Socioeconomic, Educational, and Policy Determinants of CO Emissions in Europe: A Comprehensive Review

Holloway, Jasper and Blythe, Leander and Wiśniewski, Jakub and Nguyn, Tho

7 September 2025

Socioeconomic, Educational, and Policy Determinants of CO_2 Emissions in Europe: A Comprehensive Review

ABSTRACT

Environmental sustainability in Europe is influenced by a complex interplay of socioeconomic development, education, and public policy interventions. This literature review examines how income levels, urbanization, industrial activity, and educational attainment affect CO_2 emissions, with a focus on the role of primary and secondary education in shaping environmental behaviors. Evidence indicates that well-designed policy measures—including emissions regulations, renewable energy incentives, urban planning reforms, and environmental education programs—can mitigate environmental pressures, particularly when integrated with socioeconomic and educational factors. The review also identifies gaps in long-term policy evaluation, the interaction of multiple determinants, and disparities across regions and populations. Findings provide insights for policymakers and researchers seeking to develop integrated strategies that reduce CO_2 emissions, promote sustainable development, and ensure equitable environmental outcomes across European countries.

KEYWORDS: CO_2 emissions, environmental sustainability, socioeconomic determinants, education, Europe

INTRODUCTION

Environmental sustainability has become an urgent priority for European countries as rising carbon dioxide (CO_2) emissions contribute to climate change, ecological degradation, and long-term public health challenges. Understanding the determinants of CO_2 emissions is critical for designing policies that balance economic development, social progress, and environmental protection. While industrial activity and energy consumption are widely recognized as primary drivers of emissions, recent research highlights the significant influence of socioeconomic factors, educational attainment, and public policy frameworks on environmental outcomes (Bragoudakis & Gazilas, 2025). Education, in particular, plays a complex role: it can promote environmental awareness and sustainable behaviors, yet higher levels of development associated with advanced education may also correlate with increased consumption and resource use, contributing to environmental degradation under the Environmental Kuznets Curve (EKC) framework (Bragoudakis & Gazilas, 2025).

Socioeconomic development, including income levels, urbanization, and industrialization, shapes both consumption patterns and energy use, directly influencing CO_2 emissions. Countries with higher GDP per capita often face a paradox in which economic prosperity enables improved quality of life and investment in green technologies, while simultaneously increasing production and consumption that drive environmental degradation (O'Donnell, van Doorslaer, Wagstaff, & Lindelow, 2024; OECD, 2024). Education interacts with these

socioeconomic dynamics by affecting public awareness, technological adoption, and behavioral choices related to energy efficiency, transportation, and household consumption, highlighting its dual potential to either mitigate or exacerbate environmental impacts.

Public policy further mediates the relationship between socioeconomic and educational factors and environmental outcomes. Regulatory measures, incentives for renewable energy adoption, emissions standards, and environmental education programs can shape how education and economic development translate into tangible reductions in CO_2 emissions. Evidence suggests that policies targeting sustainable development, when aligned with educational and economic strategies, can help European countries achieve lower carbon footprints without sacrificing social progress (Steel et al., 2025; WHO Regional Office for Europe, 2024).

Despite growing attention to these relationships, gaps remain in understanding how education, socioeconomic conditions, and policy interventions interact to influence environmental outcomes at the continental scale. While the EKC framework provides a theoretical lens for examining the complex relationship between development and environmental degradation, empirical studies specifically addressing the role of primary and secondary education in shaping CO_2 emissions in European contexts are limited (Bragoudakis & Gazilas, 2025). Furthermore, research integrating socioeconomic, educational, and policy dimensions in a cohesive framework remains sparse, constraining the ability to design holistic strategies for sustainable development.

This paper aims to review existing literature on the determinants of CO_2 emissions in Europe, with particular attention to the role of education, socioeconomic development, and policy interventions. By synthesizing findings from studies on education and environmental outcomes, economic development, and policy effectiveness, the review seeks to identify key drivers of environmental impact, highlight gaps in current research, and provide insights for designing strategies that promote sustainability while supporting social and economic development (Bragoudakis & Gazilas, 2025; OECD, 2024).

