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GREENHOUSE GAS (GHG) EMISSION TRENDS. REVIEW OF THE WORLD AND BALKAN REGION.

Research paper

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Abstract: This paper investigates the emissions that contribute to global warming and climate change, with particular emphasis on carbon dioxide (CO_2) released from fossil fuel consumption and production activities. The analysis first considers CO_2 emissions from fossil fuel combustion and industrial processes separately, followed by an integrated assessment of their overall impact. In 2022, fossil fuel-derived CO_2 emissions in the Balkan region were approximately 95 Mt, representing a decline of nearly 16% relative to the 1990 baseline year. This reduction was primarily attributable to substantial decreases in emissions from the sectors with the highest contribution, notably the power generation sector and industrial combustion processes, which recorded reductions of 6% and 63%, respectively.
Key words: CO2 emission, GHG, Balkan

INTRODUCTION

Climate change represents one of the major environmental challenges of the present day, being closely associated with the intensification of anthropogenic activities and the increasing concentrations of greenhouse gases (GHGs) in the atmosphere. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are among the main gases responsible for the intensification of the greenhouse effect, with their emissions primarily associated with energy production and consumption, industrial activities, transport, agriculture, and land-use changes (Crippa et al., 2021).

Over the past decades, global GHG emissions have undergone significant changes, visible on data from EDGAR (Emissions Database for Global Atmospheric Research), highlighted a substantial increase in global anthropogenic emissions since 1990, as well as considerable differences among countries and regions. These differences are determined by the level of economic development, the structure of energy systems, the degree of industrialization, and the policies implemented to reduce emissions. (Crippa et al., 2021)

A study analyzing emission trends over the period 1990–2018, showed that emissions are strongly influenced by the demand for energy, materials, mobility, and infrastructure. While some developed economies have managed to reduce emissions through improvements in energy efficiency and the expansion of renewable energy sources, in many emerging economies, increasing energy demand continues to be associated with the use of fossil fuels. (Lamb et al. 2021)

In this context, Europe shows a different trajectory compared with the global trend. Climate and energy policies, technological modernization, and the increasing use of renewable energy sources have contributed to reducing emissions in numerous European countries. Nevertheless, considerable differences remain across the regions of the continent, particularly regarding the structure of energy systems and the pace of the decarbonization process.

The Balkan region is of particular interest, as it comprises countries with different levels of economic development, distinct energy structures, and varying degrees of integration into European climate policies. Albania stands out due to the significant contribution of hydropower, whereas Serbia, Bosnia and Herzegovina, and North Macedonia exhibit a greater dependence on coal and lignite. These characteristics may lead to significant differences in GHG emission trends at the regional level. Industry, energy production, and heating represent important sources of emissions in the Western Balkans, while low energy efficiency and ageing infrastructure constitute major obstacles to the decarbonization process. (Knez et al., 2022)

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During the early years of the 21st century, the impacts of the greenhouse effect became increasingly apparent. By 2007, the global mean temperature of both terrestrial and oceanic environments had risen by approximately 0.8°C compared to the period between 1850 and 1900. Average land surface temperatures showed an even greater increase, reaching about 1°C above historical levels. Furthermore, the pace of global warming accelerated, with the average temperature rise increasing from roughly 0.1°C per decade during the 20th century to around 0.2°C per decade in recent decades. (Vranjanac et al., 2018)
According to the 2015 Paris Agreement, participating nations are required to periodically assess their achievements in reducing greenhouse gas emissions at five-year intervals. The principal objective of this framework is to prevent excessive increases in the global mean surface temperature by keeping warming significantly below 2°C relative to pre-industrial conditions, while also striving to restrict the temperature rise to 1.5°C

