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# Sustainable Development of European Countries: The Climate Component

## Abstract

This article provides a cause-and-effect analysis of the impact of carbon emissions on climate change and on the sustainable development of European countries. Despite the consolidated efforts of the world community, the global amount of greenhouse gas emissions is not decreasing, leading to irreversible climate change. The objective of this paper is to explore Europe's progress towards climate neutrality in the context of ensuring sustainable development and achieving the goals of the European Green Deal. The article aims to establish an econometric relationship between the amount of carbon emissions and the energy intensity of GDP based on statistical data from European countries, and using the example of Ukraine during a full-scale invasion to demonstrate factors that influence greenhouse-gas- emissions growth despite GDP. A significant aspect of this study is an analysis of data from 2012–2022, which indicates that Europe has reduced $CO_2$ emissions and is successfully moving towards climate neutrality. Key efforts of EU countries in preventing climate change and transitioning to renewable energy sources are reflected in the context of the Green Deal.

Based on econometric calculations, the direct relationship between the amount of carbon emissions and energy intensity of GDP in European countries was confirmed with a probability of 0.95. The obtained interdependence allows one to predict the amount of $CO_2$ emissions based on known values of energy intensity of GDP during stable economic

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development. Special attention was paid to Ukraine and the increase in $CO_2$ emissions due to the war. The authors concluded that the war disrupted the relationship between GDP and $CO_2$ emissions, leading to a 23% increase in emissions in 2022. Overcoming the climate crisis and ensuring sustainable development requires a global decarbonisation strategy. However, effective climate policy is impossible without achieving peace.

**Keywords:** Climate Change, Sustainable Development, Carbon Emissions, GDP Energy Intensity, Decarbonisation, Renewable Energy

## Introduction

In 2023, climate change was categorised as one of the five major global risks, along with threats of global extremism, cyber threats, deepening political polarisation, and an energy crisis (Alkin, 2022). International experts from 195 countries have concluded that there is a clear correlation between global warming and extreme weather events, including abnormal heatwaves, heavy rainfall, droughts, and tropical cyclones, all resulting from irresponsible human activities (United Nations, 2023). The destructive consequences of such climate events incur significant costs for states.

In a report by the Intergovernmental Panel on Climate Change (IPCC), it is unequivocally stated that human activities, including the burning of fossil fuels over the past century, the irrational use of energy and land, as well as unsustainable consumption and production patterns, have caused global warming by 1.1°C compared to pre-industrial levels (Intergovernmental Panel on Climate Change, 2022).

In an annual report from the World Meteorological Organization (WMO), it is also noted that climate change continues to progress. The state of the global climate demonstrates significant changes on the planet's land, in its oceans, and in the atmosphere, caused by record levels of greenhouse gases trapping heat (World Meteorological Organization, 2022).

According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), published on 9th August 2021, warming is occurring under a pessimistic scenario; it is now faster and more intense than projected just a few years ago, and it is likely that containing it within 1.5°C will be challenging. This level is projected to be exceeded within the next 15 years if the volume of anthropogenic greenhouse gas emissions remains unchanged and global warming accelerates, intensifying the frequency of critical climate events. If the planet warms by 1.5°C, there will be approximately 4 extreme weather

events every 10 years, at 2°C there will be 5 or 6 extreme events, and, at 4°C, they will occur annually.

According to a Global Risks Report (2023), climate and environmental risks are the core focus of global risk perceptions over the next decade – and these are the risks for which humanity is seen to be the least prepared. Global climate and ecological challenges are significant factors of threat and sources of instability.

The global community has been aware of the potential risks of climate change for several decades. This is evidenced by the significant levels of attention which have been paid to both environmental issues and climate change as regards sustainable development.

Based on the materials of the UN Conference on Environment and Development (1992), sustainable development is defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Developed through the scientific processing of a large body of empirical data, in-depth analysis of practice, and synthesis of new knowledge, this concept has laid the scientific-theoretical and policy groundwork for the further development of human civilisation (Action program "Agenda for the XXI Century", 2000).

In September 2015, at a UN meeting in New York, representatives of 193 countries adopted the document "Transforming our World: the 2030 Agenda for Sustainable Development", which enshrined Sustainable Development Goals (specifically, 17 Goals and 169 targets). The document states: "We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources, and taking urgent action on climate change so that the planet can support the needs of the present and future generations" (United Nations, 2015).

At the same time, global sustainable development directly depends on a sustainable climate, which the world community is trying to achieve through the implementation of SDG7 and SDG13. SDG7 calls for ensuring universal access to affordable, reliable, and sustainable energy. This involves improving energy efficiency, increasing the share of renewables and further diversifying the energy mix while ensuring affordability of energy for citizens. SDG13 seeks to achieve a climate-neutral world, and strengthen countries' climate resilience and adaptive capacity, with an especial focus on supporting the least-developed countries. Therefore, achieving sustainable development requires rethinking and restructuring people's activities in three interrelated spheres – those of the economic, social, and environmental. However, despite an awareness of the risks,

the global economy still relies on energy derived from fossil fuels, and the demand for energy continues to grow each year. This leads to an increase in global greenhouse gas (GHG) emissions, which have risen to over 50 billion metric tons of carbon dioxide equivalent annually, with 75% of this attributed to $CO_2$, the primary driver of climate change (Statista, 2022).

