to assess problems threatening humanity's future. Under the leadership of Donella H. Meadows, the Club of Rome published the "Limits to Growth" report in 1972 [4]. In this report, Meadows et al. [5] focused on topics such as the widening gap between rich and poor caused by economic growth, the limited availability of land and water crucial for food production, the complete depletion of many minerals in the next century, the environmental pollution caused by increasing energy use through industrialization, and the ongoing effects of the use of non-renewable resources on economic development.

By the 1980s, the negative consequences of environmental issues on human development and well-being had become apparent, and this played a significant role in the development of sustainable development and its transformation into a fundamental objective [6]. Sachs [7] has highlighted the environmental crisis faced by our planet, the massive world economy that has created it, and the threat that the crisis poses to billions of people and species. Thus, the concept of sustainability has evolved in light of all these issues and has given way to sustainable development.

Sustainable development, green economy, and green growth

Sustainable development

Sustainable development has been defined in various ways throughout history. The most commonly used definition is found in the report "Our Common Future", published in 1987 by the World Commission on Environment and Development [8]. This report, which has played an important role in the development and global-level discussion of sustainable development, defines sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." This definition emphasizes two fundamental principles. The first is the prioritization of meeting the basic needs of the poor, while the second highlights the need to maintain the ability of the environment to meet both present and future needs through the use of technology and social organization [8]. This limitation idea of sustainability highlights intergenerational interaction, emphasizing that equity is a fundamental principle. The term "basic needs" includes the combination of a healthy environment, a just society, and a functioning economy [9], while the need for global justice is emphasized to integrate intergenerational justice [10].

Green economy and green growth

The green economy and green growth are often mentioned as key elements of sustainable development. The green economy refers to an economic system that considers environmental sustainability and social welfare, while green growth refers to economic growth that is both environmentally sustainable and socially inclusive. Both concepts aim to promote a shift towards more sustainable production and consumption patterns, while also considering social equity and environmental sustainability. The implementation of green economy and green growth policies can contribute to achieving sustainable development goals, while also creating new job opportunities and improving the well-being of society [11].

The fulfillment of basic needs presents us with the challenge of achieving full growth potential. However, achieving full growth potential can endanger sustainability by bringing about environmental problems. What is intended to be conveyed here is that economic growth alone is not sufficient, and there is a need for sustainable economic growth. With sustainable development, the productive potential of societies can be increased, and basic human needs can be met by providing equal opportunities for everyone [12]. Therefore, it is not possible to

talk only about sustainable development from an economic perspective. Sustainable development encompasses environmental, economic, and social dimensions. One of the most important issues it emphasizes is poverty. In this sense, it has adopted the reduction of poverty as a primary goal by reducing the depletion of resources, environmental and cultural damage, and social instability [13].

Green Economy has been one of the important developments in the world since the 1970s, considering the environmental issues and developments that have been taking place globally. The internalization of environmental externalities and the polluter-pays principle have been proposed as solutions to environmental problems within the framework of sustainability, which brought about an environmentally conscious and green perspective to capitalism [14]. Puppim de Oliviera [15] states that the polluter-pays principle has paved the way for the sparks of green economy thinking, bringing sustainable development to further levels [15]. As a concept, Green Economy first appeared in the "Green Economy Plan" report prepared for the UK government by Pearce et al. [16–18]. The report was presented to measure progress in sustainable development and evaluate policies, but it did not refer to green economy in general. Therefore, it can be said that the concept of green economy is used to give a green perspective to the economy [17, 19]. The fact that the concept of green economy is new and there is no agreed definition yet, creates some difficulties in understanding the concept. Especially when used with the concept of green growth, it appears as complementary concepts to each other, but different from sustainable development. United Nations Environment Programme [11] refers to a green economy that reduces environmental risks and ecological scarcities, enhances human well-being, and is based on social equity. Therefore, green economy is defined as a low-carbon, resource-efficient, and socially inclusive economy (United Nations Environment Programme [11]).

In a green economy, as in sustainable development, environmental, social, and economic inclusivity must be ensured. Therefore, green economy policies should prioritize human well-being and social equity, as well as the rational use of natural and human resources, and be central to economic development [United Nations Environment Management Group (UNEMG) [20]. In short, the integration of green policies should consider the three dimensions of sustainable development.

Green growth

Green growth is a strategy aimed at promoting the green economy and changing the growth paradigm while addressing all three dimensions of sustainable development. Since its emergence, it has aimed to achieve sustainable growth. The concept was first introduced as a term in the Fifth Ministerial Conference on Environment and Development held in Seoul in March 2005. At this conference, attended by 52 governments and stakeholders from Asia and the Pacific, the necessity of a green growth policy beyond sustainable development was put forward [17, 21].

The development of green growth as a strategy occurred in 2008. This was due to the inadequacy of countries' economic policies to emerge from the global crisis, in terms of the consequences it revealed after the crisis. As a result of the crisis, it was understood that there was no single key to recovering, and the fuel and financial sectors were affected negatively. While these developments were taking place, the necessity of bringing a green perspective to the economy emerged, and countries began to implement green policies. In particular, the United Nations Environment Programme [11] and the Organization for Economic Co-operation and Development [OECD] conducted studies on different growth and economic strategies. This led to the emergence of the concepts of green economy and green growth, while giving sustainable development a different dimension. The most widely accepted definition of green growth, made by the OECD, describes it as a system that encourages economic growth and innovation while ensuring that natural assets and environmental services continue to preserve human well-being [22]. Green growth is a growth paradigm aimed at preventing environmental problems, identifying new economic development areas, and employment opportunities. At the same time, it argues against other growth models and suggests that economic growth should be addressed with a green policy [23]. Kasztelan [19] argues that the concepts of green economy and green growth essentially seek to identify ways to improve the results of existing economic activities by considering the efficiency of resource and energy from a technological advancement perspective, considering climate problems and decreases in natural resources [19].

The green transformation of the European Union and the European Green Deal

The crisis that began in 2008 as a result of the problems in the housing market in the United States [US] affected many countries, including the US, the United Kingdom, and the European Union [EU]. The global growth rates decreased, the world trade volume decreased, unemployment and public debt increased, and heavy pressures were imposed on poor people. The destructive effects of the crisis were felt not only economically, but also socially and environmentally, deeply affecting

countries. Following the crisis, countries turned to green policies and incentives, preparing comprehensive studies for achieving economic growth without harming the environment or with less harm. In this sense, the EU has based its future strategies on sustainable development and green economy, taking lessons from the crisis.

Developments prior to the crisis on the path towards the green transformation

One of the causes of climate change is greenhouse gases. These gases, which increase due to natural processes and human activities, cause an increase in temperatures by causing the greenhouse effect. Therefore, it is necessary to reduce these emissions and to carry out human activities without harming the environment for the future of the planet. The EU has focused on reducing these gases since the 1990s, and after the global crisis, it aimed to build a carbon-free and sustainable economic model while giving place to green incentives. The Rio Conference organized by the United Nations in 1992 is an important conference for taking sustainable development to further levels and combating climate change globally. The "Framework Convention on Climate Change" adopted at this conference led to the declaration of the Kyoto Protocol in 1997 [24], aiming to reduce greenhouse gas emissions and eliminate the negative effects of climate change. The Kyoto Protocol includes a 5% reduction in greenhouse gas emissions between 2008 and 2012 compared to the 1990s in developed countries. The protocol, which came into effect in 2005, was adopted by the EU in 1997. Under the Kyoto Protocol, the EU pledged to reduce greenhouse gas emissions by 8% for the period 2008–2012 [24].

At the European Council held in Helsinki in 1999, it was argued that it was necessary to develop a long-term strategy that would regulate and unify sustainable development policies in economic, social, and environmental terms across Europe. In this regard, the European Commission called on to prepare a proposal for these goals at the European Council to be held in June 2000 [25]. By the year 2000, the European Council had met again in Portugal with the participation of the leaders of the 15 member countries. At this meeting, it was suggested that growth and employment rates should be focused on in order to support the social cohesion and environmental sustainability of the EU. The aim was to establish a sustainable economic growth that does not neglect good jobs, social cohesion, and the environment within the EU in the coming decade [26]. These goals were accepted within the framework of the plan called the Lisbon Strategy, which aimed to improve the economic and social structure of the EU. However, this strategy, which was primarily adopted for the development of the EU in economic terms, contains some deficiencies in terms of climate and sustainable development goals.

In May 2001, the European Commission adopted a document entitled "European Union Sustainable Development Strategy". In this document, goals were established that included climate change, biodiversity conservation, and coordinated implementation of environmental and health policies, as well as dangerous chemical substances. Subsequently, a proposal titled "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development" was presented by the Commission at the Gothenburg Summit on June 15–16, which aimed to determine the EU's sustainable development strategy and expand the Lisbon Strategy to cover climate change and environmental issues [27, 28]. The Gothenburg Summit has thus directed the initiation and creation of the EU's first sustainable development strategy and policies. In addition, the following targets have been added to the Lisbon Strategy in line with the decisions made at Gothenburg [26]:

(i) Progress in achieving the targets set out in the Kyoto Protocol [24] by addressing the problem of climate change;
(ii) Obtaining 12% of primary energy consumption and 22% of final electricity consumption from renewable sources;
(iii) Determining the social and environmental costs of increasing traffic, noise, crowds, and pollution and addressing these issues;
(iv) Strengthening transport infrastructure and developing a regulatory framework for the taxation system;
(v) Ensuring the sustainable use of natural resources and waste levels;
(vi) Designing a taxation directive in the energy sector and adopting environmental action programs.

Several studies and commentaries have discussed different opinions and observations regarding the European Green Deal. For instance, a report by the European Court of Auditors highlighted the need for effective monitoring and evaluation of the Green Deal's implementation to ensure its success and impact. It emphasized the importance of addressing potential obstacles such as inadequate funding, bureaucratic complexities, and conflicting policy objectives within the EU [29].

