

THE ROLE OF THE GREEN ECONOMY IN REDUCING CARBON EMISSIONS AND THE CHALLENGE IN IMPLEMENTING THE EUROPEAN GREEN DEAL

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Abstract: This study examines the role of the green economy in reducing carbon emissions and assesses the challenges related to the implementation of the European Green Deal (EGD). The main objective of this research is to analyze how green economy policies can contribute to achieving the carbon reduction objectives in the European Union and to assess the main obstacles that limit the effectiveness of the implementation of the EGD. This research uses a methodology based on econometric analysis of secondary data, focusing on key variables that help to assess the impact of green policies on CO₂ emissions. The results show that the green economy, through increased investment in renewable energy and the application of sustainable economic growth models, has a direct and positive impact on reducing carbon emissions. The transition to clean energy and the use of new technologies are two key factors in this regard, which are closely linked to the green growth policy and the objectives of the Green Deal. Despite this, the implementation of the EGD faces several challenges, including economic and political disparities between EU Member States, as well as the need for sustained financial support and stronger political commitment. In conclusion, this study shows that, although the green economy has great potential to support climate objectives, sustainable progress in implementing the Green Deal requires a more coordinated and collaborative approach between Member States and EU institutions.

Keywords: Green economy, carbon emissions, European Green Deal, renewable energy, climate policy.

JEL Classification: Q56, Q58, Q01, Q51, O44

1 Introduction

Climate change represents one of the most serious challenges of the 21st century, affecting economic development, social well-being, and environmental balance. To address this crisis, the European Union (EU) has adopted the European Green Deal (EGD), a comprehensive strategy that aims for climate neutrality by 2050. This process envisions the gradual reduction of greenhouse gas emissions, the transition to a circular economy, and the development of sustainable sectors, while fostering innovation and the shift toward clean energy (Eder, 2025).

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In this context, the Green Economy is regarded as an essential mechanism for harmonizing economic growth with environmental protection. It is based on the efficient use of natural resources, the reduction of dependence on fossil fuels, and the promotion of sustainable consumption and production (Smol, 2022). However, the implementation of the Green Deal's objectives faces numerous challenges. Structural differences among member states, limited institutional and financial capacities, as well as variations in the level of political will, make this transformation uneven (Ciot, 2021).

Moreover, recent crises such as the COVID-19 pandemic and the war in Ukraine have influenced policy priorities and added difficulties in financing the green transition (Sabato et al, 2022). These challenges demonstrate that, beyond legal and financial instruments, the transformation process requires broad social engagement, technological innovation, and deeper coordination among EU member states.

This study aims to analyze the role of the green economy in reducing carbon emissions, while simultaneously examining the challenges of implementing the European Green Deal. The analysis will be based on an econometric model, through which the key factors influencing emission reduction will be identified, such as green finance, technological innovation, and environmental policies.

2 Literature Review

A number of studies confirm that Green Deal policies have contributed to the reduction of greenhouse gas emissions, particularly during the years 2018–2020, when, in addition to climate measures, the COVID-19 pandemic also had an impact. Methane emissions and total emissions proved to be the most influential factors in overall changes (Mogoş, 2023). This indicates that the green economy is not merely a political concept but is closely tied to concrete environmental outcomes.

The European Green Deal, initiated in 2019 by President von der Leyen, represents a comprehensive plan to make the European Union a modern and sustainable economy. Its goal is to respond to the climate emergency by transforming key sectors such as the economy, energy, and transport through reducing pollution and promoting the use of clean energy. The Deal aims to cut emissions by at least 50% by 2030 and to achieve climate neutrality by 2050, an objective enshrined in law. It focuses on protecting people and the environment by promoting green technologies and innovation, while also seeking to ensure social justice for communities most affected by change. Through it, European citizens benefit from cleaner air, more energy-efficient homes, and greater use of renewable resources (Commission, 2024).

The European Green Deal serves as a strategy for economic growth and competitiveness, aiming to be a global example for climate protection. Public awareness of the European Climate Law is essential to promote long-term objectives and opportunities for innovation and job creation. By 2030, around €1 trillion is expected to be mobilized for sustainability investments; however, the exact cost by 2050 remains unclear due to differences among countries. A study on Lithuania highlights discrepancies in information management between the EU and the US. The comparison shows divergences in positions but also common areas such as environmental, fiscal, and industrial policies, encouraging sustainable and innovative solutions. Deficiencies in information during processes of digitalization and urbanization call for audits and improved communication. Crises such as the COVID-19 pandemic and the war in Ukraine influence society's stance on sustainable development (Streimikiene et al 2022).