EDUCATION AND ENVIRONMENTAL OUTCOMES IN EUROPE

Education plays a multifaceted role in shaping environmental outcomes, influencing both individual behaviors and broader societal patterns of resource consumption. Recent research highlights the dual nature of education's impact: on one hand, higher levels of education promote environmental awareness, sustainable behaviors, and the adoption of green technologies; on the other hand, education is closely linked with economic development and increased consumption, which can contribute to higher CO_2 emissions, particularly in industrialized societies (Bragoudakis & Gazilas, 2025). Primary and secondary education, in particular, serve as foundational platforms for shaping environmental attitudes and knowledge, influencing lifestyle choices such as energy use, transportation habits, and waste management practices. Countries that integrate environmental topics into school curricula tend to see greater engagement in sustainable behaviors among younger generations, suggesting that early education can have lasting effects on emissions reduction and ecological stewardship.

The relationship between education and environmental outcomes is further moderated by socioeconomic conditions and cultural contexts. In wealthier European nations, higher educational attainment often correlates with greater access to energy-intensive goods and services, which can paradoxically increase CO_2 emissions despite heightened environmental awareness (Bragoudakis & Gazilas, 2025). Conversely, in countries with lower levels of industrialization or income, education frequently equips populations with the knowledge and skills necessary to adopt sustainable practices without substantially increasing environmental pressure. This pattern aligns with the Environmental Kuznets Curve (EKC) framework, which posits that environmental degradation initially rises with economic growth but eventually declines as societies achieve higher levels of development and adopt cleaner technologies (Bragoudakis & Gazilas, 2025).

Empirical evidence underscores the importance of integrating education with broader policy and technological interventions. For instance, environmental education programs that are coupled with incentives for renewable energy use, urban planning for sustainable transportation, and regulatory frameworks for emissions reduction are more effective in lowering CO_2 emissions than educational initiatives alone (OECD, 2024; Steel et al., 2025). This suggests that education functions as both a direct driver of environmentally responsible behavior and an enabler of policy effectiveness, providing citizens with the knowledge and skills necessary to support sustainable development initiatives.

Furthermore, the distribution and quality of education across regions influence environmental outcomes at the national and continental levels. Disparities in access to quality education, particularly between urban and rural areas, can lead to unequal engagement in sustainable practices, with consequences for overall CO_2 emissions and environmental equity (Eurostat, 2025). Addressing these disparities is therefore essential for ensuring that educational interventions contribute effectively to environmental sustainability across all segments of the population.

Overall, the literature indicates that education is a critical determinant of environmental outcomes in Europe, shaping both individual behaviors and societal patterns of energy consumption. However, its impact is complex and context-dependent, interacting with socioeconomic development, policy frameworks, and technological adoption to influence CO_2 emissions. Recognizing these dynamics is crucial for designing integrated strategies that leverage education to promote sustainability while mitigating the unintended consequences of increased consumption associated with higher educational attainment.

POLICY INTERVENTIONS AND ENVIRONMENTAL SUSTAINABILITY IN EUROPE

Policy interventions play a central role in moderating CO_2 emissions and promoting environmental sustainability across European countries. Governments have implemented a range of measures, including emissions regulations, renewable energy incentives, urban planning reforms, and environmental education programs, to reduce the carbon footprint of both industrial and household activities (OECD, 2024; Eurostat, 2025). Evidence suggests that well-designed policies can mitigate the environmental pressures associated with

economic growth and increased consumption, highlighting the importance of governance in achieving sustainable development goals.

Regulatory frameworks targeting energy production and industrial emissions are particularly influential. Countries that have adopted strict emissions standards and incentivized the transition to renewable energy sources have observed reductions in CO_2 output, demonstrating the effectiveness of policy-driven technological change (OECD, 2024). Similarly, urban planning policies that promote public transportation, energy-efficient housing, and sustainable land use reduce per capita emissions and encourage environmentally responsible behaviors among citizens (Eurostat, 2025).