EMISSION INVENTORY AND DISSCUSSIONS

Evidence from six widely recognized global temperature datasets indicates that the average global temperature over the 2021-2025 period reached an unprecedented level, while 2024 remains the warmest individual year recorded to date. Additionally, five of these datasets rank 2025 as the third hottest year on record, with temperatures only marginally lower than those observed in 2023. Relative to the latter half of the nineteenth century, the increase in the five-year average global temperature is estimated to be between 1.3 and 1.4°C. Since the mid-1970s, the Earth's average temperature has risen by approximately 0.1°C every five years. Nevertheless, this warming trend has not occurred at a constant rate. Considerable regional and seasonal differences have been observed, reflecting the influence of multiple climatic factors. Although the persistent rise in greenhouse gas concentrations remains the dominant driver of global warming, variations in heat distribution are also governed by internal atmospheric and oceanic dynamics, as well as by the interactions between these systems, which collectively influence the spatial and temporal patterns of temperature change worldwide. (Copernicus, 2026)

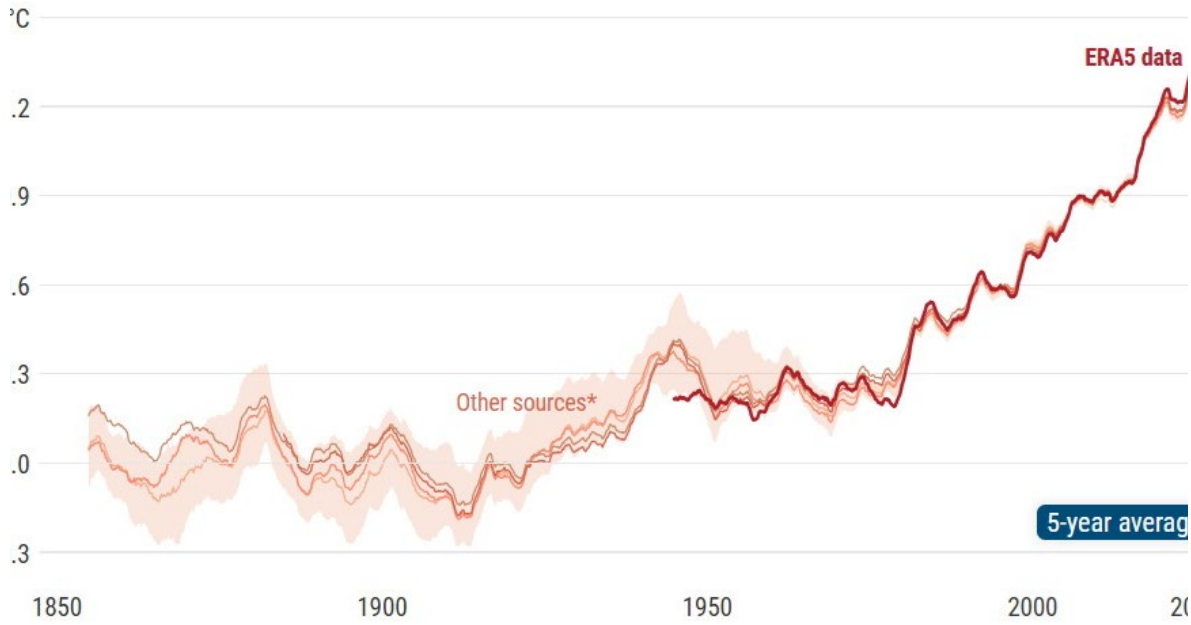


Fig. 1. *Global surface temperature increase relative to the pre-industrial baseline period (1850–1900).* (Copernicus, 2026)

The energy sector in the Balkan region has significant differences between countries but is mainly characterized by a strong dependence on fossil fuels, particularly lignite, which remains the dominant fuel for electricity generation in several countries. Serbia, for example, relies

extensively on lignite-based power production, while in most Balkan countries, fossil energy sources contribute to over 50% of total electricity generation. In contrast, Albania's power sector is largely based on hydropower, making it a notable exception within the region. (Qingsong et al., 2024) As a result of this energy profile, the production and consumption of energy represent major sources of greenhouse gas emissions. The widespread use of lignite, a highly carbon-intensive fuel, significantly influences regional emission levels and contributes to environmental degradation. Although the Balkans generally exhibit lower overall emissions than many highly industrialized European Union member states, the shift toward a low-carbon energy framework remains a complex and demanding process. One of the principal barriers is the limited availability of comprehensive emissions data and the relatively small body of scientific research addressing regional emission patterns. Consequently, the development of effective mitigation strategies, the establishment of realistic emission-reduction pathways, and the achievement of climate-related policy targets are often constrained by insufficient evidence and data-driven decision-making frameworks.