Carbon dioxide emissions caused by human activities, particularly from the burning of fossil fuels, represent the main source of greenhouse gases. In 2020, around 87% of these global emissions were linked to the energy production sector. This excessive amount of CO₂ not only intensifies climate change but also slows down efforts for sustainable economic development (Yang et al, 2023). For this reason, countries around the world are aiming to harmonize economic

growth with sustainability objectives, making the construction of a green, low-carbon economy a central issue in academic debate (Imansyah et al, 2023).

The assessment of carbon dioxide emission intensity represents a major challenge. Currently, three main approaches are used for this purpose: the emission factor method, the direct measurement method, and the material balance method (Hu et al, 2022). The emission factor method calculates the amount of carbon released based on the consumption of different energy sources and their respective emission coefficients. This approach is known for its simplicity and the ease it provides in obtaining data (Xiao et al, 2023). However, due to differences in the structure and quality of energy consumption across countries, various standards for emission coefficients have been developed by different institutions. Among these, the standards published by the IPCC are considered the most widely accepted at the global level (Wang and Zhou, 2022).

The strategies of the Green Deal (GDS) share common goals: the development of a clean and green economy through pro-environmental solutions, while taking into account social and economic well-being as well as environmental protection. The key points include: programs at national and international levels, the integration of social and environmental aspects into the economy, climate protection, preservation of natural resources, the use of renewable energy, building a low-carbon economy, creating new jobs, engaging society, and promoting sustainable consumption. The role of the state remains decisive for the clear implementation and monitoring of this green transformation (Smol, 2022).

The business model of the Tauron Group, which was previously based mainly on coal, is being transformed toward sustainability and technological modernization under the influence of the European Green Deal. Through the “Green Return” program, Tauron is developing renewable energy sources (wind, solar, hydro), modernizing the energy grid, and engaging active consumers (prosumers). Sustainable practices are being implemented across all parts of the business model. However, the profitability of this new model depends on external factors such as legislation, technological progress, and state measures. A comprehensive assessment will only be possible after approximately ten years (Samborski, 2022).

The implementation of the Green Deal is uneven among member states. Central and Southeastern European countries face numerous obstacles such as a lack of funds, weak administrative capacities, and cultural and political factors. In Romania, for example, these factors have hindered the effective implementation of the objectives, highlighting the need for tailored national plans (Ciot, 2021). In contrast, countries such as Austria have demonstrated a leading role through regional cooperation and the transfer of technologies in the energy and transport sectors.

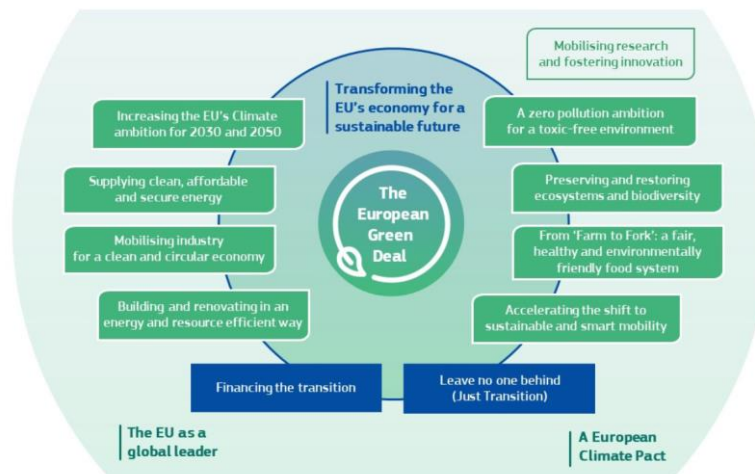


Figure 1. Elements of the European Green Deal
Source: (Europejska, 2019)

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The European Green Deal aims to transform the EU’s economy into a sustainable one, including reducing emissions, increasing renewable energy, and promoting a clean and circular economy. It focuses on environmental protection, biodiversity preservation, and the improvement of transport and agricultural systems for a healthier future. Through a “Just Transition,” it seeks to ensure that no one is left behind, while the EU commits to taking a global leadership role in climate efforts by supporting research and innovation.