In order to overcome climate change, accelerate actions, and enhance investments necessary for a sustainable low-carbon future, the parties to the United Nations Framework Convention on Climate Change (UNFCCC) entered into the Paris Agreement on December 12th 2015 in Paris (UNFCCC, 2016). The primary objective of the agreement is to limit the increase in average global temperature to well below 2°C compared to pre-industrial levels and to strive to limit the temperature increase to 1.5°C.

At the end of 2019, the European Commission adopted a strategy in the form of the European Green Deal, which is a set of measures aimed at improving the environmental situation in the EU, with the main goal of transforming Europe into a climate-neutral continent by 2050. The key measures of the strategy include promoting investments in clean technologies, supporting innovation, decarbonising the energy sector, and collaborating with international partners to enhance global environmental standards.

Upon Germany's initiative, the Climate Club was established in 2022 to mitigate the economic consequences of the energy transition. Currently, the Club has 36 participating countries, accounting for over half of the world's Gross Domestic Product (GDP) combined. The Climate Club's primary goals are to advance measures for climate protection, reduce greenhouse gas (GHG) emissions, and decarbonise industrial production. Decarbonised industrial production is envisioned to become the "business model of the future" (European Green Manifesto, 2024).

Nevertheless, despite consolidated efforts by international organisations and governments, the situation regarding climate change has not improved in recent years. Research published in 2022 in several expert reports from leading climate organisations highlight further negative changes in the global climate and emphasise that the international community is not on track to achieve the goals of the Paris Agreement (UNEP, 2022; the World Meteorological Organization, 2022; the IEA, IRENA, UN, World Bank, and WHO, 2023). According to the Intergovernmental Panel on Climate Change (IPCC), the chance of breaching the 1.5°C target by as early as 2030 stands at 50%. Current commitments made by the G7 private sector suggest an increase of 2.7°C by mid-century, way above the goals outlined in the Paris Agreement. The negative climatic changes are also noted in

"The Sustainable Development Goals Report 2023", which highlights that the consequences of the climate crisis have hindered progress towards the Goals, particularly SDG7 and SDG13 (United Nations, 2023).

The potential failure to address this existential global risk first entered the top rankings of the Global Risks Report over a decade ago, specifically in 2011. Today, atmospheric levels of carbon dioxide, methane, and nitrous oxide have all reached record highs. Emission trajectories make it very unlikely that global ambitions to limit warming to 1.5°C will be achieved.

The failure to mitigate climate change is ranked as one of the most severe threats in the short term but is the global risk humanity appears to be the least prepared for, with more than 70% of respondents rating existing measures to prevent or prepare for climate change as "ineffective" or "highly ineffective" (World Economic Forum, 2024).

The main cause of global warming is attributed to the global carbon factor ($CO_2$ emissions per ton of energy consumed), which increased again by 0.5% in 2022 (after +1.1% in 2021, its first increase since 2013, while a more than 3%/year reduction would be required to reach the 2°C pathway) (Yearbook, 2023).

The existing state of anthropogenic load and its consequences make it impossible to move towards sustainable development and will lead to irreversible climate change. To avoid a global catastrophe, the world must reduce GHG emissions by 45% by 2030. Only urgent, comprehensive systemic transformation and collective multilateral actions to implement climate-neutral initiatives by the international community and national governmental structures will help prevent a climate catastrophe (UNEP, 2022). A global decarbonisation strategy and strengthening of nationally determined contributions (NDCs) are needed from all countries.

## Decarbonisation as the Leading Principle for Achieving a Sustainable Climate in Europe

Energy consumption is a necessary condition for the functioning of an economy and the life of society, and, at the same time, it is a significant factor impacting the environment and climate. Therefore, necessitating ongoing research into the scale and structure of energy consumption is necessary to achieve optimal energy efficiency through the use of renewable energy sources and reduction of $CO_2$ emissions. The supply of clean, accessible, and safe energy is the guiding principle of the European Green Deal, while the decarbonisation of the energy system is crucial for achieving the climate goals of 2030 and 2050.

According to Eurostat data, the growth in global energy consumption halved in 2022 (from +4.9% in 2021 to 2.1% in 2022). In 2022, energy consumption growth slowed in the two largest consuming countries; it increased by 3% (compared to +5.2% in 2021) in China, the world's largest energy consumer (25% in 2022), and it rose by 1.8% in the USA (+4.9% in 2021). In contrast, primary energy consumption declined in Europe (-4%, including -4.4% in the EU, and around -3% in the UK and Türkiye), as fears of recession after Russia's invasion of Ukraine, surging energy prices, and milder temperatures all prompted industrial and residential consumers to cut their energy demand. (Yearbook, 2023).

Total energy consumption is the sum of primary and secondary consumption. Primary energy consumption represents a country's total energy demand before any transformation, excluding energy carriers used for non-energy purposes. Final energy consumption covers the energy consumed by end users such as industry, transport, households, services, and agriculture. The dynamics of primary and final energy consumption in the EU in 2010–2021, as well as their forecast for 2030, are shown in Fig. 1.