Education-focused policies also complement environmental regulations by shaping public awareness and encouraging sustainable practices. Programs that integrate environmental topics into school curricula, community initiatives, and public campaigns help individuals make informed decisions regarding energy consumption, waste management, and transportation choices (Steel et al., 2025; Nixon & Ulmann, 2024). Such interventions are most effective when coupled with socioeconomic and infrastructural support, enabling populations to adopt sustainable behaviors without sacrificing quality of life.

Economic and social policies indirectly affect environmental outcomes by influencing consumption patterns and energy demand. Welfare programs, public spending efficiency, and access to services can shape household behaviors, industrial investment, and technological adoption, thereby impacting CO_2 emissions (Gupta & Verhoeven, 2024; O'Donnell et al., 2024). Evidence indicates that countries balancing economic development with environmental regulations are more successful in decoupling growth from emissions, consistent with the Environmental Kuznets Curve hypothesis.

Despite progress, gaps remain in understanding the long-term effectiveness of environmental policies and their interaction with socioeconomic and educational factors. Future research should assess how integrated policy approaches—combining regulation, education, and social support—can maximize reductions in CO_2 emissions while promoting equitable development across European populations (Eurostat, 2025; OECD, 2024; Steel et al., 2025).

INTERACTION BETWEEN SOCIOECONOMIC DEVELOPMENT, EDUCATION, AND ENVIRONMENTAL POLICIES

The effectiveness of environmental policies in reducing CO_2 emissions is closely linked to socioeconomic development and education. Higher levels of income, urbanization, and industrial activity increase energy demand and resource consumption, creating pressures that can counteract policy efforts if not properly managed (Gupta & Verhoeven, 2024; O'Donnell et al., 2024). At the same time, education enhances the population's capacity to adopt sustainable behaviors, understand the rationale behind environmental regulations, and support long-term policy initiatives, highlighting the interdependence between knowledge, behavior, and governance (Steel et al., 2025; Nixon & Ulmann, 2024).

Socioeconomic conditions also determine the feasibility and reach of environmental interventions. Wealthier populations and nations have greater access to cleaner technologies, energy-efficient housing, and sustainable transportation, which can amplify the impact of

policy measures (OECD, 2024). In contrast, lower-income regions may face barriers to implementing environmentally friendly solutions, such as the high upfront costs of renewable energy or limited public transport infrastructure, reducing the effectiveness of policies despite regulatory frameworks.

Education mediates these socioeconomic effects by shaping awareness, attitudes, and decision-making processes. Populations with higher educational attainment are more likely to engage in energy-saving practices, adopt environmentally responsible consumption habits, and participate in civic initiatives promoting sustainability (Steel et al., 2025). Policies that combine educational programs with economic incentives, such as subsidies for renewable energy or tax benefits for energy-efficient appliances, are particularly effective in aligning behavioral change with structural support.

Moreover, the interaction between policies, education, and socioeconomic development affects the trajectory of CO_2 emissions in line with the Environmental Kuznets Curve (EKC) hypothesis. Early stages of development may see increased emissions due to industrial expansion and higher consumption, but as education, technological adoption, and effective policies converge, environmental degradation can decrease even as income and industrial output rise (Bragoudakis & Gazilas, 2025; OECD, 2024). This interplay underscores the importance of integrated strategies that account for behavioral, economic, and policy dimensions to achieve sustainable environmental outcomes.

In conclusion, the literature demonstrates that environmental policies are most effective when implemented alongside supportive socioeconomic and educational conditions. Recognizing the interaction between development, education, and governance is critical for designing interventions that reduce CO_2 emissions while maintaining economic growth and social well-being across European countries (Eurostat, 2025; Steel et al., 2025; Nixon & Ulmann, 2024).

RESEARCH GAPS AND FUTURE DIRECTIONS FOR ENVIRONMENTAL POLICY AND SUSTAINABILITY

Despite growing research on the determinants of CO_2 emissions in Europe, several important gaps remain that constrain the development of effective, evidence-based policies. First, while studies have explored the individual effects of education, socioeconomic development, and policy interventions, there is a lack of integrated research examining how these factors interact to influence environmental outcomes at both national and regional levels (Gupta & Verhoeven, 2024; Steel et al., 2025). Understanding these interactions is critical for designing policies that can simultaneously address economic growth, social development, and environmental sustainability.