Furthermore, academic research and expert opinions have discussed potential obstacles and criticisms related to the achievement of sustainable development goals in the EU. Some of these challenges include the need for stronger policy coherence, addressing regional disparities, managing the transition in energy-intensive

industries, and ensuring a just and inclusive green transition that considers social and economic aspects [30].

In order to achieve the targets, it committed to under the Kyoto Protocol on climate change, the EU decided to establish the Emissions Trading System [ETS] with Directive 2003/87/EC in 2003. The ETS, implemented in 2005, involves the buying and selling of emission credits allocated to businesses, thus enabling the economically efficient reduction or limitation of greenhouse gas emissions. The ETS has been developed for four periods, covering 2005–2007, 2008–2012, 2013–2020, and 2021–2030, respectively. During the first period of the ETS, particularly high carbon dioxide emitting industries such as energy and heat production and some energy-intensive facilities were selected, with a total of 10,500 facilities included in the ETS for the EU-27. The system was extended to include aviation emissions between 2008 and 2012, and Iceland, Liechtenstein, and Norway were included in the system, which would cover a total of 11,500 facilities. The EU aims to expand its emission targets for future years within the scope of the ETS. Thus, in the third period of the ETS, covering the years 2013–2020, with the condition that developed countries also commit to it, the EU set its 2020 emission reduction target to be 21% less than the levels in 2005 for the areas covered by the ETS. In addition to the ETS, the Effort Sharing Decision [ESD] has been presented to share the responsibility for emission reductions among countries in areas not covered by the ETS.

Several observations can be made regarding the attainment of these goals. Firstly, the EU has made significant strides in areas such as renewable energy production and energy efficiency. According to Eurostat, the share of renewable energy in the EU's gross final energy consumption increased from 8.5% in 2004 to 19.7% in 2019. Additionally, energy consumption per capita has decreased over the years, reflecting improved energy efficiency practices [31].

The EU has made progress in reducing greenhouse gas emissions. From 1990 to 2019, the EU managed to reduce its total greenhouse gas emissions by 24%, as reported by the European Environment Agency. These achievements indicate a positive trajectory towards the goals of sustainable development.

In 2005, the Council of Europe began working on identifying principles that are important for achieving sustainable development. These principles include the promotion of social cohesion and the creation of a competitive and eco-efficient union that protects and improves environmental quality, while fostering economic development and ensuring its global implications. In this context, a revised sustainable development strategy was adopted by the European Commission in June 2006 [77]. The EU sustainable development strategy is primarily based on the creation of environmentally sustainable societies that efficiently use resources and manage resource utilization well, leading to long-term improvements in quality of life. To this end, seven priority objectives have been identified: combating climate change, achieving sustainable production and consumption, providing sustainable transportation, conserving and managing natural resources, protecting public health, eliminating demographic, social inclusion, and migration-related issues, combating global poverty, and promoting sustainable development [10].

In 2007, a new report was published by the European Commission to observe progress made towards the principles identified in the Sustainable Development Strategy. According to the report, while progress has been made in the identified areas, the targets have not been achieved to a significant extent [32]. Subsequently, in mid-2008, the crisis that emerged in the United States deeply affected the economies of member countries and macroeconomic indicators deteriorated. In response, countries directed their policies towards finding a solution to the crisis and implemented incentive programs for the recovery of their financial systems.

The EU, deeply affected by the crisis, launched the Economic Recovery Plan in November 2008 to stimulate demand, rebuild the shattered confidence, and promote employment. Along with this plan, it also provided smart investment proposals for skills and technologies to enhance long-term economic growth and sustainable prosperity [33]. In this sense, considering not only the economic but also the environmental and social dimensions of the crisis, policies, and actions for the future of the EU for 2009–2010 were aimed at. While the Economic Development Plan consisted mainly of adopting fiscal policies, emphasis was also placed on innovation and greening of EU investments, and four main objectives were identified. These objectives were to: (i) revive declining demand and increase consumer confidence post-crisis; (ii) prevent the impact of economic consequences, particularly on the poor, and revitalize the labor market; (iii) reduce structural unemployment, promote innovation and create a knowledge economy; and (iv) accelerate the transition to a low-carbon economy [33]. The European Commission has identified these goals to increase demand and achieve them quickly, and has allocated approximately 1.5% of the EU's GDP, or about €200 billion, to the budget [33–35]. 13.2% of the designated budget of €200 billion was allocated to green investments. Within this ratio, 75% of green investments were allocated to energy efficiency in buildings, 20% to railways, and 5% to vehicles [36]. The plan emphasized the importance of energy efficiency in buildings and the need

for EU institutions and member states to work together to achieve it and increase green products. More than two-thirds of the portion allocated to climate change in the €200 billion stimulus package was allocated to energy efficiency. Accordingly, the most significant investments were made for the development of energy-efficient buildings, while investments in grids and low-carbon vehicles also played an important role. Figure 1 shows the distribution of green incentive spending.

Czech Republic has allocated 900 million euros of the 2.7-billion-euro renewable energy railway and Low Carbon Vehicles package to green incentives. Despite being significantly affected by the crisis, Belgium has allocated 170 million euros to green incentives. Estonia has allocated approximately 248 million euros, Portugal 305 million euros, and Slovakia approximately 166 million euros to green incentives. The United Kingdom, which left the EU in 2020, is also among the countries allocating a significant share of green incentives. As part of its rescue plan set for the years 2009–2010, which had a total size of 25.3 billion pounds, the UK has allocated 1.31 billion pounds to green investments [37]. France and Germany are seen to allocate the most funds for green incentives among member countries. Germany has announced two incentive packages in November 2008 and January 2009. The packages, totaling 80 billion euros, represent 1.5% of GDP for 2009 and 2% of GDP for 2010. This package, prepared by Germany, is the largest economic recovery program against the crisis among member countries [34]. The proportion of green investments in the package was realized as 13.3% [37], and resources were primarily allocated for energy efficiency works. France has also announced an economic recovery package for the years 2009–2010. The package, consisting of 26 billion euros, which corresponds to 1.3% of gross domestic product for 2009. Of the 26-billion-euro budget, 11 billion euros were allocated for increasing commercial liquidity flows, another 11 billion euros were allocated for direct government investments, and the remaining 4 billion euros were allocated to public companies for increasing railway infrastructure, postal services and energy services [34].

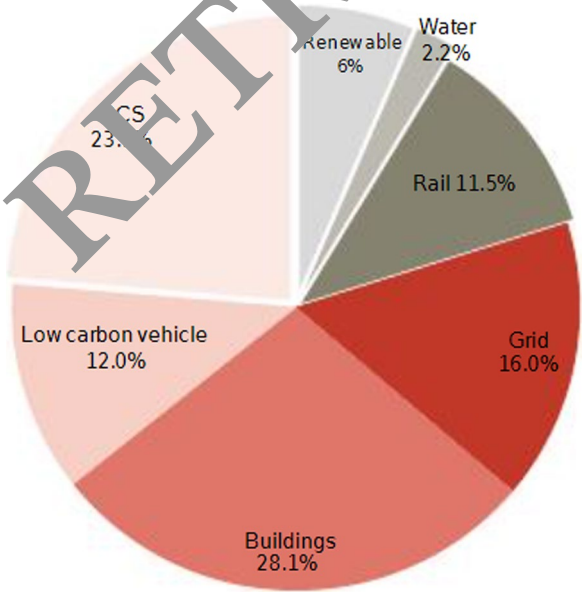

Fig. 1 Green stimulus spending in the EU. Source: [36:15]

Developments after the crisis

Following the global crisis, the need for a more comprehensive strategy by the EU on climate change and environmental issues has emerged. In this sense, a new strategy was launched by the European Commission in 2010, which will replace the Lisbon Strategy. The strategy, named "Europe 2020," focuses on reducing the negative effects of the crisis and reducing climate change and environmental issues. Additionally, it establishes a vision of achieving smart, sustainable, and inclusive growth. The 20/20/20 Strategy, also known as this strategy, aims to develop a knowledge- and innovation-based economy with smart growth, promote a greener and more competitive economy by sustainable growth that uses resources efficiently, and encourage social and regional cohesion with inclusive growth [38:3]. Within the scope of the Europe 2020 Strategy, three main targets related to climate change and the environment have been identified. These targets are reducing greenhouse gas emissions by 20% compared to 1990, increase the share of renewable energy sources in total energy consumption by 20%, and increase energy efficiency by 20% [38]. Although the targets have been set until 2020, the Union has started to create its goals for after 2020. This is evidenced by the fact that other targets, except for those set under the ETS, have been created for 2020. Therefore, work is needed to determine the Union's post-2020 targets and how they will be established. For this reason, the European Commission has set out to establish the 2030 strategy to create climate and energy policies. In 2013, the Commission published a Green Paper entitled "2030 Framework for Climate and Energy Policies" [39]. After the publication of the Green Paper, the Commission proposed a framework for climate and energy for 2030 on January 22, 2014 [39]. This framework creates new opportunities for affordable energy for consumers, growth, and employment to create a low-carbon economy. This situation leads to ensuring energy supply security and reducing energy imports. With this aim, the Union has put forward a policy framework for 2030 [40]. This policy framework was adopted by 28 member states on October 24, 2014. Accordingly, the main targets for reducing greenhouse gas emissions,

increasing renewable energy use and energy efficiency have been identified. It is aimed to reduce greenhouse gas emissions by 40% by 2030 compared to 1990, increase the use of renewable energy and energy efficiency to 27% [41]. Furthermore, emphasizing the importance of ETS in the transition to a low-carbon economy, the goal of establishing a carbon market to create a Market Stability Reserve in 2021 has been put forward [40].

