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Dynamic interaction analyses between green territory expansion, emissions reduction, and tourism in the balkan and european countries

Análisis de la interacción dinámica entre la expansión de territorios verdes, la reducción de emisiones y el turismo en los países balcánicos y europeos

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Abstract

This paper studies the dynamics and trends in the intricate interplay of factors shaping the environmental landscape within the Balkan region and several European countries in a context of a highly competitive and global economic environment. The aim of this study is to analyse the dynamic relationships among expenditure on green technologies, expansion of green territories, waste management practices, energy efficiency, and activation of tourism. A comparative analysis of the green territories coefficient was conducted for Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Central Europe and the Baltics, Georgia, the Republic of North Macedonia, Moldova, Montenegro, Romania, Serbia, and Ukraine. It was established that the leaders are Bulgaria and Albania, as the coefficient of green territories expansion for these countries, like for the majority analyzed, does not undergo significant growth. However, the difference between the coefficient of green territory expansion and the growth rates of the total emissions of pollutants increases, indicating the implementation of "green technologies" in production by these countries, resulting in a reduction in emissions of various types of pollutants. Through a comprehensive analysis of regional data and case studies, the authors explore the causal relations between terrestrial and marine protected areas, nitrous oxide emissions, methane emissions, total greenhouse gas emissions, CO2 emissions, forest area, GDP per capita. The authors' contribution to scientific knowledge lies in the formulation of the green territory expansion coefficient, defined as the difference between green territories and the incremental growth in emissions. The study produces a definition and discusses benefits such as enhanced understanding of environmental dynamics and trends and potential for fostering sustainable practices. However, drawbacks may include the complexity of integrating various factors and the challenges associated with implementation and coordination across diverse regions. Practical recommendations for policymakers and other stakeholders committed to fostering resilient and sustainable regional ecosystems in the context of global environmental changes and the growth of tourism are proposed.

***Keywords*:** Green territory expansion, Tourism and Emissions reduction, Risks, Climate changes, Greenhouse gas emission, Comparative Analysis, Data Analysis.

Resumen

Este artículo estudia las dinámicas y tendencias en la compleja interacción de factores que configuran el paisaje ambiental en la región de los Balcanes y varios países europeos en un contexto de un entorno económico altamente competitivo y global. El objetivo de este estudio es analizar las relaciones dinámicas entre el gasto en tecnologías verdes, la expansión de territorios verdes, las prácticas de gestión de residuos, la eficiencia energética y la activación del turismo. Se realizó un análisis comparativo del coeficiente de territorios verdes para Albania, Bosnia y Herzegovina, Bulgaria, Croacia, Europa Central y los Países Bálticos, Georgia, la República de Macedonia del Norte, Moldavia, Montenegro, Rumania, Serbia y Ucrania. Se estableció que los líderes son Bulgaria y Albania, ya que el coeficiente de expansión de territorios verdes para estos países, al igual que para la mayoría de los analizados, no experimenta un crecimiento significativo. Sin embargo, la diferencia entre el coeficiente de expansión de territorios verdes y las tasas de crecimiento de las emisiones totales de contaminantes aumenta, lo que indica la implementación de "tecnologías verdes" en la producción por parte de estos países, resultando en una reducción de emisiones de varios tipos de contaminantes. A través de un análisis exhaustivo de datos regionales y estudios de caso, los autores exploran las relaciones causales entre las áreas protegidas terrestres y marinas, las emisiones de óxido nitroso, las emisiones de metano, las emisiones totales de gases de efecto invernadero, las emisiones de CO2, la superficie forestal y el PIB per cápita. La contribución de los autores al conocimiento científico radica en la formulación del coeficiente de expansión de territorios verdes, definido como la diferencia entre los territorios verdes y el crecimiento incremental en emisiones. El estudio produce una definición y discute beneficios como una mejor comprensión de las dinámicas y tendencias ambientales y el potencial para fomentar prácticas sostenibles. Sin embargo, los inconvenientes pueden incluir la complejidad de integrar varios factores y los desafíos asociados con la implementación y coordinación en diversas regiones. Se proponen recomendaciones prácticas para los responsables políticos y otros interesados comprometidos con fomentar ecosistemas regionales resilientes y sostenibles en el contexto de los cambios ambientales globales y el crecimiento del turismo.