The Balkan peninsula is formed by 11 states: Greece, Albania, North Macedonia, Bulgaria, Romania, Serbia, Montenegro, Bosnia and Herzegovina, Croatia and Slovenia. To analyze the evolution of CO_2 emissions globally, at EU level and Balkan level we used the data provided by EDGAR - Emissions Database for Global Atmospheric Research. IEA-EDGAR CO_2 emissions represent the total contribution of fossil-derived carbon dioxide from a broad range of anthropogenic activities, including fossil fuel use, cement and other non-metallic mineral production, metal processing industries, urea production, agricultural liming, and solvent-related applications. Harmonization procedures are applied to global fossil CO_2 inventories to improve the consistency and reliability of emission estimates. (EDGARD, 2026)

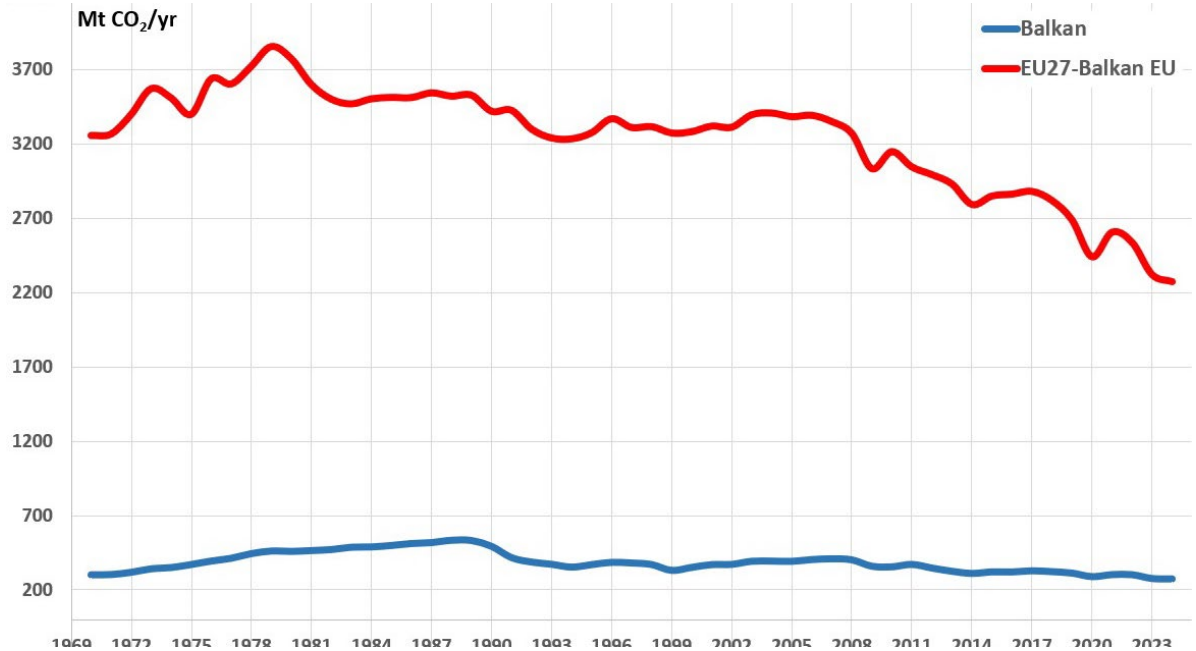


Fig. 2. *CO_2 emissions in EU (without Balkan EU states) and Balkan peninsula (1970–2024).* (data extracted from EDGAR, 2025)

Figure 2 shows the evolution of CO_2 emissions in Balkan countries and EU 27 countries (from EU27 Romania, Slovenia, Bulgaria, Croatia and Greece were extracted). It is clear from the data that green politics implemented in EU27 countries have a direct effect on CO_2 emissions while in Balkan countries the reduction of CO_2 emissions is not as rapid as expected.