Similarly, the Union has established its vision for what it wants to achieve by 2050 with the 7th Environmental Action Program published in 2014. Covering the years 2014–2020, this program represents a vision for a low-carbon, green, and circular economy with the slogan "Living Well, Within the Limits of Our Planet" [42]. These goals set by the EU are significant developments in providing global crisis and reducing dependency on energy. Moreover, the 2020 goals have played a crucial role in maintaining economic growth and sustaining employment for approximately 4.2 million people in various industries after the crisis [40]. The most cost-effective way to increase energy security and reduce greenhouse gases and other pollutants is to increase energy efficiency. In this sense, the Union focuses on increasing energy efficiency, aiming to reduce costs and create new job opportunities in line with its objectives [43]. Additionally, the Union, which desires the signing of a global climate agreement, concretely expressed its desire at the "21st Conference of the Parties to the United Nations Framework Convention on Climate Change" held in Paris in 2015 [44]. This conference, also known as COP 21, was one of the most important conferences of that period in terms of determining global climate goals and creating binding obligations for countries. It paved the way for the establishment of a global framework on climate change after 2020, leading to an agreement between countries, and the "Paris Agreement" was adopted at the conference. The EU played a leading role in addressing the fundamental problems of climate change and in the emergence of global responses in line with the Paris Agreement [45]. On April 22, 2016, the EU signed the Paris Agreement and approved it on October 5 of the same year [27].

Since the signing of the Paris Agreement in 2016, the EU has been working on long-term strategies to reduce greenhouse gas emissions and has developed a plan called the "European Green Deal" [EGD] on December 11, 2019, which sets out its long-term goals and roadmap for addressing environmental and climate change issues in all policy areas [46]. The announcement of the EGD by the EU coincided with the emergence of the Covid-19 pandemic, which began in late 2019 in Wuhan province, China. The pandemic had a significant negative impact on food, health, and the economy in many countries in 2020. Countries began working on solutions to the problems caused by the pandemic and like in the 2008 crisis, introduced economic recovery packages. The EU prepared a Recovery Plan to reduce the social and economic impacts of the pandemic in its member states. The EGD is seen as a means for the EU to resist current and future crises, such as Covid-19, by carbon-neutralizing the economy by 2050. The 2008 crisis demonstrated that crises have multiple dimensions, and solving them with unilateral economic policies is no longer feasible. Therefore, the EU believes that the EGD is essential not only for addressing the ecological imbalance but also for recovering from the effects of Covid-19. As such, the EU announced that it would use one-third of the investments in its €1.8 trillion recovery package and its 7-year budget to finance the EGD [47].

The European Green Deal [EGD] aims to transform the EU economy with the ultimate goal of creating a sustainable future. It encompasses various elements, as shown in Fig. 2.

This new growth strategy necessitates the integration of environmental, productivity, stability, and equity dimensions at the center of policies and actions by prioritizing sustainability. The EGD seeks to achieve a carbon-neutral continent by 2050 and ensure that the benefits arising from this transition are enjoyed by all. Furthermore, the EGD aims to develop new technologies and sustainable solutions to position Europe at the forefront of economic growth and leadership in the digital world [48].

To achieve the identified environmental and climate goals, the Commission believes that effective carbon pricing is necessary throughout the economy [49, 50]. This necessitates the introduction of new taxes and non-tariff barriers on trade through the Carbon Border Adjustment Mechanism [CBAM] system, aimed at reducing carbon leakage. The Commission is working towards establishing this system, and through the Green Taxonomy Mechanism, aims to identify investments for climate goals and inject climate finance into these investments [46].

In addition, financing and the creation of mechanisms that address all sectors are necessary to achieve the goals set within the scope of the European Green Deal [EGD]. Therefore, it is important to determine financing and use the budget effectively. The EU has announced that it will allocate a portion of its current budget for the EGD and will present the Sustainable Europe Investment Plan for areas that require additional financing. Additionally, the European Investment Fund [InvestEU] program has emphasized that a portion of the allocated budget will be used for green investments. [51]. Figure 3 shows the Sustainable Europe Investment Plan, which aims to provide a framework that facilitates and encourages public and private investments necessary for a climate-neutral, green, competitive, and inclusive economy by triggering EU

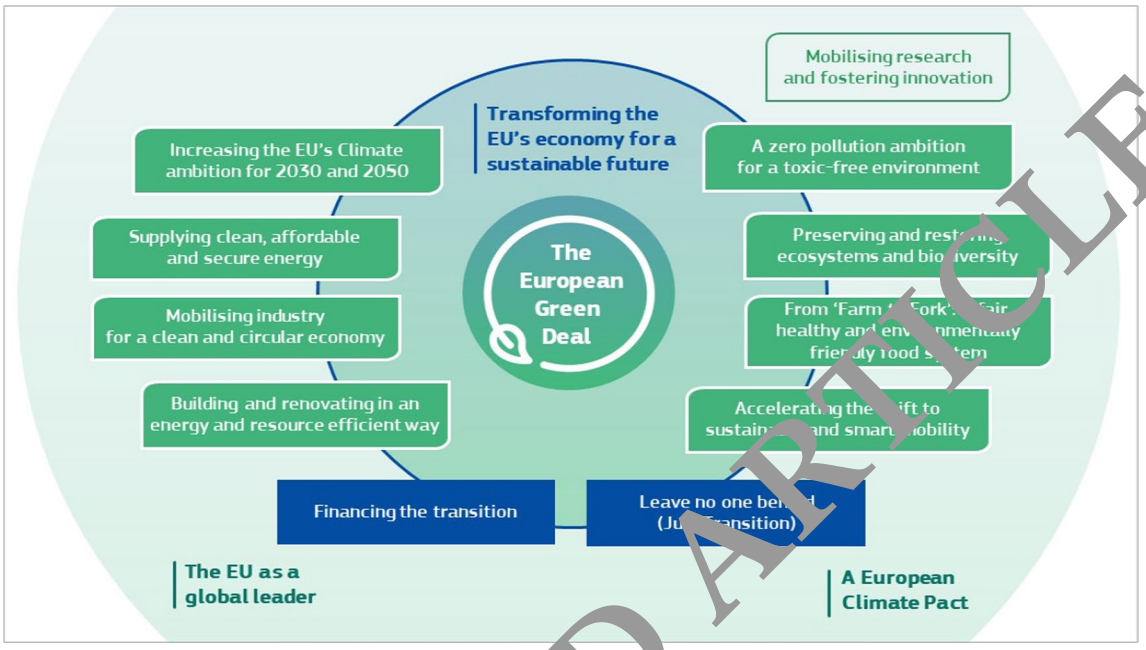

Fig. 2 The figure illustrates the various elements of the Green Deal. Source: [47]

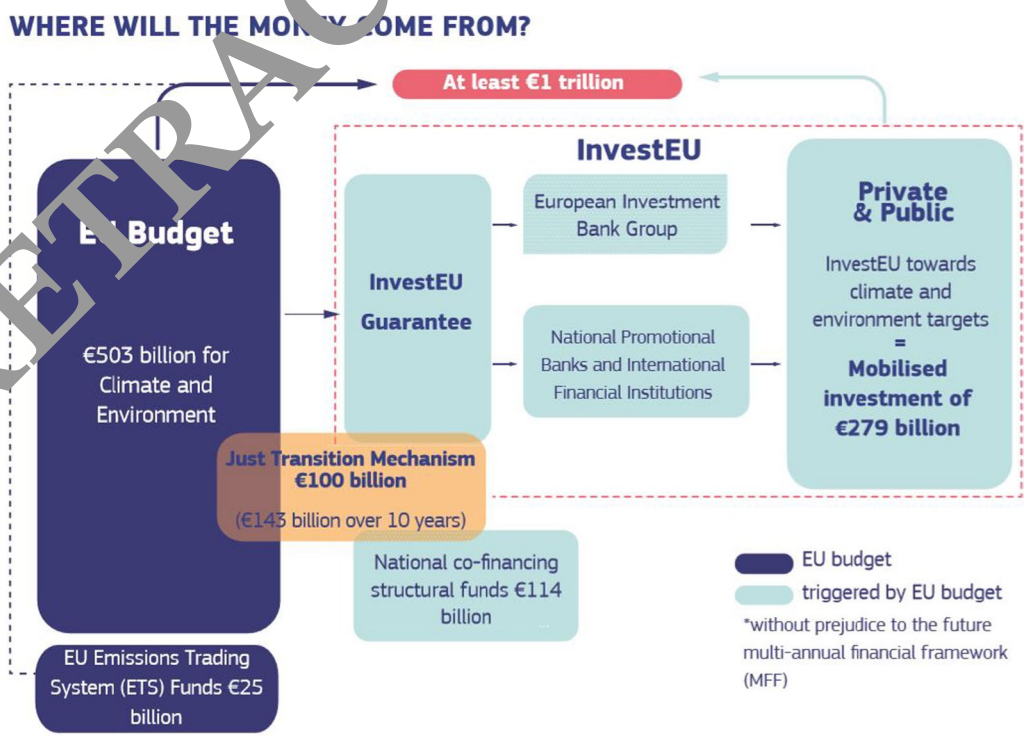

Fig. 3 Sustainable European investment plan finance mechanism. Source: [53]

funds. The plan is based on three dimensions, which are financing, enabling, and implementation support [52].

(i) The aim is to mobilize sustainable investments worth at least 1 trillion euros within the next 10 years for financing.
(ii) The plan aims to facilitate sustainable investments by encouraging public and private sector investments through activation.
(iii) The objective of implementation support is to encourage public officials and project supporters in planning, designing, and executing sustainable projects.

2020 targets and achievements

The European 2020 strategy was primarily established around three objectives: a 20% reduction in greenhouse gas emissions by 2020 compared to 1990 levels, a 20% increase in energy from renewable sources, and a 20% increase in energy efficiency.