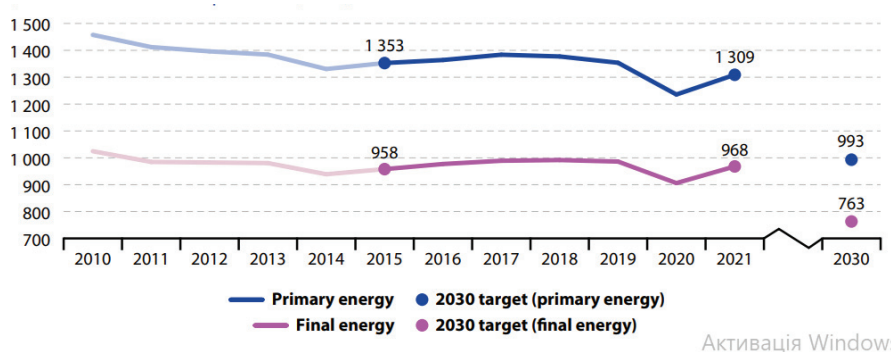


**Figure 1. Primary and Final Energy Consumption, EU, 2010–2021 [Million Tons of Oil Equivalent (Mtoe)]**
Source: Eurostat, 2023b.

As indicated by the data in Figure 1, there was a noticeable trend of energy consumption reduction in Europe during 2019–2020 (amid the COVID-19 pandemic which caused a decline in business activity). Sustaining such a trend would have allowed for the achievement of the specified consumption goals by 2030. However, the world in general, and Europe in particular, returned to their normal pace of activity after the pandemic, leading to an increase in energy consumption in 2021. Therefore, without significant restrictions on energy consumption or a transition to alternative energy sources, 2030's goals will not be attainable.

Global energy-related $CO_2$ emissions also increased in 2022 (+2.5%), at a slower rate than in 2021 (+6%), but more than twice as fast than over the 2010–2019 period (+1%/year). Emissions reached a record high at over 33.8 $GtCO_2$, despite the global economic slowdown. $CO_2$ emissions increased slightly in the two largest emitting countries, namely, China (+1%), and the United States (+1.2%). On the other hand, $CO_2$ emissions declined in Europe (-2%, including -1.8% in the EU, -2.7% in Türkiye, and -2.6% in the UK) (Yearbook, 2023).

Positive trends in reducing $CO_2$ emissions, which have been observed in Europe, have been achieved through the adoption and implementation of initiatives and goals of the European Green Deal, which is the most comprehensive and ambitious strategy on climate and environmental protection initiated by the EU (EUR-Lex, 2019). In practice, the European Green Deal entails the minimal consumption of fossil fuels (such as oil, gas, and coal) and a transition towards green energy sources, electric mobility, organic land use, and a host of other innovative transformations.

The research shows that European countries, compared to other continents, demonstrate positive trends towards climate neutrality and $CO_2$ emissions reduction. The total $CO_2$ emissions in European countries in 2022 amounted to 3514 $MtCO_2$, while globally the figure was 33.8 $GtCO_2$. Over the past decade, $CO_2$ emissions in European countries have decreased by 1.15 times, from 4043 $MtCO_2$ to 3514 $MtCO_2$. This attests to the commitment and progress towards energy efficiency as a priority principle of EU development.

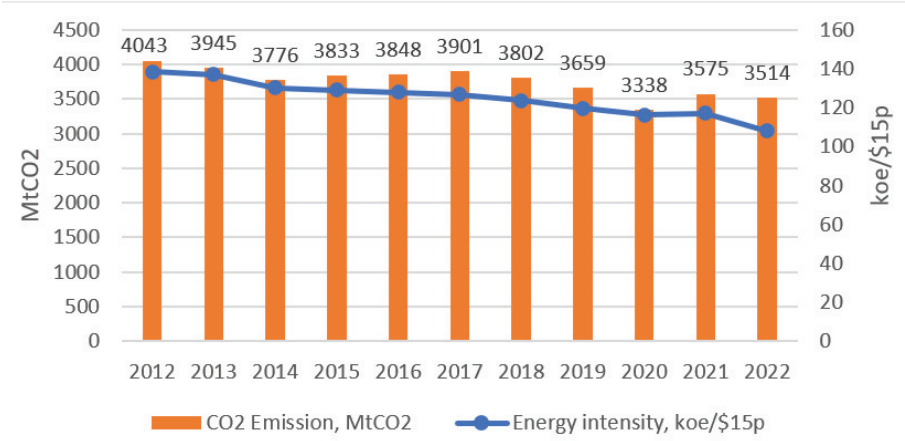


**Figure 2. Dynamics of $CO_2$ Emissions and GDP Energy Intensity in European Countries in 2012–2022 ($MtCO_2$, koe/$15p)**

Source: chart developed based on Yearbook, 2023; Eurostat 2023a.

Considering that the volume of $CO_2$ emissions depends on the amount of energy consumed (as studied in the works of Sarkodie, Strezov, 2019), the dynamics of both indicators is shown in Fig. 2 above.

The dynamics in Fig. 2 indicate a reduction of $CO_2$ emissions and GDP energy intensity in the EU during the 2012–2022 period, showing a direct relationship between the selected indicators. Moreover, from 1990 to 2018, EU industry reduced GHG emissions by 23%, while the economy grew by 61% (Global Compact. Network Ukraine, 2022). This occurred against the backdrop of the ecological modernisation of the economy and a decrease in energy intensity of industrial production. In other words, the amount of GHG emissions is a result of energy consumption, and the higher the energy efficiency of production, the fewer emissions will be generated.