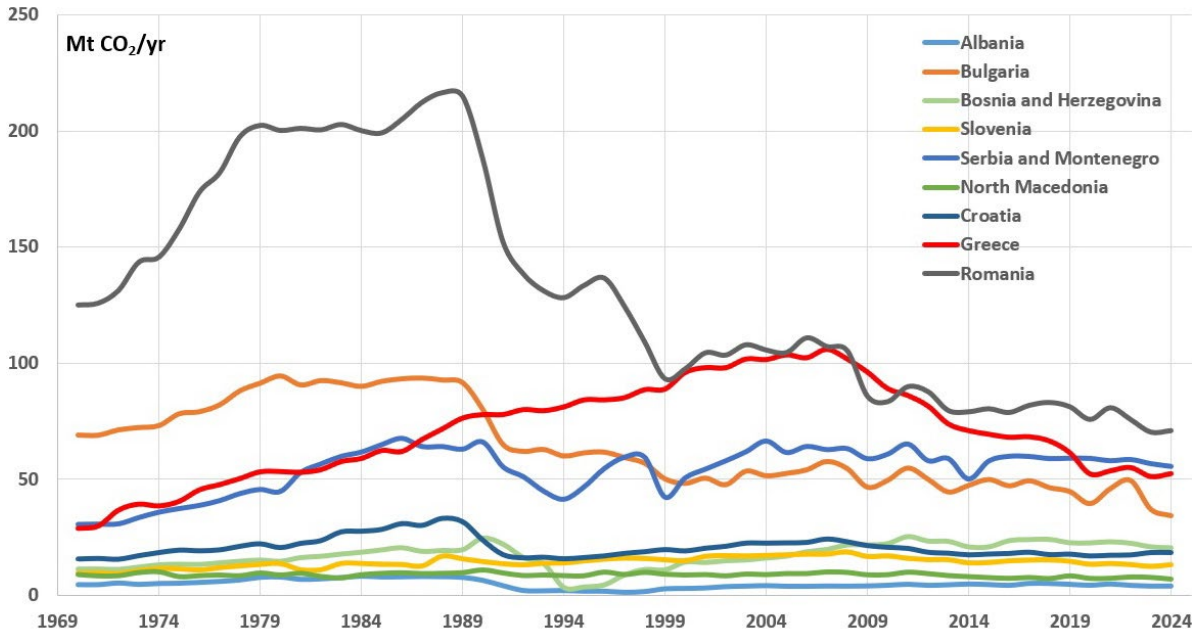


Fig. 3. *CO_2 emissions in Balkan peninsula (1970–2024).* (data extracted from EDGAR, 2025)

Figure 4 shows the evolution in time of CO_2 emissions from all Balkan countries. A significant reduction can be observed in Romania and Bulgaria in 1990, a reduction that is not due to implementation of CO_2 reduction policies but caused by the dismantle of existing large industrial complex because of communism era end. In the rest of Balkan countries, although they experience the same political change (Croatia, Serbia, Bosnia and Herzegovina), the energy intensive industry recovered, and the CO_2 emissions remained relatively constant up to present.