Approximately 55% of greenhouse gas emissions in the EU are generated from activities in the transportation, construction, agriculture, and waste sectors. The remaining 45% of emissions are mainly caused by energy power plants and industrial facilities. ESDs were established for the 55% sector responsible for greenhouse gas emissions. As a result, member states have established their own national emission targets and committed to adhering to them. This is expected to result in a 10% reduction in emissions by 2020. In addition, more than 11,000 facilities responsible for 45% of greenhouse gas emissions have been included in the ETS. Under the ETS, companies are allowed to buy and sell emission permits. If a company emits more than the amount allowed by its permit, it will be penalized, whereas if it emits less, it can sell its excess permits to another country. Through the establishment of the ETS, incentives are provided to companies to reduce total emission values and invest in low-carbon technologies by setting a monetary value on carbon [54].

The 2020 emissions were taken into consideration in the determination of the ESD and ETS. In this regard, if greenhouse gas emissions under the ETS are reduced by 21% and emissions under the ESD are reduced by 10%, the 20% target can be achieved. Table 1 illustrates the variation of the 20% target for greenhouse gas emissions reduction by year.

According to Table 1, greenhouse gas emissions for the EU-27 have been decreasing since 2010. By 2013, the 20% reduction target had been achieved. By 2015, emissions had decreased in all sectors except for the refrigeration and cooling industries. The highest reduction was seen in the industrial and energy supply sectors [54]. After 2015, the decrease continued and by 2018, greenhouse gas emissions had decreased by approximately 22% compared to 1990 levels. This indicates that the targets set for 2020 were achieved and is also important for the targets set for 2030 and 2050. According to a report published by the EEA in 2020, emissions within the scope of ETS for the EU-27 could decrease by 33% by 2030. Similarly, emissions within the scope of ESD are estimated to decrease by 18% by 2030. This suggests that with planned policies and measures, there could be a 41% reduction in emissions by 2030 [56].

Another target set under the 2020 strategy is to increase the share of renewable energy sources in total energy consumption by 20%. Member states have set their own national plans and targets to achieve this goal. For example, Germany has set its target for 2020 at 18% from renewable sources, Austria at 34%, Spain at 20%, and France at 23%. When countries are examined in terms of their targets, the highest targets are shared among Denmark, Sweden, Finland, Austria, and Latvia. Table 2 shows the targets and achievements set by countries.

Since 2011, it has been observed that the target set has been approached every year. By 2019, the target was achieved with 19%, and as of 2020, the target was realized with 22%. According to the EEA [58], 22% of the energy consumed in 2021 was provided from renewable sources, which is at the same level as in 2020. The increase in electricity production from solar energy contributed to this rate. However, the negative developments experienced after Covid-19 have caused a decrease in the rate of increase. In this regard, the long-term expectations for renewable energy may be negatively affected, and the target of 32% set for 2030 may not be achieved [58].

The European Union has implemented various measures to decrease the level of carbon emissions from fossil fuels and promote the transition to cleaner energy sources. Here are a few key initiatives:

- Renewable Energy Directive: The EU has set renewable energy targets and implemented the Renewable Energy Directive. This directive sets binding targets for each member state to increase the share of renewable energy in their energy consumption. The objective is to reach a renewable energy share of at least 32% by 2030 [59].
- Emission Trading System (EU ETS): The EU ETS is the world's largest carbon market and a key instrument to reduce carbon emissions. It puts a price on carbon and establishes a cap on the total amount of greenhouse gas emissions allowed from sectors such as power generation, industry, and aviation. The cap is gradually reduced over time, encouraging emission reductions [60].

Table 1 Greenhouse gas emission values: 2009–2020 [%]

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
European Union Goal (27 countries from 2020)	84.4	82.1	80.4	78.5	76.0	77.3	77.6	79.5	77.6	74.6	66.7
Belgium	94.2	87.3	85.1	84.6	80.9	84.0	83.0	83.1	83.8	83.1	75.2
Bulgaria	58.5	69.2	63.7	60.1	62.6	67.4	62.7	66.8	62.9	61.9	49.3
Czech Republic	70.6	69.6	67.4	65.0	63.9	64.6	65.8	67.3	69.3	69.8	66.4
Denmark	86.1	79.1	72.7	74.4	70.3	65.7	69.8	66.9	69.2	[illegible]	57.5
Germany	73.8	71.7	71.5	73.1	70.0	70.4	70.7	69.7	67.2	63.6	57.1
Estonia	44.3	44.3	44.9	53.6	52.7	43.3	47.9	53.[illegible]	[illegible]	39.1	34.8
Ireland	116.9	108.4	108.2	109.4	108.4	114.0	116.5	[illegible]	117.6	113.7	106.8
Greece	113.7	110.9	107.5	99.7	98.2	91.1	88.1	[illegible]	88.8	83.4	69.6
Spain	129.1	129.4	127.2	117.4	117.6	121.3	117.5	[illegible]	121.1	114.3	94.9
France	91.8	87.3	87.0	86.5	81.8	83.4	[illegible]	[illegible]	84.6	83.5	73.2
Croatia	82.3	86.2	81.1	73.7	71.3	74.3	[illegible]	[illegible]	76.1	76.6	71.8
Italy	93.2	92.4	90.4	80.6	76.4	78.4	[illegible]	81.6	78.0	75.0	67.7
Cyprus	166.9	161.5	152.4	139.2	145.4	145.8	[illegible]	160.8	159.3	159.8	147.6
Latvia	74.5	65.8	54.7	63.3	90.1	81.3	[illegible]	58.4	80.6	66.5	81.6
Lithuania	24.5	25.6	26.8	25.4	27.5	29.7	31.6	33.6	33.2	36.1	35.0
Luxembourg	101.1	98.3	95.0	89.7	[illegible]	85.4	84.0	87.9	92.4	92.4	78.1
Hungary	67.6	66.1	61.6	59.3	[illegible]	61.2	63.3	65.4	66.3	65.6	61.1
Malta	116.5	116.6	123.0	111.[illegible]	112.[illegible]	88.9	79.9	88.0	90.1	95.0	83.2
Netherlands	98.4	92.4	90.4	[illegible]	8[illegible]	90.6	90.9	89.6	87.5	84.8	75.6
Austria	122.6	119.0	115.8	117.8	[illegible]2.8	116.6	118.6	120.9	115.9	119.0	109.1
Poland	84.9	83.5	81.[illegible]	80.3	79.2	80.7	81.5	84.6	84.6	83.7	79.9
Portugal	102.4	98.2	[illegible]	[illegible]	93.1	101.5	105.7	138.8	105.6	98.3	85.5
Romania	42.7	45.6	43.6	38.3	36.7	37.1	35.6	38.2	39.6	38.6	34.6
Slovenia	131.1	85.9	78.0	61.8	59.7	54.4	52.8	52.8	53.2	53.8	55.7
Finland	94.7	[illegible]	[illegible]	79.0	67.5	65.1	71.9	69.7	87.1	71.1	53.4
Sweden	65.8	54.3	[illegible]4.9	46.4	41.7	49.3	48.0	58.4	56.5	46.3	20.6
United Kingdom	78.0	72.[illegible]	74.5	72.8	67.9	65.9	62.9	61.8	60.9	59.0	51.1

Source: [55]

- Effort Sharing Regulation: The Effort Sharing Regulation sets binding national targets for sectors not covered by the EU ETS, including transportation, buildings, agriculture, and waste. It ensures that each member state contributes to the overall EU target of reducing emissions by 30% by 2030 compared to 2005 levels [61].
- Clean Energy Package: The Clean Energy Package, adopted in 2018, introduces a range of measures to support the clean energy transition. It includes provisions for energy efficiency improvements, the deployment of renewable energy, and the integration of renewable energy sources into the electricity grid [62].

Another important goal that the EU has considered regarding climate change is to increase energy efficiency by 20%, which also means reducing energy consumption by 20%. In this context, the Energy Efficiency Directive No. 2012/27/EU was adopted and came into force in 2012. The target includes primary energy consumption and final energy consumption. In order to reach the target in 2020, primary energy consumption should not exceed 1483 Mtoe, and final energy consumption should not exceed 1086 Mtoe. Tables 3 and 4 show the changes in primary and final energy consumption in EU countries by year [63].