Palabras claves: Expansión de territorios verdes, Turismo y reducción de emisiones, Riesgos, Cambios climáticos, Emisión de gases de efecto invernadero, Análisis comparativo, Análisis de datos.

Introduction

The research problem is understanding how technological advancements and various factors influence the green transition and its role in promoting sustainable development across different sectors, particularly in the context of the European Green Deal.

The research focuses on the analysis, systematization, and generalization of the concept of a green transition and green territories within the framework of the European Green Deal. It particularly emphasizes the green territory coefficient and its comparison with GDP per capita to assess a country's ecological efficiency.

Research Aim and Research Questions

The purpose of the study is to explore the significance of green territories in promoting sustainable development and to evaluate how effectively countries utilize their economic potential in ecological terms during the green transition. The main objectives are:

-to analyze how technological advancements drive innovation in the green transition across various sectors such as renewable energy, sustainable agriculture, urban development, waste management, and tourism.

-to identify the factors that have propelled innovative development in the modern green economy, including increased environmental awareness, shifting consumer preferences, and supportive governmental policies.

-to investigate the role of sustainable tourism in the green transition, particularly how green technologies can minimize environmental impact and enhance the travel experience.

-to compare the green territory coefficient with GDP per capita to assess how efficiently countries utilize their economic potential in ecological terms within the context of the green transition.

-to evaluate the impact of government policies and changing consumer preferences on promoting sustainable development and facilitating the green transition.

Technological advancements play a pivotal role in the green transition, encompassing sectors like renewable energy, sustainable agriculture, urban territories development, waste management, and tourism. This article delves into the significance of the green territories of countries in promoting sustainable development. Recent years have witnessed various factors propelling innovative development in the modern green economy, including heightened environmental awareness, shifting consumer preferences, and governmental policies advocating for sustainable development. Moreover, technological advancements have been instrumental in fostering innovation within the green transition. The term "green transition" signifies a shift from traditional to sustainable practices, addressing environmental challenges and promoting eco-friendly alternatives. In the Paris Agreement of 2015, it was introduced as a key element in global efforts to combat climate change. The European Council actively supports the green transition, empowering consumers with information and promoting investments in green technologies through initiatives like the net-zero industry act, aligned with the broader goal of achieving climate neutrality by 2050 under the European Green Deal (European Council of the European Union, 2024). The factors influencing the green transition include a shift from resource-intensive to sustainable practices, increased awareness of environmental issues, changing consumer preferences, and government policies promoting sustainable development. Additionally, technological advancements play a significant role in driving innovation in the green economy. Tourism, as a significant economic sector, is increasingly being recognized for its potential to contribute to the green transition. Sustainable tourism practices aim to minimize environmental impact, support local economies, and preserve cultural and natural heritage. The integration of green technologies in tourism not only reduces the carbon footprint but also enhances the overall experience for travelers who are becoming more environmentally conscious. With the outlined considerations, the research objectives were formulated, and a comprehensive set of methods was

established. The focus of this article revolves around the analysis, systematization, and generalization of the concept of a green transition and green territories within the framework of the European Green Deal. The emphasis lies on understanding and promoting the green territory coefficient, which can be compared with GDP per capita for each country to assess how efficiently the country utilizes its economic potential in ecological terms in the context of the green transition.