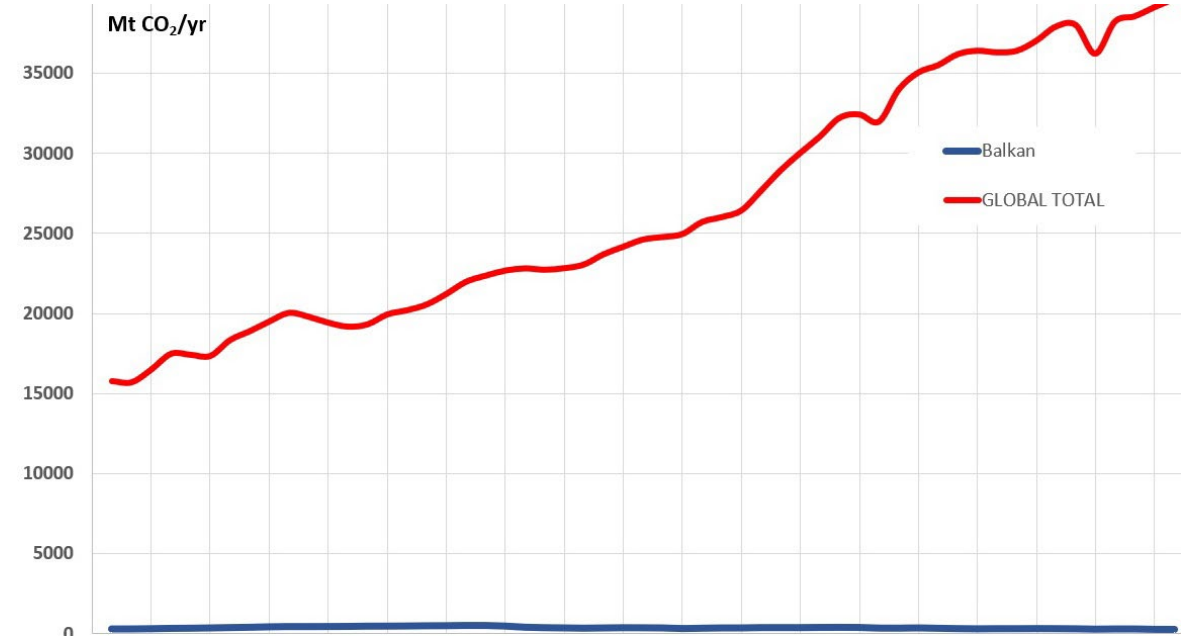


Fig. 4. *CO_2 emissions in Balkan countries and Worldwide (1970–2024).* (data extracted from EDGAR, 2025)

Figure 4 presents the evolution of Balkan and global CO_2 emissions. Net CO_2 emissions from Balkans are insignificant in relation to global CO_2 emissions, and, from figure 2, that are marginal by comparison with EU27 CO_2 emissions.

Countries in the Balkans remain comparatively underdeveloped in the field of renewable energy generation technologies. Expanding the uptake and diffusion of these technologies throughout the region has the potential to alleviate the environmental pressures resulting from the current energy consumption model. (Obradović et al., 2025)

CONCLUSION

To address the challenges posed by climate change and mitigate its adverse consequences, global leaders achieved a landmark milestone during the United Nations Climate Change Conference (COP21) held in Paris. On 12 December 2015, they adopted the historic *Paris Agreement*, establishing a comprehensive international framework for reducing greenhouse gas emissions and strengthening global climate action. Scientific evidence unequivocally indicates that avoiding the most severe consequences of climate change and maintaining conditions conducive to human well-being requires limiting the increase in global mean temperature to 1.5°C above pre-industrial levels. At present, the global average surface temperature is currently about 1.2°C than that recorded during the late nineteenth century, while greenhouse gas emissions continue to follow an upward trajectory. To achieve the temperature target established under the Paris Agreement, global emissions must decline by approximately 45% by 2030 relative to current levels and reach net-zero emissions by 2050.
The pursuit of a net-zero future constitutes a major global challenge, necessitating profound changes across all sectors of society. This transformation involves redefining the ways in which energy is generated and utilized, resources are consumed, and goods and people are transported. As the energy sector is responsible for nearly 75% of anthropogenic greenhouse gas emissions, it remains a critical component of strategies designed to reduce emissions and support the achievement of long-term climate objectives.
The key question is: will we reach net zero by 2050? The answer is simple: no! From 2015 to 2026, 195 countries (194 + EU) ratified the Parris Agreement. The combined effect of the existing national climate action plans adopted by the 195 Parties to the Paris Agreement is estimated to result in a reduction of 12% in global greenhouse gas emissions by 2035 relative to 2019 levels. Despite this projected decline, current commitments remain insufficient to meet the Paris Agreement target of limiting global temperature rise to 1.5°C. To align with this objective, global emissions must be reduced by approximately 55% by 2035, followed by the achievement of net-zero emissions by 2050.
China, the United States of America, India, the European Union, the Russian Federation, and Indonesia represent the six leading sources of greenhouse gas emissions globally. Together, the member states of the G20, comprising the world's twenty largest economies, were responsible for 77% of total global GHG emissions in 2024. (UN, 2026) In comparison, all Balkan countries (Albania, Serbia, Montenegro, Romania, Bulgaria, Slovenia, Greece and Croatia) were responsible in 2024 for 0.69 % of global CO_2 emissions.

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