When examining AB27, it is observed that primary energy consumption decreased until 2015 but increased between 2016 and 2018. This increase gave way to a decrease in 2019, and it is seen that the target set was achieved, and energy consumption decreased in 2020. In 2018, the transportation and industry sectors experienced the highest increase in energy consumption, while energy consumption in the housing and services sectors decreased. The share of sectors in final energy consumption showed a distribution among the sectors of 34% transportation, 25% industry, 25% housing, 13% services,

Table 2 Share of energy from renewable sources: 2012–2020 [%]

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Target
European Union Goal (27 countries from 2020)	14,547	16,002	16,660	17,417	17,821	17,980	18,412	19,096	19,885	22,090	–
Belgium	6302	7086	7671	8038	8060	8744	9136	9472	9929	13,000	13
Bulgaria	14,152	15,837	18,898	18,050	18,261	18,760	18,695	20,581	21,546	23,319	16
Czech Republic	10,945	12,814	13,927	15,074	15,070	14,926	14,799	15,140	16,239	17,303	13
Denmark	23,389	25,465	27,173	29,310	30,469	31,715	34,387	35,160	37,020	39,131	30
Germany	12,470	13,549	13,760	14,385	14,906	14,889	15,476	16,660	17,266	19,312	18
Estonia	25,515	25,586	25,356	26,130	28,987	29,232	29,538	29,9[illegible]	[illegible]	30,069	25
Ireland	6605	7029	7521	8516	9083	9189	10,520	[illegible]42	11,979	16,160	16
Greece	11,153	13,741	15,326	15,683	15,690	15,391	17,300	[illegible]001	[illegible]633	21,749	18
Spain	13,176	14,239	15,081	15,880	16,221	17,015	17,118	17,[illegible]	17,852	21,220	20
France	10,813	13,239	13,880	14,362	14,803	15,451	[illegible]5,84[illegible]	16,38[illegible]	17,174	19,109	23
Croatia	25,389	26,757	28,040	27,817	28,969	28,266	[illegible]	[illegible]8,047	28,466	31,023	20
Italy	12,881	15,441	16,741	17,082	17,526	17,415	18,2[illegible]	17,796	18,181	20,359	17
Cyprus	6245	7111	8428	9144	9903	98[illegible]	10,478	13,873	13,777	16,879	13
Latvia	33,478	35,709	37,037	38,629	37,538	37,13[illegible]	[illegible]9,008	40,019	40,929	42,132	40
Lithuania	19,943	21,437	22,689	23,592	25,748	25,613	26,038	24,695	25,475	26,773	23
Luxembourg	2855	3112	3494	4471	4987	5364	6194	8942	7046	11,699	11
Hungary	13,972	15,530	16,205	14,618	1[illegible]95	[illegible]4,377	13,556	12,549	12,634	13,850	13
Malta	1850	2862	3760	474[illegible]	511[illegible]	6208	7219	7914	8230	10.714	10
Netherlands	4524	4659	4691	[illegible]54	5[illegible]14	5846	6507	7394	8886	13,999	14
Austria	31,552	32,734	32,665	33,550	[illegible],498	33,370	33,137	33,784	33,755	36,545	34
Poland	10,337	10,955	11,45[illegible]	[illegible],605	11,881	11,396	11,059	14,936	15,377	16,102	15
Portugal	24,603	24,574	[illegible],[illegible]00	29,[illegible]93	30,514	30,864	30,611	30,203	30,623	33,982	31
Romania	21,743	22,825	23,886	24,845	24,785	25,032	24,454	23,875	24,290	24,478	24
Slovenia	20,937	21,551	[illegible],161	22,459	22,879	21,975	21,658	21,378	21,968	25,000	25
Slovakia	10,348	[illegible]153	10,[illegible]35	11,713	12,883	12,029	11,465	11,896	16,894	17,345	14
Finland	32,532	34,[illegible]22	[illegible],630	38,632	39,228	38,942	40,855	41,182	42,723	43,802	38
Sweden	47,63[illegible]	49,4[illegible]3	50,153	51,151	52,220	52,597	53,390	53,916	55,785	60,124	49
United Kingdom	[illegible]92	446[illegible]	5524	6737	8385	9032	9858	11,138	12,336	15,000	15

Source: [57]

and 3% agri[illegible]ulture, fi[illegible]ries, and forestry in the same year [65]. [illegible]he d[illegible]crease in production due to the Covid-19 pandemic that [illegible]tarted in 2019 had a positive impact on [illegible]he [illegible]020 da[illegible]a. The pandemic brought about many chan[illegible]s, s[illegible]h as border closures, suspension of production, an[illegible] implementation of remote work, in many countries. Therefore, energy consumption decreased in most countries.

Looking at the 2020 data, it can be seen that the EU has achieved the goals set. These data, which are quite important in terms of the 2030 and 2050 goals, support the EU's desire and efforts to be a global leader in green economy. However, global developments in recent years have brought about some problems both in the EU and in other countries. In particular, the war that started between Russia and Ukraine in 2022 brought the energy issue to the agenda. Because the EU imports more than half of the energy used. This situation highlights energy supply security and global developments affect energy imports.

The EU's production of energy from renewable sources reduces its dependence on foreign sources and prevents other countries from using energy as an economic and political tool [66]. However, it is observed that the war between Russia and Ukraine has turned the EU's energy imports into a global energy crisis. As Russia increased energy prices and made cuts in energy, member countries started energy storage studies and energy-saving studies were carried out. Considering the EU's need for Russian gas, the increasing costs bring economic problems and make it difficult for the EU to implement its green economy goals.

AB's "REPowerEU" plan aims to end the use of Russian fossil fuels by 2030 in response to the energy crisis, with the goal of ensuring a smooth transition to green energy. The plan is based on three main objectives: to promote

Table 3 Change of primary energy consumption by years: 2012–2020 [mtoe]

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EU-27 Goal (from 2020)	1457.6	1412.1	1396.2	1384.2	1330.5	1352.7	1364.0	1383.7	1377.2	1353.8	1235.6
Belgium	53.4	49.5	47.1	48.6	45.2	45.7	48.5	48.5	46.5	[illegible]	[illegible]
Bulgaria	17.4	18.6	17.8	16.5	17.3	18.0	17.7	18.3	18.4	18.2	[illegible]
Czech Republic	42.5	40.9	40.4	40.7	39.0	39.4	39.7	40.4	40.5	39.7	37.6
Denmark	19.9	18.5	17.7	17.8	16.9	16.8	17.3	17.4	[illegible]	16.8	15.4
Germany	315.2	297.8	301.1	308.3	293.6	295.9	297.6	298.1	292.0	[illegible]	262.1
Estonia	5.8	5.7	5.2	5.7	5.5	4.8	6.0	5.8	5.6	4.7	4.3
Ireland	14.7	13.6	13.7	13.1	13.3	14.0	14.7	[illegible]	[illegible]	14.7	13.5
Greece	27.2	26.7	26.5	23.4	23.3	23.4	23.1	23.2	22.6	22.3	19.2
Spain	123.0	122.7	123.0	115.7	113.8	118.2	118.4	[illegible]	124.3	120.6	105.0
France	254.5	249.1	249.0	250.4	239.7	244.3	[illegible]	[illegible]	238.6	235.1	208.0
Croatia	8.9	8.7	8.2	8.0	7.6	8.0	[illegible]	8.3	8.2	8.2	7.8
Italy	167.3	162.0	156.6	152.1	142.7	149.1	[illegible]	149.0	147.2	145.9	132.3
Cyprus	2.7	2.7	2.5	2.2	2.2	[illegible]	[illegible]	2.5	2.6	2.5	2.2
Latvia	4.6	4.3	4.4	4.4	4.4	[illegible]	[illegible]	4.5	4.7	4.6	4.3
Lithuania	6.2	5.9	6.0	5.8	5.8	5.8	6.0	6.2	6.4	6.3	6.2
Luxembourg	4.6	4.5	4.4	4.3	[illegible]	4.1	4.2	4.3	4.5	4.5	3.9
Hungary	24.6	24.4	23.1	22.4	22.0	23.3	23.7	24.5	24.5	24.6	23.9
Malta	0.9	0.9	1.0	0.9	[illegible]	0.8	0.7	0.8	0.8	0.9	0.7
Netherlands	71.7	67.1	66.8	[illegible]	62.3	64.0	65.1	65.1	64.4	63.6	58.5
Austria	32.9	32.0	31.7	[illegible]	[illegible]	31.7	32.0	32.8	31.8	32.3	29.9
Poland	96.6	96.6	92.8	93.4	89.5	90.1	94.8	99.1	104.1	100.2	96.9
Portugal	22.7	22.0	[illegible]	21.0	20.7	21.7	21.8	22.8	22.7	22.1	19.5
Romania	33.0	33.5	[illegible]	[illegible]	30.1	30.8	30.7	32.5	32.6	32.1	30.9
Slovenia	7.0	7.1	6.8	6.7	6.4	6.3	6.6	6.7	6.7	6.5	6.2
Slovakia	16.7	16.0	[illegible]	15.7	14.8	15.2	15.4	16.2	15.8	16.0	15.2
Finland	35.4	[illegible]	33.0	32.0	32.7	31.2	32.3	32.2	32.8	32.1	29.9
Sweden	48.3	[illegible]	47.5	46.4	46.0	43.8	45.4	46.4	47.3	45.8	41.3
United Kingdom	[illegible]	[illegible]	195.2	191.6	180.7	182.6	179.4	177.3	177.2	174.3	N/A

N/A represents data that are not available for the year

Source: [64]

energy efficiency, produce clean energy, and diversify energy sources [67].

The EU's RepowerEU plan, which aims to end the use of Russian fossil fuels by 2030 in response to the energy crisis, presents a significant challenge in finding alternative sources of fossil fuels, particularly natural gas, in the short run. While the EU has been diversifying its energy sources and reducing dependence on any single supplier, the task of replacing Russian fossil fuels entirely within a short timeframe is highly ambitious [68]. The EU relies on natural gas imports from various countries, including Norway, Algeria, and Qatar, to meet its demand. However, meeting the increasing demand for natural gas from non-Russian sources would require expanding infrastructure, securing new supply contracts, and addressing potential geopolitical and economic implications [69]. The feasibility of achieving such diversification within the specified timeframe will depend on factors such as resource availability, infrastructure development, and geopolitical dynamics.