Existing studies emphasize that carbon emissions are closely linked to factors such as economic growth, energy use intensity, population size, and the degree of urbanization (Sharma, 2011) highlighted that GDP per capita and urbanization constitute the main factors influencing global carbon emission levels. On the other hand, (Murshed, 2020) argued that trade in the field of Information and Communication Technology (ICT) reduces energy intensity, improves energy efficiency, and consequently helps in reducing carbon dioxide emissions. Meanwhile, Yeh and Liao, (2017) emphasized that population growth has driven higher energy consumption both in the production sector and in daily life, creating increased pressure on the ecosystem.

The process of economic development is inevitably accompanied by an increase in carbon emissions, and this relationship has consistently been one of the main topics of scientific research (Tao, 2022). (Wang et al, 2022) showed that the level of economic development significantly and positively affects the scale of carbon emissions. In general, studies examining this relationship rely on two main approaches: the analysis of the decoupling between economic growth and carbon emissions (Hardt, et al., 2018) and the testing of the environmental Kuznets curve model (Guo et al, 2022; Wen et al, 2022). This model suggests an inverted U-shaped relationship, where the environment undergoes significant degradation in the early stages of economic development. However, after reaching a certain threshold of development, emissions peak and then begin to decline. This implies that, despite the early negative impacts on the environment, in the long-term perspective more favorable ecological conditions can be achieved, along with the realization of carbon reduction objectives (Grossman and Krueger, 1991).

3 Methodology of the Research

The aim of this research is to assess the role of the green economy in reducing CO₂ emissions in EU countries and to analyze the challenges of implementing the European Green Deal (EGD). To conduct this research, secondary data will be used, while for the literature review materials will be drawn from reports published by relevant institutions, scientific publications, books, online sources, and materials from international conferences. The period analyzed in the research is 2004–2024, focusing on EU member states. For data processing, the Stata software will be employed, and the tests to be conducted in this program include: descriptive statistics, correlation analysis, Linear Regression, Random Effects – GLS Regression, Fixed Effects Regression, Hausman–Taylor Regression, GEE Model, and GMM Model.

The research questions of the study are:

Are the growth of the green economy and the use of renewable energy related to the reduction of CO₂?

What is the role of environmental taxes, access to energy, GDP, and population in CO₂ dynamics?

Research Hypothesis:

H1: *The green economy contributes to the reduction of carbon emissions.*

$$CO_2 = \beta_0 + \beta_1 GGE_{i,t-1} + \beta_2 REN_{i,t} + \beta_3 GDPpc_{i,t} + \beta_4 POP_{i,t} + \beta_5 AC_{i,t} + \beta_6 ETAX_{i,t} + \varepsilon_{i,t} \quad (1)$$

Table 1. Description of the variables included in the econometric model

| Variables | Symbol | Variable | Unit/Transformation | Source |
|------------------------------|--------|-------------|--|-----------------------------|
| Carbon emissions | CO2 | Dependent | CO ₂ emissions per capita (tons per capita) | Eurostat |
| Green Growth Economy | GGE | Independent | Index or % of “green” employment/investments | International Monetary Fond |
| Renewable energy consumption | REN | Independent | % of total final energy consumption | World Bank |
| GDP per capita | GDPpc | Independent | current US\$ | World Bank |
| Population | POP | Independent | Population, total | World Bank |
| Access to energy | ACC | Independent | % of population | World Bank |
| Environmental taxes | ETAX | Independent | Environmental tax revenue (% of GDP) | OECD |

Source: Data obtained by authors (2025)

4 Results

In the chapter, the results will be presented through econometric analysis, where in this part the hypotheses presented in the research will be tested and we will try to get answers to the research questions presented earlier.