Literature empirical review

This study extends the authors' earlier research efforts by delving into more intricate methods identified in their prior work. By incorporating fresh datasets, improving methodologies, and investigating additional aspects of the topic under scrutiny, the current study builds upon the findings of their previous research (Marchenko *et al.*, 2022; Korohodova *et al.*, 2024). Through this iterative process, the author's studies aim to provide a more in-depth analysis, providing a nuanced comprehension of the subject matter (Hlushchenko *et al.*, 2023). The study (Marchenko *et al.*, 2022) focuses on analyzing incentives aimed at managing construction waste generated during conflicts, aiming to stimulate economic interest in waste management practices. The authors examine the challenge of balancing the economic interests of stakeholders involved in managing war-generated construction waste and propose practical insights for state and local waste management policies.Investigating the policy of military waste management in conflict zones, the article (Marchenko *et al.*, 2022) utilizes military waste management models grounded in economic, social, and environmental efficiency criteria, revealing the absence of effective mechanisms and schemes for managing such waste in these regions, so this research contributes valuable insights to the ongoing discourse on the green transition. Climate monitoring and assessments reveal that numerous countries have already been impacted by global changes, highlighting the urgency and necessity of action. These changes, ranging from extreme weather events to rising sea levels, underscore the critical need for a green transition (Jacimovic & Korohodova, 2023). This consistent approach not only

enhances the reliability of the current research but also contributes to the theoretical framework, advancing expertise in the domain.

The following scientists looked into the issues of creating scientific issues related to determining the green transition (Mathiesen, 2023; Cavalli, 2023; Jermain *et al.*, 2022). ”For the EU, this is apparent in the vision put forward by the EU Commission – A Clean Planet for all scenarios (European Commission 2050 long-term strategy, 2020), part of a long-term strategy for the EU to transition to a 100% climate-neutral society, and a commitment to the global objectives of the Paris agreement” (United Nations, 2015). The seventeen Sustainable Development Goals of the 2030 Agenda, effective from January 1, 2016, include Goal Seven, focusing on energy accessibility, and Goal Twelve, targeting sustainable consumption and production. Goal Twelve aims to ensure global awareness of sustainable development and rationalize inefficient fossil fuel subsidies, while this analysis delves into state support for coal mining and coal-based electricity generation, considering market distortions and consumption patterns in selected Energy Community Contracting Parties (Miljević *et al.*, 2019). “The dirtiest fossil fuel is still raising trillions of dollars of funding, despite finance industry pledges to back net zero carbon targets by the middle of the century” (Ainger, 2022).

Following (Dat & Hung, 2023) “Climate change is one of humanity's most significant challenges in the 21st century, directly affecting ecosystems, environmental resources, and human life”. In the paper "European Green Deal: Opportunities and Challenges of Croatia's Green Transition," Kotarsky delves into the European Green Deal as the EU’s response to climate change (Kotarsky, 2020).

In paper by (Cavalli *et al.*, 2023) the model for exploring the feasibility and effectiveness of a green transition from dirty to clean technologies is proposed, which relies on an evolutionary framework for the technology selection that accounts for the environmental domain dynamics, in terms of pollution evolution. As noted in the research by (Prendi, 2023), a green economy is characterised as a public good. Nevertheless, the innovative development of the modern green economy for sustainable development is primarily driven by climate challenges, which stimulate

innovations aimed at developing and implementing environmentally friendly technologies and solutions, as well as energy transformations, fostering the development of new technologies in energy production, energy saving, and energy efficiency. Additionally, clean technologies, including innovations in renewable energy sources, energy efficiency, ecological construction, sustainable tourism and other sectors, along with circular economy principles, which stimulate the development of innovative methods of resource management and recycling, play significant roles. Moreover, investments and financing not only support the growth of green industries but also contribute to job creation, economic growth, and the overall transition to a more sustainable and low-carbon future (Hlushchenko, 2023).

The study by (Baydeniz, 2024) examines the impact of green human resource management, green culture, environmental consciousness, green psychological climate, green behavioral intentions, and employees' green behavior, all of which are closely connected to green technologies and sustainable tourism. Green tourism emphasizes the responsible use of natural resources, minimizing environmental impact, and promoting conservation efforts while providing economic benefits to local communities. This alignment necessitates robust environmental governance capacity to effectively manage and implement these sustainable practices. As noted in research by (Joshi, 2024) “...government initiatives and local community engagement emerge as the most influential drivers of change in the tourism sector”.