In addition to the environmental and economic aspects, the social dimension of green growth is a crucial consideration. As the transition to a green economy progresses, it is important to address potential challenges related to rising energy prices and energy poverty. While renewable energy technologies contribute to reducing greenhouse gas emissions, they may initially entail higher costs that can affect vulnerable populations. Therefore, ensuring equitable access to affordable and clean energy becomes paramount in the pursuit of sustainable and socially inclusive development. Future research should focus on identifying effective policies and mechanisms to mitigate energy poverty, promote energy efficiency measures, and provide support for vulnerable communities during the

Table 4 Change in final energy consumption by year: 2010–2020 (mtoe)

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EU—27 countries (from 2020)	1,024.5	984.6	982.6	980.4	938.8	957.9	976.9	989.0	991.6	986.0	905.9
Belgium	38.2	35.4	35.5	36.7	34.4	36.0	36.4	36.1	36.4	[illegible]	33.2
Bulgaria	8.8	9.3	9.2	8.8	9.0	9.5	9.7	9.9	9.9	9.9	9.5
Czech Republic	25.3	24.5	24.4	24.2	23.6	24.2	24.8	25.5	25.7	25.3	24.5
Denmark	15.5	14.8	14.3	14.1	13.7	14.2	14.5	14.6	14.6	14.3	13.1
Germany	223.0	211.7	215.8	221.0	210.0	212.8	216.9	218.6	215.2	214.7	201.9
Estonia	2.9	2.8	2.9	2.9	2.8	2.8	2.8	2.9	3.0	2.9	2.8
Ireland	11.9	11.0	10.7	10.9	10.9	11.3	11.8	[illegible]	[illegible]	12.4	11.2
Greece	19.1	18.9	17.1	15.3	15.6	16.6	16.8	16.4	15.9	16.2	14.5
Spain	89.6	87.1	83.5	81.1	79.6	80.5	82.2	84.8	86.7	86.5	73.8
France	154.0	148.9	153.3	156.0	145.0	148.0	150.0	[illegible]	146.5	145.1	129.7
Croatia	7.2	7.0	6.7	6.6	6.2	6.6	6.6	6.9	6.9	6.9	6.5
Italy	128.5	123.2	121.8	118.6	113.3	116.2	115.9	115.2	116.3	115.4	102.7
Cyprus	1.9	1.9	1.8	1.6	1.6	1.7	[illegible]	1.9	1.9	1.9	1.6
Latvia	4.1	3.9	4.0	3.9	3.9	[illegible]	3.8	4.0	4.2	4.1	3.9
Lithuania	4.8	4.8	4.9	4.8	4.9	4.9	5.1	5.3	5.6	5.6	5.3
Luxembourg	4.3	4.3	4.2	4.1	[illegible]	[illegible]	4.0	4.2	4.4	4.4	3.8
Hungary	17.5	17.5	16.5	16.6	16.2	17.4	17.7	18.5	18.5	18.6	18.0
Malta	0.5	0.5	0.5	[illegible]	0.6	0.6	0.6	0.6	0.7	0.7	0.6
Netherlands	55.6	52.0	52.1	51.9	[illegible]	48.6	49.7	50.0	50.4	49.5	45.1
Austria	28.0	27.2	27.2	[illegible]	26.8	27.5	28.1	28.5	27.9	28.3	26.1
Poland	66.3	64.7	[illegible]	63	61.6	62.3	66.6	70.9	74.9	73.7	71.1
Portugal	18.2	17.4	16.[illegible]	15.8	15.8	16.0	16.2	16.6	16.9	17.1	15.0
Romania	22.5	22.[illegible]	22.8	21.8	21.7	21.9	22.2	23.3	23.6	23.9	23.5
Slovenia	5.1	[illegible]	4.9	4.8	4.6	4.7	4.9	5.0	5.0	4.9	4.4
Slovakia	11.5	10.[illegible]	10.3	10.6	10.0	10.1	10.4	11.1	11.1	11.2	10.4
Finland	26.2	25.0	25.2	24.7	24.5	24.2	25.2	25.3	25.8	25.5	23.4
Sweden	34.0	32.[illegible]	32.6	32.0	31.2	31.8	32.3	32.1	31.9	31.6	30.6
United Kingdom	133.1	132.2	135.8	136.9	130.1	132.6	133.8	133.6	135.1	134.1	N/A

Source: [31]

green transition. Each member state should tailor their strategies to tackle these social challenges based on their specific socio-economic context and ensure that the benefits of green growth are shared equitably across society.

The plan includes short- and medium-term targets. In the short term, goals include purchasing gas, LNG, and hydrogen through the AB Energy Platform, establishing new partnerships with reliable suppliers, increasing the production of biogas, and launching new solar and wind energy projects to reduce gas imports. In the medium term, targets include identifying national REPowerEU plans to support investment and reforms worth €300 billion, investing in gas and electricity infrastructure networks, increasing the renewable energy target to 45% by 2030, and taking regulatory measures to increase energy efficiency in the transportation sector [67].

By reducing energy imports and ensuring energy security, AB aims to achieve a green transition and reduce energy imports through this plan, which is aimed at solving the energy crisis caused by the war.

Recovery plan for Europe—NextGenerationEU

The Recovery Plan for Europe, known as NextGenerationEU, is a post-Covid-19 recovery plan that serves as an operationalization of the European Green Deal. This section highlights the key aspects, priority areas, and main objectives of the plan, aiming to drive sustainable and inclusive growth in Europe. It should be noted that the financial values mentioned in this summary were valid at the time of the plan's adoption, and potential changes may have occurred since then, particularly in light of the Ukrainian conflict [70].

NextGenerationEU encompasses a comprehensive set of measures and financial support aimed at revitalizing the European economy and advancing the green

transition. With a total financial envelope of €750 billion, the plan focuses on six main priority areas, namely [71]:

Green transition

A significant portion of the funds is allocated to support the European Green Deal objectives, including investments in renewable energy, energy efficiency, sustainable mobility, and circular economy initiatives. The aim is to foster a green and climate-resilient economy while creating jobs and ensuring a just and inclusive transition.

Digital transformation

NextGenerationEU aims to accelerate digitalization across various sectors, investing in digital infrastructure, connectivity, and digital skills development. This supports the EU's goal of becoming a globally competitive digital economy while improving public services and fostering innovation.

Resilience and recovery

The plan includes measures to enhance the resilience of European economies and societies, focusing on strategic sectors such as healthcare, research and innovation, and critical supply chains. It aims to strengthen Europe's ability to respond effectively to future crises and improve overall societal well-being.

Cohesion and regional development

NextGenerationEU emphasizes cohesion among member states by providing financial support through cohesion policy programs. It aims to reduce regional disparities, promote sustainable development, and foster economic and social cohesion across Europe.

Social inclusion and skills

The plan aims to address social challenges exacerbated by the pandemic, with a particular focus on combating poverty, improving access to quality education and training, and promoting social inclusion. It seeks to ensure that no one is left behind in the recovery process.

Youth and employment

NextGenerationEU places a strong emphasis on addressing youth unemployment and supporting job creation initiatives. It includes measures such as the European Youth Guarantee and investments in skills development to equip the younger generation for future employment opportunities [70].

The Recovery Plan for Europe—NextGenerationEU provides a strategic framework and substantial financial resources to support Europe's recovery from the Covid-19 pandemic while advancing the green transition. Its priority areas encompass crucial aspects such as the green economy, digital transformation, resilience, cohesion, social inclusion, and employment. However, it is important to note that the financial indicators presented here were valid at the time of the plan's adoption, and changes may have occurred subsequently due to evolving circumstances such as the Ukrainian conflict [72].

Discussion and recommendations

This section provides a discussion on the feasibility and reliability of the European Green Deal, along with different aspects and recommendations for its future implementation. It highlights various perspectives from scholarly articles, addressing legal and financial challenges, job creation potential, efficiency improvements, decarbonization in Southeast Europe, and regional transition paths. Additionally, it incorporates the insights from a manuscript regarding the medium-term multipliers and regional disparities in economic transformation within the context of the Recovery Plan for Europe. These sources contribute to a comprehensive understanding of the obstacles and differences that may arise on the path to decarbonization.

Feasibility and reliability of the Green Deal

The implementation of the European Green Deal faces legal and financial challenges, requiring careful consideration. Legal scholars have discussed the need for a robust legal framework to support the ambitious goals of the Green Deal, addressing issues such as regulatory coherence, enforcement mechanisms, and potential conflicts with existing laws and treaties [73]. Financial aspects, including the availability of funding and the mobilization of resources, are also crucial for the successful implementation of the Green Deal. It is essential to ensure adequate financial support and investment mechanisms to facilitate the transition to a sustainable and low-carbon economy.

Job creation potential

The Green Deal has the potential to stimulate job creation and contribute to sustainable economic growth. Studies have highlighted the positive employment effects associated with the transition to a greener economy, particularly in sectors such as renewable energy, energy efficiency, and circular economy practices [74]. Policymakers should focus on developing supportive policies, fostering skills development, and promoting innovation to maximize job creation opportunities while ensuring a just transition for affected workers.

Improving the efficiency of the Green Deal

To enhance the efficiency of the Green Deal, several recommendations have been put forward. These include

the need for coherent and integrated policy frameworks, effective governance structures, and the alignment of financial instruments with sustainability goals treaties [73]. Strengthening international cooperation, promoting knowledge sharing, and leveraging technological advancements are also crucial for accelerating the green transition.

Decarbonization in Southeast Europe

Southeast Europe presents specific challenges and opportunities in the decarbonization journey. The region's diverse energy mix, varying levels of development, and geopolitical factors influence the transition process. Policymakers should focus on establishing a supportive policy environment, enhancing regional cooperation, and leveraging the potential of renewable energy sources to facilitate decarbonization in Southeast Europe [73].

Regional disparities and economic transformation

The manuscript referenced [29] highlights the existence of regional disparities and differential transition paths within the context of the Recovery Plan for Europe. Factors such as location, development level, EU tenure, euro area membership, and national borders contribute to asymmetries in economic transformation. Understanding these differences is crucial for addressing regional disparities and ensuring an inclusive and equitable transition.

The European Green Deal faces both opportunities and challenges in its quest for decarbonization and sustainable growth. Legal and financial considerations, job creation potential, efficiency improvements, regional disparities, and specific challenges in Southeast Europe should be considered for effective implementation. By addressing these aspects and incorporating relevant recommendations, policymakers can navigate the complex landscape and work towards achieving the ambitious goals of the Green Deal.