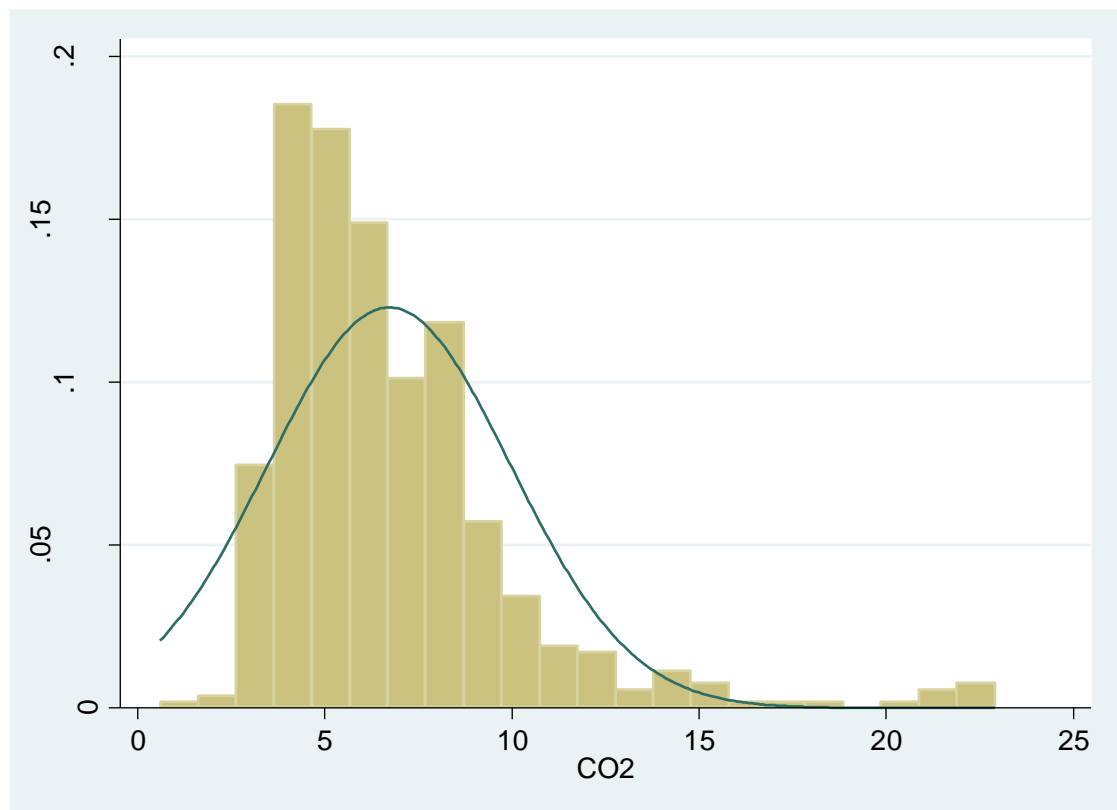


Figure 1. Graphic representation of the histogram

Source: Authors' calculations in Stata (2025)

This graph presents the distribution of the CO₂ variable through a histogram and a density function. It can be observed that the data do not follow a perfectly normal distribution but are right-skewed. Most of the values are concentrated in the 3–8 interval, where the density is highest, while

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there are some higher values (outliers) reaching around 20–25, which extend the tail of the distribution to the right.

Table 2. Correlation analysis for the variables included in the econometric model

| Variables | Obs. | Mean | Std.Deviation | Minimum | Maximum |
|-----------|------|----------|---------------|---------|---------|
| CO2 | 516 | 6.718992 | 3.243208 | 0.6 | 22.9 |
| GGE | 502 | 3.146992 | 11.33124 | 1.1 | 256 |
| REN | 504 | 19.92534 | 11.56621 | 0.1 | 60.5 |
| POP | 506 | 6.858182 | 0.5933251 | 5.61 | 7.92 |
| GDPpc | 498 | 2.314478 | 4.086278 | -14.8 | 24.5 |
| AC | 516 | 99.7688 | 1.069713 | 91.4 | 100 |
| ETAX | 502 | 3.120359 | 11.32918 | 1.09 | 256 |

Source: Authors' calculations in Stata (2025)

The presented table provides a statistical summary of the variables. It reports the number of observations, the mean, the standard deviation, the minimum, and the maximum for each variable. In our case, the CO₂ variable has 516 observations with a mean of 6.72 and a standard deviation of 3.24, indicating a considerable spread of the data. Meanwhile, the GGE variable has a mean of 3.15 and a higher standard deviation of 11.33, reflecting a large variability in the data. The GDPpc variable has a mean of 2.31, but a notably negative minimum value (-14.8), which may suggest unusual occurrences in the dataset, such as extremely low values for certain countries or time periods.