The relationship between $CO_2$ emissions and energy dependency on GDP in European countries has already been studied in the works of various scientists (González-Álvarez, Montañés, 2023; Sarkodie, Strezov, 2019; Onofrei, Vatamanu, Cigu, 2022). The scholars have concluded that the relationship between economic growth, energy consumption, and carbon emissions is not stable. While the authors of this article concur with the research findings, the stability of the development of EU countries over the past 10 years has allowed them to derive a mathematical relationship between those indicators based on econometric calculations using Eurostat data from 2012 to 2022 (Eurostat, 2022a; 2023a).

The coefficient of determination of the linear model is $R^2 = 0.7845$, indicating a significant, direct relationship between the factors studied with a probability of 0.95. Thus, the coefficients of the model are statistically significant. The regression enabled the authors to obtain the following model of the interdependence of indicators:

Carbon Emission ($MtCO_2$) = 802.93 + 23.46 GDP Energy Intensity (koe/$15p).

The obtained dependence allows one to forecast carbon emissions in European countries based on data on projected GDP values and its energy intensity. It is evident that reducing the carbon footprint can be achieved gradually by reducing the energy intensity of GDP. Europe has made significant progress in this regard – currently, Europe's energy intensity is 42% lower than the global average.

Decarbonising the EU's energy system is crucial to achieving climate targets in 2030 and 2050. Indeed, the production and use of energy across different sectors of the economy account for over 75% of the EU's

greenhouse gas (GHG) emissions, making energy efficiency a top priority. The movement of European countries towards sustainable development, the pursuit of energy independence, and the need to mitigate ecological disasters require investment in the development and improvement of environmental projects.

Renewable energy sources (RES) need to be developed simultaneously with a rapid phase-out of coal and gas. This includes the use of renewable energy sources for electricity generation, eco-friendly transportation, the prevention of environmental pollution, climate change mitigation, and more. However, the transition to clean energy should engage and bring about benefits to consumers. Effective programs, such as household financing for energy-efficient building improvements, can reduce electricity bills and benefit the environment. Consequently, the implementation of environmentally-friendly projects necessitates significant investments.

By recognising the primary obstacle of insufficient investment in climate projects, the European Commission acknowledges the importance of directing investments towards sustainable projects and measures to achieve both the EU's climate and energy goals by 2030 and the objectives of the European Green Deal. To this end, on April 21st 2021, the European Commission adopted a comprehensive package of measures to enhance sustainable investment in EU countries (European Commission, 2021).

According to a 2022 report entitled "Investment Trends in Energy Transition" (BloombergNEF, 2023), over $1 trillion was spent worldwide on enabling the green transition, including moves towards renewable energy, electric vehicles, energy storage systems, new fuel sources such as hydrogen, and nuclear energy.

If developed countries have the opportunity to attract free investment resources, particularly through developed stock markets or the banking sector, then *developing* countries face a shortage of internal financial resources and only have access to a small number of private companies willing to carry out the ecologicalisation of production processes and develop renewable energy. Specifically, green investments are a tool for mobilising funds into low-carbon infrastructure, clean energy production, and the greening of industrial production processes. An important factor promoting the growth of sustainable investments can be considered the EU Taxonomy regulation (the principle of information classification and systematisation) which has been included in the European Commission's Sustainable Development Finance Plan in line with the Green Deal initiative. The Taxonomy was developed to provide a clear description of what is considered "green" and to put an end to "green" PR (EUR-Lex, 2019), and has been identified as a priority tool for classifying a given

company's economic activities according to the principles of environmental sustainability. The main goal is to direct the flow of private and public capital towards sustainable financing. To comply with the EU Taxonomy requirements, an economic entity must make a significant contribution to one of the six environmental objectives without causing harm to others, while also ensuring social guarantees. However, the insufficient progress made thus far by European countries in achieving a balance of net-zero greenhouse gas emissions by 2050 combined with their limited progress in meeting the goals of the European Green Deal prompted the European Council to adopt five laws on 25th April 2023. These laws will enable the EU to reduce greenhouse gas emissions in key sectors of the economy while providing effective support to the most vulnerable citizens, micro-enterprises, and carbon-leakage sectors during the climate transition. The laws are part of the *Fit for 55* package, which sets the EU's policy in line with its commitment to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels and achieve climate neutrality by 2050 (European Council, 2023).

The *Fit for 55* package is, essentially, a set of proposals for reviewing and updating EU legislation and implementing new initiatives to ensure that EU policies align with the goals and initiatives of the Green Deal, including the establishment of quotas and the introduction of the EU Emissions Trading System, which has already been agreed upon by the Council and the European Parliament. Thus, European countries, led by the European Council, are committed to an unequivocal movement towards creating a climate-neutral world and achieving sustainable climate goals on the European continent.

## Energy Efficiency of EU Economies

The use of energy from renewable-energy sources is currently a priority for all European countries. This aligns with SDG7, SDG13, and the Green Deal initiatives. International governments should review their policies on supplying clean energy to their industries, agriculture, construction, infrastructure facilities, and transportation. All measures should be aimed at sustainable resource use, including energy production.