Conclusions

The emergence of the concepts of green economy and green growth in the wake of the 2008 global financial crisis enabled the EU to adopt a green approach to the economy in order to mitigate the effects of the crisis. In its rescue plan put forward at the end of 2008, the EU included green incentives, with the aim of addressing economic, social, and environmental issues in its efforts to recover from the crisis. Accordingly, the EU allocated 13% of the budget of its €200 billion rescue plan to green incentives. Many EU member states have also included green incentives in their national policies, aiming to reduce the environmental and social impact of the crisis. Germany and France were the countries that allocated the highest budget to green incentives among member states. In addition, three initiatives were launched to address the construction, automotive, and manufacturing sectors, which were the most affected by the crisis. These initiatives are the Green Vehicle Initiative, the Energy-efficient Buildings Initiative, and the Future Factories Initiative. Through these initiatives, the EU aimed to promote the use of green technologies, increase energy efficiency, and reduce carbon emissions.

Following the crisis, the idea that climate change and environmental issues should be included in the Union's future strategies gained importance. In this context, the Europe 2020 Strategy was launched in 2010. This strategy is a long-term roadmap that focuses on greenhouse gas emissions and aims to fulfill both commitments and the goal of transforming the EU into a sustainable society in the future. Similarly, the orientation towards renewable sources in energy consumption is important in terms of using resources efficiently and ensuring that non-renewable resources do not run out. Increasing energy efficiency means reducing energy consumption.

In 2020, the EU, which determined its strategy, continued its efforts, and aimed to be a leader in terms of climate and environment in the global system. To this end, it set targets for 2030 and 2050, aiming to reduce the financial burden caused by energy dependence in economic terms, create new job opportunities, and promote the transition to a low-carbon economy. In 2015, the EU also accepted the Paris Agreement at the COP21 conference, committing to contribute to reducing the effects of climate change and reducing greenhouse gas emissions caused by the EU by 40% by 2030. The Paris Agreement has been an important agreement for the EU to become a global leader and has made significant contributions to the development of long-term strategies.

Especially after the crisis, the EU's efforts to green its economy and establish a long-term roadmap reached its peak by 2019. In December 2019, the European Green Deal was declared with the idea that the EU needed a new growth strategy. With this agreement, it was aimed to decarbonize the economies and become climate-neutral by 2050.

With the Climate Law, the goal of creating a carbon-neutral Europe by 2050, which was determined within the framework of European Green Deal, has become a binding target for member states and the Union. It is evident that the EU is very determined and willing in its long-term climate and environment strategies. However, crises such as Covid-19 and the Russia–Ukraine war, which have emerged and are likely to emerge in the future, may hinder the achievement of the targets set. Therefore, improvement programs need to be determined in a way that is suitable for current crises, and policies to be implemented by member states should be

determined in this context. The EU has put forward the REPowerEU plan with this awareness, aiming to overcome the energy crisis and show development in the field of renewable energy.

While the EU's RepowerEU plan sets an ambitious target to reduce reliance on Russian fossil fuels by 2030, achieving complete independence from Russian natural gas in the short run appears challenging. The EU will likely face obstacles in finding alternative sources of fossil fuels, particularly natural gas, to meet its energy demand. Balancing the need for energy security, affordability, and environmental sustainability will require careful consideration and long-term planning. Diversification efforts should be complemented by accelerating the transition to renewable energy sources and enhancing energy efficiency measures to reduce overall fossil fuel dependency. Ultimately, the EU's ability to achieve its energy goals will rely on a combination of diverse energy sources, sustainable practices, and diplomatic efforts to ensure a secure and reliable energy supply.

The study by Canova, et al. (2021) highlights that the medium-term multipliers associated with the economic recovery plan for Europe are positive and of significant economic importance. Moreover, the research emphasizes that there are diverse regional transition paths and outlooks for economic transformation. Factors such as location, level of development, EU tenure, Euro area membership, and national borders play a crucial role in accounting for the observed asymmetries in the decarbonization process [75].

Furthermore, the European Union has set ambitious targets for the reduction of greenhouse gas emissions and the promotion of renewable energy sources. The EU's goal of achieving at least a 55% reduction in greenhouse gas emissions by 2030 is a testament to its commitment to combating climate change and transitioning to a greener economy [76]. Additionally, the EU aims to achieve climate neutrality by 2050, aligning itself with the objectives of the Paris Agreement and positioning itself as a global leader in climate action [70].

The EU, which successfully achieved its 2020 targets, can make significant progress towards achieving its targets for 2030 and beyond, particularly for 2050, if it does not increase the use of non-renewable energy sources in the face of the energy crisis and instead focuses its budget on ensuring a green transition. As a result, it can be seen that the EU has directed its policies towards green policies and strategies, particularly after the 2008 crisis, in its transition to sustainable development and a green economy. By determining its long-term strategies based on green policies and strategies, the EU was able to declare the European Green Deal in 2019 and achieve its 2020 targets through the transformations and advancements it has experienced.

In conclusion, the European Union has demonstrated a strong financial commitment to green investments and sustainability measures. The allocation of a significant portion of its budget, as well as the dedication of member states such as Germany and France to green initiatives, highlights the importance placed on addressing environmental challenges and promoting a sustainable future. The ambitious targets set by the EU for greenhouse gas emissions reduction and the transition to renewable energy sources further emphasize its commitment to the objectives of the Green Deal and the global fight against climate change.

Abbreviations

CBAM	Carbon Border Adjustment Mechanism
COP	Conference of the Parties
EEA	European Environment Agency
EGD	European Green Deal
ESD	Effort Sharing Decision
ETS	Emissions Trading System
MTOE	Million tons of oil equivalent
OECD	Organisation for Economic Co-operation and Development
TUSIAD	Turkish Industrialists and Businesspeople Association
UNEMG	United Nations Environment Management Group
UNEP	United Nations Environment Programme

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Declarations

Competing interests
The authors declare no competing interests.

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References

1. Haradhan M (2019) The first industrial revolution: creation of a new global human era. J Soc Sci Humanit 5(4):377–387
2. Du PJA (2006) Sustainable development-historical roots of the concept. Environ Sci 3(2):83–96. https://doi.org/10.1080/15693430600688831
3. Carson R (2011) Sessiz Bahar. Palme Yayıncılık, Ankara. [The original edition of the book was published in 1962]