Table 3. Correlation analysis for the variables included in the econometric model

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|-----------|---------|---------|---------|---------|---------|--------|--------|
| (1) CO2 | 1.0000 | | | | | | |
| (2) GGE | -0.0365 | 1.0000 | | | | | |
| (3) REN | 0.3132 | -0.0069 | 1.0000 | | | | |
| (4) POP | 0.2264 | 0.0585 | -0.0385 | 1.0000 | | | |
| (5) GDPpc | 0.0145 | -0.0120 | -0.0590 | -0.1362 | 1.0000 | | |
| (6) AC | 0.1079 | 0.0112 | 0.0877 | -0.0521 | -0.0660 | 1.0000 | |
| (7) ETAX | -0.0365 | 0.9998 | -0.0091 | 0.0595 | -0.0128 | 0.0106 | 1.0000 |

Source: Authors' calculations in Stata (2025)

The table presents the correlation matrix among seven variables, showing that the strongest relationship is between GGE and ETAX with an almost perfect coefficient (0.9998), suggesting that they represent very close or interconnected aspects of the same indicator. On the other hand, renewable energy (REN) has a positive correlation with CO₂ emissions (0.3132), implying that its use has not been sufficient to reduce pollution in this case. Population (POP) is positively related to both CO₂ (0.2264) and ETAX (0.0595), but these relationships remain weak. Meanwhile, GDP per capita (GDPpc) and AC display very low correlations with the other variables, indicating that their impact is almost negligible in this relationship. Overall, the table shows that apart from the strong link between GGE and ETAX, as well as the modest influence of REN and POP on CO₂, the other variables do not exhibit statistically significant relationships.

Table 4. Econometric results and empirical findings of the study

| Variablat | Linear Regression | Random Effects – GLS Regression | Fixed – Effects Regression | Hausman – Taylor Regression | GEE Model | GMM Model |
|-----------|----------------------|---------------------------------|----------------------------|-----------------------------|-----------------------|----------------------|
| CO2 | - | - | - | - | - | - |
| GGE | -1.522614 (0.620) | -0.5870116 (0.363) | -.5810669 (0.371) | -0.5856155 (0.358) | -0.6203206 (0.401) | -0.256956 (0.955) |
| REC | -0.1165421 | -0.265582 | -0.270501 | -0.2661055 | -0.2670609 | -0.200202 |

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| | (0.000)*** | (0.000)*** | (0.000)*** | (0.000)*** | (0.000)*** | (0.000)*** |
|--------------------|-------------------------|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| POP | -1.776394 (0.000)*** | -2.49612 (0.007)*** | -2.719536 (0.017)*** | -2.580874 (0.005)** | -2.583858 (0.013)*** | -1.395383 (0.634) |
| GDPpc | -0.1116695 (0.161) | -0.010757 (0.329) | -0.0098776 (0.292) | -0.0104506 (0.318) | -0.0125353 (0.368) | 0.0116371 (0.000)*** |
| AC | 0.1213734 (0.003)*** | 0.15417 (0.000)*** | 0.1586336 (0.000)*** | 0.1519321 (0.000)*** | 0.1442649 (0.00)*** | -0.0782602 (0.960) |
| ETAX | -0.9168395 (0.629) | -0.2141887 (0.361) | -0.2165171 (0.369) | -0.2113107 (0.357) | -0.2475141 (0.399) | -0.2711571 (0.960) |
| Const. | 42.99299 (0.142) | -20.09897 (0.443) | -20.89097 (0.465) | -18.04349 (0.661) | -21.3019 (0.479) | |
| R Square | 0.1750 | 0.6304 | 0.6304 | | | |
| Adj.R ² | 0.1650 | 0.0903 | 0.0907 | | | |

Source: Authors' calculations in Stata (2025)

Explanation: *P*-values are shown in brackets: *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level and * indicates 10% statistical significance.

From this table, we have several regression models (Linear, Random Effects, Fixed Effects, Hausman–Taylor, GEE, and GMM). For more analytical and robust commentary, the Fixed Effects Regression model appears to be the most adequate, as it controls for time-invariant heterogeneity and is frequently used in panel data analysis.