In the context of achieving sustainable development through the implementation of climate neutrality, it is worth examining the levels of carbon emissions in European countries and the share of energy from renewable sources in order to draw conclusions on the progress being made towards decarbonising EU countries (Fig. 3).

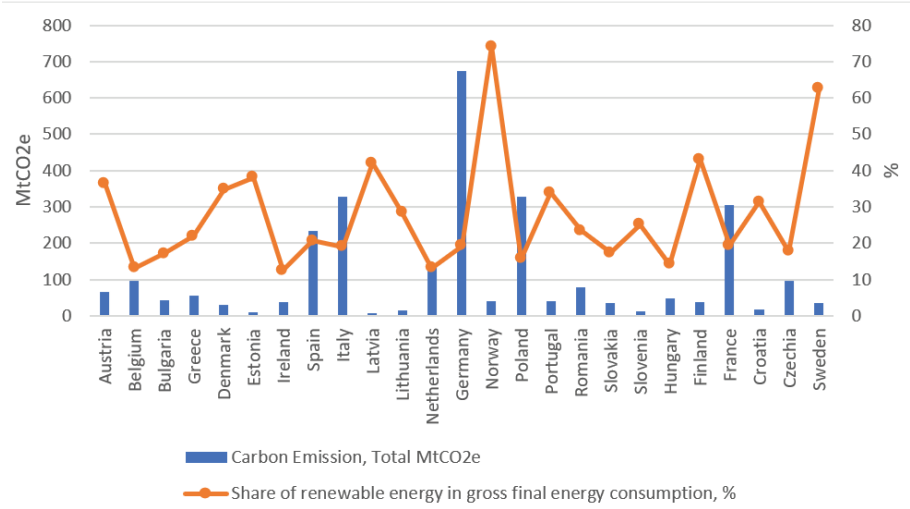


**Figure 3. Carbon Emissions Volume and the Share of Renewable Energy in Gross Final Energy Consumption by European Countries in 2021, %, $MtCO_2$**

Source: authors' own chart based on Eurostat, 2022a; Eurostat, 2022b; Yearbook, 2022.

According to the data in Fig. 3, the carbon emission anti-leaders in Europe in 2021 were the large, industrial countries of Germany (674 $MtCO_2$), Italy (328.7 $MtCO_2$), Poland (328.59 $MtCO_2$), and France (305.98 $MtCO_2$), whose total emissions accounted for 45.8% of the total emissions of European countries in 2021. By comparison, the lowest emission volumes were recorded by Latvia (7.25 $MtCO_2$), Estonia (10.44 $MtCO_2$), and Slovenia (12.57 $MtCO_2$). Norway, in 2021, had the highest share of renewable energy in gross final energy consumption at 74.09%, followed by Sweden at 62.57%. Additionally, an inverse proportional relationship can be observed between the volume of GHG emissions and the share of renewable energy. However, it is worth noting that, in 2022, all EU countries showed a positive trend in increasing the share of renewable energy (Eurostat, 2024), which is in line with the goals of the Green Deal. Norway remained the leader, with its share of renewable energy in gross final energy consumption increasing to 75.82%. However, countries with the highest $CO_2$ emissions also increased their share of renewable energy by 1–1.5% on average, and were, namely, Germany 19.39% (2021) – 20.79% (2022); Poland 15.61% (2021) – 16.87% (2022); and France 19.20% (2021) – 20.25% (2022). Only a slight decrease was observed in Italy at 19.15% (2021) – 19.00% (2022). Thus, European countries have been steadily

moving towards achieving their nationally-determined contributions to climate neutrality and ensuring sustainable development in terms of climate components over the past decade. However, the share of green energy and the pace of its growth are still insufficient to achieve the goals of sustainable economic development and to lower the temperature by 1.5–2°C in line with the Paris Agreement.

The onset of Russia's war against Ukraine in February 2022 influenced the development of green energy in Europe. Europe raced to find alternative energy sources after Russia cut gas flows in the wake of its invasion of Ukraine, sending energy costs soaring. That decision led to a greater reliance on fossil fuels, partially due to a drop in nuclear and hydropower levels, and contributed to an increase in emissions. And yet, solar and wind energy filled in much of the gap, producing a record 22% of the EU's electricity last year and dethroning gas for the first time. Renewables will keep pushing out fossil fuels as wind and solar alternatives grow (Fig. 4).