4. Klarin T (2018) The concept of sustainable development from its beginning to the contemporary issues. Zagreb Int Rev Econ Bus 21(1):67–94. https://doi.org/10.2478/zireb-2018-0005
5. Meadows DH, Meadows DL, Randers J, Behrens WW (1978) Ekonomik Büyümenin Sınırları. [Translate: Kemal Tosun vd.]. İstanbul Üniversitesi, İstanbul
6. Munasingle M (2009) Sustainable development in practice, 1st edn. Cambridge University Press, New York
7. Sachs JD (2019) Sürdürülebilir Kalkınma Çağı. [Çev: Barış Gönülşen]. Yeditepe Üniversitesi Yayınevi, İstanbul.
8. World Commission on Environment and Development (1987) Our common future, 1st edn. Oxford University Press, New York
9. Diesendorf M (2000) Sustainability and sustainable development. Allen & Unwin, Sydney
10. Mengi A,Algan N (2003) Küreselleşme ve Yerelleşme Çağında Bölgesel Sürdürülebilir Gelişme AB ve Türkiye Örneği [1st Edition]. Siyasal Kitapevi, Ankara
11. United Nations Environment Programme (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers, https://www.unep.org/greeneconomy. Accessed 23 Oct2022
12. El B et al (2020) Social reproduction, gender equality and economic growth. Camb J Econ 4(1):129–156. https://doi.org/10.1093/cje/bez032
13. Barbier EB (1987) The concept of sustainable economic development. Environ Conserv 14(2):101–110. https://doi.org/10.1017/S0376892900011449
14. Purkis S (2020) Yeşil Ekonominin Ekoloji Politiği [1st Edition]. Ekin Yayınevi, Ankara
15. PuppimdeOliveira JA (2012) Framing the debate on the green economy and governance from different angles. In: Puppim de Oliveira JA (ed) Green economy and good governance for sustainable development: opportunities, promises and concerns. United Nations University Press, Tokyo
16. Georgeson L, Maslin M, Poessinouw M (2017) The global green economy: a review of concepts, definitions, measurement methodologies and their interactions. Geogr Environ 4(1):1–23. https://doi.org/10.1002/geo2.36
17. Kanianska R (2017) Green Growth and Green Economy. Belianum, Banská Bystrica
18. Pearce DW, Markandya A, Barbier EB (1989) Blueprint for a green economy. Earthscan, London
19. Kasztelan A (2017) Green growth, green economy and sustainable development terminological and relational discourse. Prague Econ Pap. 26(4):487–499. https://doi.org/10.18267/j.pep.626
20. United Nations Environment Management Group (2011) Working towards a balanced and inclusive green economy: a United Nations System-wide Perspective. Geneva. https://wedocs.unep.org/20.500.11822/8065. Accessed 05 May 2022
21. United Nations Economic and Social Commission for Asia and the Pacific (2012) Low carbon green growth roadmap for Asia and the pacific: turning resource constraints and the climate crisis into economic growth opportunities. United Nations Publication, Bangkok
22. Organisation for Economic Co-operation and Development (2011) Towards green growth. A summary for policy makers. https://www.oecd.org/greengrowth/48012345.pdf. Accessed 03 Nov 2022.
23. Yalçın C (2017) Yeşil Büyüme Çevre Kirliliği ve Eşitsizliklere Karşı Yeni Bir Büyüme Paradigması [1st Edition]. Ekin Basım Yayın Dağıtım, Bursa
24. European Commission (2004) Kyoto Protocol. MEMO/04/43. https://ec.europa.eu/commission/presscorner/detail/en/MEMO_04_43. Accessed 30 Dec 2022
25. Commission of The European Communities (2001) Communication from the commission a sustainable Europe for a better world: a European Union strategy for sustainable development. Commission of The European Communities, Brussels
26. Kok W (2004) Facing the challenge the Lisbon strategy for growth and employment. European Communities, Brussels
27. Talu N (2019) Avrupa Birliği İklim Politikaları. İklim Değişikliği Eğitim Modülleri Serisi 3. İklim Değişikliği Alanında Ortak Çabaların Desteklenmesi Projesi. Ankara. https://www.iklimin.org/moduller/abpolitikalari.pdf
28. Akses S (2014) Avrupa 2020 Stratejisi. İstanbul: İktisadi Kalkınma Vakfı Yayınları. Yayın No: 269, https://www.ikv.org.tr/images/files/2020stratejisi.pdf
29. European Court of Auditors (2021) EU audit in brief - introducing the 2021 annual reports of the European Court of Auditors (2022). https://www.eca.europa.eu/Lists/ECADocuments/auditinbrief-2021/auditinbrief-2021_EN.pdf
30. Trane M, Marelli L, Siragusa A, Pollo R, Lombardi P (2023) Progress by research to achieve the sustainable development goals in the EU: a systematic literature review. Sustainability 15(9):7055. https://doi.org/10.3390/su15097055
31. Eurostat (2023d) Final energy consumption https://ec.europa.eu/eurostat/databrowser/view/sdg_07_11/default/table?lang=en. Accessed 05 Jan 2023
32. Commission of The European Communities (2007) Communication from the commission to the council and the European parliament progress report on the sustainable development strategy 2007. European Commission, Brussels
33. Commission of The European Communities (2008) communication from the commission to the European council a European Economic Recovery Plan. European Commission, Brussels
34. Hongkong and Shanghai Banking Corporation (2009) A climate for recovery the color of stimulus goes green. HSBC Global Research, London
35. Watt, A (2009) A quantum of solace? An assessment of fiscal stimulus packages by EU Member States in response to the economic crisis. Working Paper 2009.05. European Trade Union Institute, Brussels
36. International Labour Organization (2010) Green Stimulus Measures. EC-IILS Joing Discussion Paper Series. No. 15, https://www.readkong.com/page/green-stimulus-measures-6045271. Accessed 09 Dec 2022
37. Allit H (2011) Assessing the Implementation and Impact of Green Elements of Member States' National Recovery Plans. Final Report. Cambridge Econometrics, Cambridge
38. European Commission (2010) Communication from the commission Europe 2020: a strategy for smart, sustainable and inclusive growth. European Commission, Brussels
39. Ohlendorf NM, Duwe M, Umpfenbach K, McFarland K (2014) The Next EU Climate and Energy Package – EU Climate Policies after 2020. Ecologic Institute, Berlin
40. European Commission (2014) A policy framework for climate and energy in the period from 2020 to 2030. European Commission, Brussels
41. Önsöz M (2014) AB, 2030 İklim ve Enerji Paketi Üzerinde Anlaşmaya Vardı, Ekonomik Forum 64–68. http://haber.tobb.org.tr/ekonomikforum/2014/246/064_068.pdf. Accessed 15 Dec 2022
42. European Environment Agency (2023) European Emission Inventory Report 1990–2021. Publication Office of the European Union, https://www.eea.europa.eu/publications/european-union-emissions-inventory-report-1990-2021. Accessed 06 Jan 2023
43. Stoyanova Z (2017) Impact of climate change related policies on the sector of green jobs. Trakia J Sci 15(4):374–380. https://doi.org/10.15547/tjs.2017.04.020
44. COP21 (2015) IOM contributions to the "Year of Climate" Paris 2015. 21st Conference of the parties of the United Nations framework convention on climate change. Paris, 2015.https://environmentalmigration.iom.int/sites/g/files/tmzbdl1411/files/mecc_cop_21.pdf. Accessed 03 Nov 2022
45. European Commission (2018) A clean planet for all: a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. European Commission, Brussels
46. Acar S (2020) Türk Sanayicileri ve İş İnsanları Derneği. Ekonomik Göstergeler Merceğinden Yeni İklim Rejimi, Istanbul
47. European Commission (2019a) A European Green Deal Striving to be the first climate-neutral continent. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_enAccessed 06 Nov 2022
48. European Commission (2019c) The InvestEU Programme: Questions and Answers. https://ec.europa.eu/commission/presscorner/detail/en/MEMO_19_2135. Accessed 10 Jan 2023
49. World Bank (2023) State and Trends of Carbon Pricing 2023. http://hdl.handle.net/10986/39796. Accessed 06 Nov 2022
50. 2019 Annual Report - Brookings (2019) https://www.brookings.edu/wp-content/uploads/2019/11/2019-annual-report.pdf. Accessed 07 Nov .2022.
51. European Commission (2019b) The European Green Deal. Brussels: European Commission. European Commission. [2019c]. The InvestEU Programme: Questions and Answers. https://ec.europa.eu/commission/presscorner/detail/en/MEMO. Accessed 09 Oct 2022

52. European Commission (2020b) Financing the green transition: The European Green Deal Investment Plan and Just Transition Mechanism. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_17. Accessed 07 Nov 2022
53. European Commission (2020a) The European Green Deal Investment Plan and Just Transition Mechanism explained. https://ec.europa.eu/commission/presscorner/detail/en/qanda. Accessed 06 Feb 2023
54. Avrupa Çevre Ajansı (2021) Enerji ve İklim Değişikliği. https://www.eea.europa.eu/tr/isaretler/isaretler-2017-avrupa2019da-enerjinin-gelecegini/makaleler/enerji-ve-iklim-degisikligi. Accessed 22 Oct 2022
55. Eurostat (2023a) Net greenhouse gas emissions. https://ec.europa.eu/eurostat/databrowser/view/sdg_13_10/default/table?lang=en Accessed 05 Jan 2023
56. European Environment Agency (2020) Trends and projections in Europe 2020 Tracking progress towards Europe's climate and energy targets - Report No:13/2020. Publications Office of the European Union Luxembourg
57. Eurostat (2023b) Share of energy from renewable sources. https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_ren/default/table?lang=en. Accessed 05 Jan 2023
58. European Environment Agency (2022) Share of energy consumption from renewable sources in Europe. https://www.eea.europa.eu/ims/share-of-energy-consumption-from. Accessed 05 Jan 2023
59. European Commission Renewable Energy Directive. https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en. Accessed 09 Jan 2023
60. European Commission. EU Emission Trading System (EU ETS). https://ec.europa.eu/clima/policies/ets_en. Accessed 08 Jan 2023
61. European Commission Effort Sharing Regulation. https://ec.europa.eu/clima/policies/effort_en. Accessed 10 Jan 2023
62. European Commission Clean Energy Package. https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en. Accessed 10 Jan 2023.
63. European Commission (2022a) Energy efficiency directive. https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en. Accessed 10 Jan 2023
64. Eurostat (2023c) Primary energy consumption. https://ec.europa.eu/eurostat/databrowser/view/sdg_07_10/default/table?lang=en. Accessed 05 Jan 2023
65. European Commission (2020c) Decision of the European Parliament And Of The Council on a General Union Environment Action Programme to 2030. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0652. Accessed 10 Jan 2023
66. Demir N, Baş P (2020) Avrupa Birliği Enerji sorunsalında yenilenebilir enerji kaynaklarının yeri ve geleceği. Mehmet Akif Ersoy Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi. 7(3):806–831. https://doi.org/10.30798/makuiibf.693153
67. European Commission (2022b) REPowerEU: affordable, secure and sustainable energy for Europe. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en#repowereu-actions. Accessed 15 Jan 2023
68. Vanderheiden S, Dworkin MH (2014) Global energy justice: problems, principles and practices. Cambridge University Press, Cambridge
69. Kuzemko C, Blondeel M, Dupont C, Brisbois MC (2022) Russia's war on Ukraine, European energy policy responses & implications for sustainable transformations. Energy Res Soc Sci 93:102842. https://doi.org/10.1016/j.erss.2022.102842
70. European Commission (2021) The Recovery Plan for Europe. https://commission.europa.eu/strategy-and-policy/recovery-plan-europe_en. Accessed 20 Jan 2023.
71. Bisciari P, Bultzen P, Gelade W, Melyn W, Van Parys SEU budget and the Next Generation EU Recovery Plan: a game changer? Economic Review, National Bank of Belgium II:26–67, https://ideas.repec.org/a/nbb/ecrart/y2021mseptemberiiip29-67.html
72. EPRC Strathclyde (2021) The Recovery Plan for Europe and Cohesion Policy: An Initial Assessment. https://eprc-strath.org/wp-content/uploads/2021/09/EPRC_EoRPA20_1_THE-RECOVERY-PLAN-FOR-EUROPE-AND-COHESION-POLICY_-AN-INITIAL-ASSESSMENT.pdf. Accessed 15 Jan 2023
73. European Research Council (2023) 4861 ERC work programme 2023. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023/wp_horizon-erc-2023_en.pdf. Accessed 16 Jan 2023
74. Bruninx K, Ovaere M (2022) COVID-19, Green Deal and recovery plan permanently change emissions and prices in EU ETS Phase IV. Nat Commun 13:1165. https://doi.org/10.1038/s41467-022-28398-2
75. Canova F, Pappa E (202) What are the Likely Macroeconomic Effects of the EU Recovery Plan? CEPR Discussion Paper No. DP16669, Available at SSRN: https://ssrn.com/abstract=3960273. Accessed 12 Jan 2023
76. European Commission (2020) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions. A European Green Deal. COM(2019) 640 final. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0640&from=EN Accessed 10 Jan 2023.
77. Council of The European Union (2006) Renewed Sustainable Development Strategy. Council of The European Union, Brussels

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