In the Fixed Effects Regression model, some variables turn out to be statistically significant, while others do not. First, **REC (-0.270, p<0.01)** shows a negative and highly significant coefficient. This indicates that an increase in the consumption of renewable energy helps reduce CO₂ emissions. Economically, this is a positive finding, as it demonstrates that the use of green resources has a clear impact on reducing pollution. Similarly, **POP (-2.719, p<0.05)** has a negative and significant effect, suggesting that population growth is associated with lower CO₂ emissions. Although this appears counterintuitive, the result is often linked to the fact that in countries with large populations, per capita consumption is lower, or stricter environmental policies are enforced. Economically, this shows that population growth does not necessarily equate to more pollution, provided it is managed with sustainable policies. Furthermore, **AC (0.158, p<0.01)** is positive and highly significant. This result shows that increased access to energy is associated with higher CO₂ emissions, as the additional energy supplied often comes from fossil fuels. Economically, this is a clear warning that the expansion of energy access should be directed toward clean sources to avoid driving up pollution. On the other hand, some variables are not statistically significant but remain valuable for interpretation. **GGE** has a negative coefficient (**-0.581, p=0.371**), suggesting that improvements in green economic growth may go hand in hand with reduced pollution. Although this result is not statistically significant, it is economically reasonable. Countries implementing more sustainable policies and promoting green development may experience economic growth without increasing pollution, by leveraging opportunities to use clean technologies and renewable resources. **GDPpc (-0.009, p=0.292)** is negative and not significant, but it can be economically interpreted as a trend in which higher per capita income is associated with reduced pollution. In practice, this is related to the fact that wealthier countries have more resources to finance clean technologies, although the lack of statistical significance indicates that this relationship is not uniform across all countries. **ETAX (-0.216, p=0.369)** has a negative but insignificant coefficient. The result is consistent with theoretical expectations that environmental taxes can help reduce pollution, although the data do not provide strong statistical evidence. Economically, this suggests that taxation alone is not sufficient; to be effective, it must be accompanied by complementary policies such as subsidies for green energy and investments in energy efficiency.

Conclusion

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The analyses show that the main factors influencing the level of CO₂ emissions are the use of renewable energy, population, and access to energy. The increase in the consumption of green resources has a reducing effect on pollution, confirming the importance of investments in the energy transition. Likewise, population growth is found to be associated with lower per capita emissions, which implies that stronger environmental policies, urbanization, and energy efficiency can offset the added pressure from population growth. In contrast, the expansion of access to energy contributes to higher CO₂ levels, as this access is still often supplied by fossil sources.

Meanwhile, variables such as green economic growth, income per capita, and environmental taxes do not show a significant impact, but they remain important to consider. Good governance suggests potential for more effective environmental policies, higher per capita incomes enable investments in clean technologies, while environmental taxes need to be accompanied by additional supportive measures to be truly effective.

In conclusion, the results highlight that pollution reduction does not depend solely on economic development but on a combination of energy, social, and institutional policies. Renewable energies emerge as the strongest factor for achieving sustainable development, while the expansion of energy access must be closely tied to clean sources to avoid increasing CO₂ emissions.

Recommendations

Promotion of renewable energy – The results clearly show that the use of green energy reduces pollution. It is recommended that states increase subsidies and investments in renewable sources, accelerating the energy transition.

Management of energy access – Since the expansion of access to energy (AC) appears as a factor that increases pollution, it is recommended that expansion policies be based on clean sources, so that the growth in consumption does not generate additional emissions.

Exploitation of green opportunities – To stimulate the growth of the green economy, it is necessary to invest in renewable resources, sustainable agriculture, and effective waste management. Support for innovation and sustainable practices will contribute to reducing pollution while opening opportunities for economic development and job creation.

Integration of fiscal policies – Environmental taxes should be combined with other incentive measures (such as fiscal relief for green businesses or subsidies for clean technologies) in order to have a measurable effect on reducing pollution.

Balancing economic and environmental development – Countries with higher GDP have better opportunities to finance the green transition. It is recommended that economic growth be accompanied by concrete plans for investment in clean technologies to avoid the historical link between development and pollution.

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