In paper by (Martus, 2023), analysis utilizes a case study of Georgia to evaluate environmental governance capacity in a transitional state. The evaluation draws upon a framework derived from the literature on green states. Research by (Prendi, 2024) focuses on the utilization of selected OECD Green Growth indicators to monitor progress towards green growth in Albania. These indicators encompass environmental and resource productivity, the environmental dimension of quality of life, economic opportunities and policy responses, and the socio-economic context. In the research conducted by (Dhoska, 2024), the analysis of energy efficiency in the Albanian metallurgical sector focuses on the implementation of wind energy in private metallurgical companies, aiming to enhance the security of supply for this

industry through the addition of new generation capacity from Renewable Energy Sources within the context of industrial energy communities.

The impact of transitioning to renewable energy sources on energy expenses and economic development has prompted concerns about costs and a prioritization of economic issues, particularly amidst economic crises. Despite being the EU's poorest state, Bulgaria has already met its 2020 renewable energy targets, challenging the common perception that economically disadvantaged countries struggle to attain environmental objectives (Andreas *et al*, 2018).

The study by (Bjelić, 2021) aims to allocate costs within the green economy framework, focusing on two primary expenditures in a Serbian public electric power company: electric energy from thermal and hydroelectric power plants. Through rigorous analysis, it assesses the true cost to Serbian citizens of producing 1 MWh of electric energy from lignite, factoring in hidden expenses and anticipating future costs post-transition to sustainable energy sources. (Felea *et al.*, 2023) assert the importance of Romania revising its national strategies and implementing a National Green Deal to align its national targets (TNs) with those of the EU (TEs), with the primary goal of achieving net zero emissions by 2050, considering the current circumstances and the EU's pivotal commitment to net zero emissions. According to opinion (Hebda, 2023), Romania's primary challenge lies in ensuring energy security, with decarbonization closely linked to the nation's economic and political capacities. The transition away from fossil fuels in power generation necessitates the development of alternative energy sources, particularly in the nuclear, wind, and solar energy sectors.

Specifically, drivers for a green reconstruction and technology options for a green reconstruction are analyzed in the paper by (Saha, 2022). The main sources of pollutants entering the environment during hostilities are discussed in (Angurec *et al.,* 2023). These authors are consistent supporters of the concept of sustainable development and "green economy" and have repeatedly researched and raised the issue of green transition. Green tourism, which emphasizes sustainable travel practices and minimizes environmental impact, is crucial for preserving natural

resources and promoting conservation efforts. As noted in study (Conefreys, 2024), international tourists are often found to be "producing higher levels of emissions than domestic tourists," highlighting the urgent need for more eco-friendly travel options. The importance of measuring the carbon footprint in tourism is very important, as it allows for the assessment of environmental impact and the implementation of strategies to reduce greenhouse gas emissions.

The observations made in the research dedicated to Bulgaria's economics and energetics into green transition, led the authors (Todorov *et al.,* 2024) to conclude that, despite the efforts made and ambitious political will, there is a pressing need for the identification of reliable technological and socioeconomic measures (accompanied by interdisciplinary research involving technical, social, environmental, and policy factors). While renewables have made significant progress, there is still a long way to go towards complete substitution of fossil fuels for power generation, transport, and manufacturing (Todorov *et al*., 2024), highlighting the necessity for further research on these issues.