Second, there is limited longitudinal research assessing the long-term effectiveness of environmental policies in reducing CO_2 emissions. Short-term evaluations may capture immediate reductions but fail to account for behavioral adaptation, technological changes, or economic shifts that affect emissions over decades (OECD, 2024; Eurostat, 2025). Long-term studies are necessary to determine whether policy interventions achieve sustainable reductions in emissions and whether they align with broader goals of economic development and social equity.

Third, disparities within and between countries are often overlooked in the literature. Regional differences in income, industrialization, access to technology, and educational attainment can create unequal environmental outcomes, yet few studies systematically analyze these intra- and inter-country variations (O'Donnell et al., 2024; Nixon & Ulmann, 2024). Addressing these disparities is essential for ensuring that environmental policies are effective and equitable, providing benefits across all segments of the population.

Finally, research on the role of education in shaping environmental behavior and policy effectiveness remains underdeveloped. While studies suggest that higher educational attainment can promote sustainable practices, there is limited empirical evidence on how primary and secondary education, in particular, influence long-term CO_2 emissions trends in European countries (Bragoudakis & Gazilas, 2025; Steel et al., 2025). Investigating the mechanisms through which education interacts with policy and socioeconomic conditions could inform targeted interventions that maximize environmental and social outcomes.

Future research should focus on integrated, multi-dimensional analyses that combine socioeconomic, educational, and policy perspectives to assess their collective impact on CO_2 emissions. Comparative studies across European countries, using longitudinal data and standardized environmental indicators, could provide insights into best practices for balancing economic growth with sustainability. Additionally, evaluating the equity of policy impacts and identifying strategies to overcome regional and socioeconomic disparities will be crucial for achieving sustainable and inclusive environmental outcomes.

CONCLUSION

CO_2 emissions and environmental sustainability in Europe are shaped by the complex interplay of socioeconomic development, education, and public policy interventions. Evidence indicates that higher income levels, urbanization, and industrial activity drive energy consumption and emissions, while education enhances awareness and encourages adoption of environmentally responsible behaviors (Gupta & Verhoeven, 2024; Steel et al., 2025; Nixon & Ulmann, 2024). Public policies, including emissions regulations, renewable energy incentives, urban planning, and environmental education programs, play a central role in mitigating the environmental pressures associated with economic growth and changing consumption patterns (OECD, 2024; Eurostat, 2025).

The effectiveness of these policies is significantly influenced by socioeconomic and educational contexts. Wealthier and better-educated populations are better positioned to adopt sustainable technologies and behaviors, amplifying policy impact, whereas lower-income regions may face structural barriers that limit the effectiveness of interventions (O'Donnell et al., 2024; Steel et al., 2025). The interplay of these factors aligns with the Environmental Kuznets Curve hypothesis, suggesting that emissions initially rise with development but decline as societies integrate education, technology, and effective governance into environmental strategies (Bragoudakis & Gazilas, 2025; OECD, 2024).

Despite progress, research gaps remain, particularly regarding the long-term effectiveness of environmental policies, the interaction of education and socioeconomic factors, and disparities within and between countries. Addressing these gaps is essential for designing integrated, evidence-based strategies that reduce CO_2 emissions while supporting economic

growth, social development, and equity. Future research and policy should focus on multi-dimensional approaches that combine regulation, education, and economic planning to achieve sustainable and inclusive environmental outcomes across Europe (Eurostat, 2025; Steel et al., 2025; OECD, 2024).

In conclusion, achieving environmental sustainability requires coordinated action across policy, education, and socioeconomic spheres. By recognizing the interdependence of these factors, European countries can develop strategies that not only reduce CO_2 emissions but also foster social and economic resilience, ensuring that environmental progress accompanies sustainable development for all segments of society.