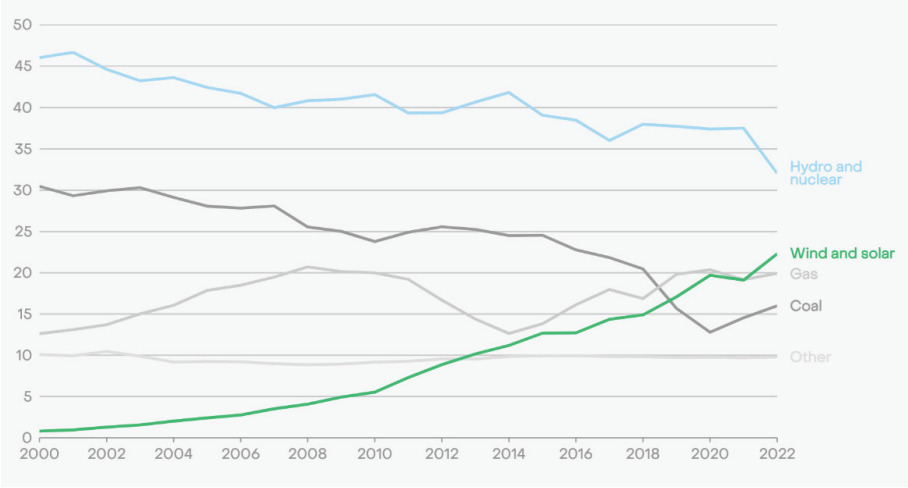


**Figure 4. % Share of Electricity Generation in the EU in 2000–2022**
Source: Ember, 2023.

## The Challenges of Achieving Climate Sustainability in Ukraine

The environmental ambition of the Green Deal will not be achieved by Europe acting alone (EUR-Lex, 2019). The achievement of climate neutrality and a low-carbon economy in Europe is impossible without a significant reduction in greenhouse gas emissions and adherence to climate goals for sustainable development in one of the largest European

countries in the form of Ukraine. Ukraine has committed to gradually aligning its legislation with EU law within 2–10 years in accordance with Annex XXIX of the Association Agreement with the EU, which provides a list of 35 EU directives. This is a crucial part of environmental legislation and policy of the EU, including methods of environmental management, air and water quality, waste management, industrial pollution and hazards, nature conservation, GMO use in agriculture, and climate change.

Having a low, controlled carbon footprint is a guarantee of access to EU markets. If Ukrainian enterprises do not follow the environmental trends set by the EU, they risk losing access to one of the world's largest markets, as their products may face restrictive tariffs or taxes on $CO_2$ content (after their introduction). Ukraine has, however, demonstrated commitment to European values and gradually reduced GHG emissions. Indeed, in 2021, the country's emissions amounted to 156 $MtCO_2$, compared to 285 $MtCO_2$ in 2012 (Yearbook, 2023). Therefore, over the past decade, Ukraine has achieved a 45.2% reduction in $CO_2$ emissions, while European countries have achieved an 11.6% reduction over a similar period.

However, the full-scale invasion perpetrated by Russian forces into Ukrainian territory and the ongoing war have nullified all of Ukraine's efforts towards achieving climate sustainability and caused significant losses and damage. The Russian invasion led to a substantial economic downturn, with Ukraine's GDP decreasing by nearly 30% in 2022. As a result, industrial carbon emissions were significantly reduced. And yet, the war has resulted in the emergence of new carbon emissions sources.

A study conducted by the Initiative on GHG Accounting of War revealed that during the last 12 months of the Russian war in Ukraine, GHG emissions amounted to 120 $MtCO_2$ (Klerk, et al., 2023). The war directly caused emissions of almost 22 $MtCO_2$, with a significant portion coming from the production of ammunition, military equipment, and fuel consumption by Russian forces. The number of fires increased 36 fold compared to the pre-war 12-month period, leading to an additional 17.7 $MtCO_2$ in emissions. Approximately 42% of the total emissions were attributed to the reconstruction of damaged infrastructure, as carbon-intensive materials such as concrete and steel are commonly used in construction and repairs. Additionally, the displacement of refugees both within and outside the country contributed to emissions of 1.4 $MtCO_2$. Thus, the Russian war in Ukraine undermines global efforts to overcome the climate crisis, further contributing to emissions of greenhouse gases into the atmosphere. Furthermore, the increase in carbon emissions amid economic decline confirms the theory of González-Álvarez and Montañés (2023) that the relationship between economic growth and

carbon emissions is not stable. But the researchers have only considered economic crises as unstable factors. In the present context, a significant factor contributing to the rise in carbon emissions is military actions in Ukraine. The authors agree with the views of other researchers that econometric correlations between carbon emissions and energy intensity of the economy are only supported in stable economic conditions. During any crisis, including those of a military nature, forecasts and models do not hold true.

Despite the war, Ukraine continues to fulfill its international commitments and does not waiver from its climate goals, and has specifically adopted the Global Methane Pledge, with plans to reduce methane emissions by 30% by 2030 *and* is already planning its green recovery using the best innovative technologies, including hydrogen.

As of January 1st 2022, the Law of Ukraine "On the Principles of Monitoring, Reporting, and Verification of Greenhouse Gas Emissions" came into effect, which not only provides information on the volume of greenhouse gas emissions from specific enterprises but also enables the control and potential limitation of these emissions (Verkhovna Rada of Ukraine, 2022). The functioning of this system is the first step towards establishing a greenhouse gas emissions quota market in Ukraine.

Ukraine's "On Energy Efficiency" (2022) law has also been adopted, defining the legal, economic, and organisational principles of relations arising in the field of ensuring energy efficiency during the production, transportation, transmission, distribution, supply, and consumption of energy (Verkhovna Rada of Ukraine, 2022).