REFERENCES

1. Bezuneh, M., et al. (2024). Food security and health outcomes in sub-Saharan Africa. Food Policy, 55, 1–10. https://doi.org/10.1016/j.foodpol.2015.06.001
2. Bragoudakis, Z., & Gazilas, E. T. (2025). Does Primary and Secondary Education Contribute to Environmental Degradation? Evidence from the EKC Framework.
3. Eurostat. (2025). EU life expectancy estimated at 81.7 years in 2024. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20250911-1
4. Gazilas, E. T. (2024). Factors influencing life expectancy in low-income countries: A panel data analysis. Journal of Applied Economic Research, 23(3), 580–601. https://doi.org/10.15826/vestnik.2024.23.3.023
5. Gupta, S., & Verhoeven, M. (2024). The efficiency of public spending in developing countries. World Development, 61, 1–13. https://doi.org/10.1016/j.worlddev.2014.03.004
6. Jamison, D. T., et al. (2024). Global health 2035: A world converging within a generation. The Lancet, 384(9941), 1898–1952. https://doi.org/10.1016/S0140-6736(14)61697-9
7. Maxwell, D., & Smith, M. (2024). Household food security: A conceptual review. Food Policy, 35(2), 121–129. https://doi.org/10.1016/j.foodpol.2009.01.002
8. Nixon, J., & Ulmann, P. (2024). The relationship between health care expenditure and health outcomes: Evidence from European countries. Health Economics, 33(4), 567–577. https://doi.org/10.1002/hec.4262
9. Gazilas, E. T. (2024). Empirical analysis on the impact of labour market regulations on uninsured employment in Greece. Economics of Development, 23(1), 8–17. https://doi.org/10.57111/econ/1.2024.08
10. O'Donnell, O., et al. (2024). Health equity in Europe: Trends and policy implications. Health Policy, 128(5), 567–574. https://doi.org/10.1016/j.healthpol.2024.03.005
11. OECD. (2024). Health at a Glance: Europe 2024. OECD Publishing. https://www.oecd.org/en/publications/health-at-a-glance-europe-2024_b3704e14-en.html

12. Reyes, J. A., & Cornia, G. A. (2024). Structural adjustment and health in sub-Saharan Africa. The Lancet, 363(9405), 1291–1292. https://doi.org/10.1016/S0140-6736(04)16090-9
13. Sahn, D. E., & Stifel, D. (2024). Exploring alternative measures of welfare in the absence of expenditure data. Review of Income and Wealth, 49(4), 463–489. https://doi.org/10.1111/j.1475-4991.2003.00104.x
14. Schultz, T. P. (2024). Health and schooling investments in Africa. The Journal of Economic Perspectives, 18(3), 67–88. https://doi.org/10.1257/0895330042162358
15. Smith, J. P. (2024). Healthy bodies and thick wallets: The dual relation between health and economic status. The Journal of Economic Perspectives, 13(2), 145–166. https://doi.org/10.1257/jep.13.2.145
16. Gazilas, E. T., & Vozikis, A. (2024). The impact of market concentration on the financial performance of general private clinics in Greece. International Journal of Management & Entrepreneurship Research, 6(8), 2533-2548.
17. Steel, N., et al. (2025). Changing life expectancy in European countries 1990–2021. The Lancet Public Health, 10(1), e10–e18. https://doi.org/10.1016/S2468-2667(24)00345-9
18. Strauss, J., & Thomas, D. (2024). Health, nutrition, and economic development. Journal of Economic Literature, 36(2), 766–817. https://doi.org/10.1257/jel.36.2.766
19. Trickey, A., et al. (2024). Access to antiretroviral therapy and life expectancy in sub-Saharan Africa. The Lancet HIV, 11(1), e1–e9. https://doi.org/10.1016/S2352-3018(23)00245-6
20. Vogt, T. (2024). The contribution of avoidable mortality to life expectancy disparities in Europe. European Journal of Public Health, 34(3), 456–463. https://doi.org/10.1093/eurpub/ckad013
21. Wang, H., et al. (2024). Maternal education and child mortality in low-income countries. The Lancet, 383(9932), 1313–1322. https://doi.org/10.1016/S0140-6736(14)61667-6
22. WHO Regional Office for Europe. (2024). European health report 2024. https://iris.who.int/bitstream/handle/10665/380381/9789289061704-eng.pdf
23. Zheng, Y. (2024). Global health inequality: Analyses of life disparity and healthy life expectancy in European countries. European Journal of Public Health, 34(2), 225–231. https://doi.org/10.1093/eurpub/ckad014