According to the State Treasury Service of Ukraine, in 2021, the state received 1.18 billion UAH from the environmental tax on $CO_2$ emissions. In 2022, this figure reached 1.63 billion UAH. In the spring of 2023, a special section entitled the "State Decarbonization and Energy Efficiency Transformation Fund" was created within the state budget, into which 100% of the proceeds from the payment of the $CO_2$ emission tax would be directed starting from 2024. The funds from the Decarbonization Fund are earmarked for the implementation of measures and state target programs in the field of energy efficiency, increasing the use of renewable energy sources and alternative fuels, and reducing carbon emissions.

The government of Ukraine is already working towards the future by mobilising funds for energy restoration, improving the energy efficiency of its economy, and establishing a Green Innovation Fund. Fixing its energy-inefficient economy is a priority for Ukraine's recovery and has been discussed at numerous international conferences and meetings, including the "Ukraine Recovery Conference 2023" (URC23) held in

London on June 21st and 22nd 2023 (Conference on Ukraine Recovery, 2023), the "Green Recovery of Ukraine" conference in Vilnius, Lithuania, from November 28th to December 1st 2023 (Ukraine Green Recovery Conference) (European Commission, 2023), and at the international ecological forum "United for Nature. Agenda for Ukraine" held in Kyiv on January 31st 2024 (Ministry of Environmental Protection and Natural Resources of Ukraine, 2023). The new economy of Ukraine will align with sustainable development, be decarbonised, energy-efficient, and contribute to achieving the goals of climate neutrality for the European continent.

However, Ukraine needs assistance to achieve victory and reconstruction. Every country in the world must understand that war is costly, and every civilised country must make its contribution. Without this, sustainable peace and development are impossible. Each day of war moves the civilised world further away from achieving the civilised goals of sustainable development.

## Conclusions

Climate change has been regarded as one of the greatest global risks for many years. Despite the efforts of the global community to achieve planned levels of decarbonisation, it has not been successful. Against the background of other countries, European countries demonstrate a positive trend towards climate neutrality by reducing primary energy consumption, lowering $CO_2$ emissions while increasing GDP, and increasing the share of energy derived from renewable sources compared to global indicators.

The study conducted in this article has led to the conclusion that the EU is gradually and dynamically implementing the goals and initiatives of the European Green Deal, the Paris Agreement, and the UN Global Compact on achieving climate goals for sustainable development. EU countries are confidently progressing towards the 2030 goals, with most of those countries demonstrating positive results in reducing carbon emissions, transitioning to renewable energy sources, and attracting green investments. Research has also shown that European countries with high levels of energy-intensive GDP produce the highest volume of carbon emissions, which negatively impacts climate change and hinders the achievement of Sustainable Development Goals (SDGs 7 and 13). To further increase GDP, countries must actively utilise renewable energy sources and carry out a decarbonisation of the most energy-intensive spheres. European countries with a significant proportion of renewable energy generation exhibit lower levels of greenhouse gas emissions, which is a crucial step towards carbon neutrality. The European

Union's Taxonomy regulation and the implementation of the *Fit for 55* package carry significant importance as regards the reduction of greenhouse gas emissions.

Based on the analysis of statistical data over the past decade, a direct correlation between $CO_2$ emissions and GDP energy intensity with a probability of 0.95 has been proven. This dependency can be used to forecast levels of $CO_2$ emissions in European countries with stable development.

The war between Russia and Ukraine has disrupted the evident connection between GDP, its energy intensity, and $CO_2$ emissions, indicating the presence of alternative emission sources typically not considered in analyses, and with a 30% decrease in GDP, greenhouse gas emissions increased by 23% in just one year of the war. The sudden surge in $CO_2$ emissions due to the war poses a threat to Europe's progress toward climate neutrality, demanding swift action from international organisations. Therefore, military conflicts are a significant factor contributing to $CO_2$ emission growth, negatively impacting climate neutrality and sustainable development.

The global climate is in a constant risk zone and is quite unstable. Therefore, the European community needs to continue increasing its collective efforts to assist and support the Ukrainian government in overcoming the consequences of the war. The ecological transition for EU countries will be effective only when the closest neighbours of the EU also become climate-neutral and energy-efficient.

## References

Action program "Agenda for the XXI century" (2000) Adopted by the UN Conference on Environment and Development in Rio de Janeiro (Planet Earth Summit, 1992). Kyiv.

Alkin, K. (2022) "5 main global risks for 2023", *Daily Sabah.* Available at: https://www.dailysabah.com/opinion/columns/5-main-global-risks-for-2023 (Access 13.05.2024).

BloombergNEF (2023) $*1 Trillion Green Investment Matches Fossil Fuels for First Time*. Available at: https://www.bloomberg.com/news/articles/2023-01-26/global-clean-energy-investments-match-fossil-fuel-for-first-time (Access 20.04.2024).

Ember 2023. European Electricity Review 2023. Available at: https://ember-climate.org/insights/research/european-electricity-review-2023/ (Access 13.05.2024).

EUR-Lex (2019) *The European Green Deal*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640 (Access 11.05.2024).

European Commission (2021) *EU Taxonomy, Corporate Sustainability Reporting, Sustainability Preferences and Fiduciary Duties: Directing finance towards the European Green Deal.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0188 (Access 18.05.2024).

European Commission (2023) *Ukraine Green Recovery Conference*. Available at: https://eu-solidarity-ukraine.ec.europa.eu/ukraine-green-recovery-conference-2023-11-28_en (Access 13.05.2024).

European Council (2023) *Fit for 55*. Available at: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/ (Access 13.05.2024).

Eurostat (2022a) *Greenhouse gas emissions intensity of energy consumption*. Available at: https://ec.europa.eu/eurostat/databrowser/view/SDG_13_20/default/table?lang=en (Access 13.05.2024).

Eurostat (2022b) *Share of renewable energy in gross final energy consumption by sector.* Available at: https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/ default/table?lang=en&category=sdg.sdg_07 (Access 13.05.2024).

Eurostat (2023a) *Energy intensity.* Available at: https://ec.europa.eu/eurostat/ databrowser/view/nrg_ind_ei/default/table?lang=en (Access 13.05.2024).

Eurostat (2023b) *Primary energy consumption.* Available at: https://ec.europa.eu/eurostat/databrowser/view/sdg_07_10/default/table?lang=en (Access 13.05.2024).

Eurostat (2024) *Share of renewable energy in gross final energy consumption by sector*. Available at: https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/ table?lang=en&category=sdg.sdg_07 (Access 13.05.2024).

Global Compact. Network Ukraine (2022) *What should be the ecological reconstruction of industry in Ukraine?* Available at: https://globalcompact.org.ua/news (Access 13.05.2024).

González-Álvarez, M.A. and Montañés, A. (2023) $CO_2$ emissions, energy consumption, and economic growth: Determining the stability of the 3E relationship, *Economic Modelling*. Vol. 121. DOI: 10.1016/j.econmod.2023.106195.

IEA, IRENA, UN, World Bank and WHO (2023) *Tracking SDG7. The Energy Progress Report 2023*. Available at: https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2023-full_report.pdf (Access 13.05.2024).

Intergovernmental Panel on Climate Change (2022) *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Available at: https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf (Access 13.05.2024).

Klerk, L. et al. (2023) *The impact of the Russian war in Ukraine on the climate. Initiative to account for greenhouse gas emissions due to war*. Available at: https://ecoaction.org.ua/wp-content/uploads/2023/07/vplyv-ros-viyny-na-klimat-2023.pdf (Access 22.08.2023).

Ministry of Environmental Protection and Natural Resources of Ukraine (2023) *International forum "United for Nature. Agenda for Ukraine"*. Available at: https://ecopolitic.com.ua/ua/news/u-kiievi-zavershivsya-ekoforum-united-for-nature-agenda-for-ukraine-kljuchovi-rezultati/ (Access 19.04.2024).

Onofrei, M., Vatamanu, A.F. and Cigu, E. (2022) "The Relationship Between Economic Growth and $CO_2$ Emissions in EU Countries: A Cointegration Analysis", *Frontiers in Environmental Science*. Vol. 10. DOI: 10.3389/fenvs.2022.934885.

Pasinovych, I. and Myskiv, G. (2023) "Ukrainian context of sustainable development and the role of business in its achievement", *Regional Science Policy & Practice*. DOI: 10.1111/rsp3.12619.

Sarkodie, S.A. and Strezov, V. (2019) "Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries", *Science of The Total Environment*. Vol. 646, pp. 862–871. DOI: 10.1016/j.scitotenv.2018.07.365.

Statista (2022) *Annual greenhouse gas emissions worldwide from 1990 to 2021*. Available at: https://www.statista.com/statistics/1285502/annual-global-greenhouse-gas-emissions/ (Access 19.04.2024).

Ukraine Recovery Conference (2023) *The UK, jointly with Ukraine, hosted the international Ukraine Recovery Conference (URC 2023) in London on 21–22 June 2023*. Available at: https://www.urc-international.com/ (Access 29.04.2024).

UNEP (2022) *Emissions Gap Report 2022: The Closing Window – Climate crisis calls for rapid transformation of societies*. Available at: https://wedocs.unep.org/handle/ 20.500.11822/40874 (Access 29.04.2024).

UNFCCC (2016) *Key aspects of the Paris Agreement United Nations. Climat change*. Available at: https://unfccc.int/most-requested/key-aspects-of-the-paris-agreement#:~:text (Access 29.04.2024).

United Nations (2015) *Resolution adopted by the General Assembly on 25 September 2015*. Available at: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf (Access 29.04.2024).

United Nations (2023) *The Sustainable Development Goals Report 2023: Special edition*. Available at: https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf (Access 29.04.2024).

Verkhovna Rada of Ukraine (2022) *Legislation of Ukraine*. Available at: https://zakon.rada.gov.ua/laws (Access 29.04.2024).

World Economic Forum (2023) *Global Risks Report 2023*. Available at: https://www.weforum.org/reports/globalrisks-report-2023/(Access 29.04.2024).

World Meteorological organization (2022) *State of the Global Climate in 2022*. Available at: https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate (Access 29.04.2024).

Yearbook (2022) *Share of renewables in electricity production*. Available at: https://yearbook.enerdata.net/renewables/renewable-in-electricity-production-share.html (Access 29.04.2024).

Yearbook (2023) *World Energy & Climate Statistics*. Available at: https: // yearbook.enerdata.net/co2/toe-emissions-co2.html (Access 29.04.2024).