Methodologies and Data

The research design has limitations connected to European countries that have applied for EU membership and the countries from this region that have access to the sea. For countries aspiring to join the European Union with access to the sea, support for the green transition is crucial. Membership in the EU entails alignment with sustainable practices, renewable energy adoption, and adherence to environmental standards. Embracing the green transition not only facilitates compliance with EU criteria but also ensures long-term environmental sustainability, fostering economic growth and harmonious integration into the EU community. Tourism plays a significant role in this context, as coastal and marine areas often attract tourists. Implementing sustainable tourism practices is essential for these countries to protect their natural resources while benefiting economically from tourism. Green tourism initiatives, such as eco-friendly accommodations, sustainable transportation options, and conservation-focused tourist activities, can

help mitigate the environmental impact of tourism and support the overall goals of the green transition. Various methods of scientific research are employed to enhance the analysis of data. This article employs quantitative research methods, utilizing numerical data and statistical analysis (specifically Eurostat, World Bank, Organisation for Economic Cooperation and Development, Statista) to address research questions concerning the implementation of green transition provisions. In the research conducted, the coefficient of expansion of green territories was calculated, demonstrating the increase in terrestrial and marine protected areas and forest area in each of the studied countries from 2016 to 2020. This coefficient characterizes the change in the area of territories that absorb CO2. The research revealed no significant fluctuations in the area of terrestrial and marine protected areas and forest area for the studied countries, indicating that this indicator remained relatively stable throughout the study years. A slight increase was observed in Bosnia and Herzegovina, Croatia, and Moldova, while Bulgaria, Georgia, the Republic of North Macedonia, and Montenegro showed a decreasing trend in this indicator over the last studied years. Therefore, overall, discounting minor fluctuations in individual countries, it can be concluded that significant changes in the coefficient of expansion of green territories did not occur in the studied countries. Additionally, the authors calculated the difference between the coefficient of green territories and the increase in emissions of pollutants. Comparing the results of this calculation with GDP per capita allows conclusions to be drawn regarding whether a country invests in the development of green production technologies and whether there is an increase in the ecological efficiency of the economy in the country. A high coefficient of expansion of green territories and a positive difference between green territories and the increase in emissions of pollutants may indicate that economic development in the country is occurring without worsening the environmental situation. Furthermore, this may indicate that countries with increasing GDP per capita levels are enhancing their level of environmental responsibility, expanding resource-efficient and environmentally friendly production technologies, and striving to adhere closely to European business and household ecological standards. Low or negative values of the difference between green territories and the increase in emissions of pollutants

may suggest that economic development is accompanied by a growth in negative environmental impact. Additionally, similar calculations are conducted by the authors for several European countries. The selection of candidate EU countries is compared with neighboring EU member countries based on geographical indicators.

A comparative analysis of similar indicators for candidate and EU member countries will allow conclusions to be drawn regarding the extent to which the environmental efficiency of production in candidate countries aligns with European standards, how effectively the process of business and household ecological practices is being carried out, and to establish whether there is a significant gap between the researched countries in the field of eco-technologies and resource conservation.

The study employed a variety of scientific inquiry methods, both general and specific. Tabular description methods are utilized to systematically organize the data, providing a structured presentation. Furthermore, graphical description methods are used to visually represent the organized data, facilitating a clearer understanding. The research is founded on a comprehensive dataset, incorporating official reports, academic articles, materials from periodicals, and the official data from both national and international statistics. This multi-methodological approach ensures a robust and comprehensive exploration of the research topic.

Results and discussion

Following the research conducted, the authors observed distinct trends related to indicators like the expansion rate of green areas, changes in GDP per capita, and the variance between the expansion of green spaces and the rise in pollutant emissions. Furthermore, they examined statistical data and overall insights on each country's involvement in resource-efficient technologies, eco-friendly business practices, and efforts towards environmental preservation. Consequently, the research outcomes for each country are outlined below.

In this study, authors rely on the following established definitions of indicators:

1. Emissions index, which reflects changes in the level of greenhouse gas emissions (such as nitrous oxide, methane, carbon dioxide, etc.) compared to the previous year. An increase in the emissions index may indicate increased environmental pollution and may have a negative impact on human health and ecosystems.

2. Green index, which reflects changes in green development indicators, such as the area of protected territories and forest area. An increase in this index may indicate an improvement in the ecological situation and sustainable development.

3. EGD (Environmental Green Development), which reflects the difference between the green development index and the emissions index. A positive value of EGD indicates that the country is on the path of sustainable development, reducing greenhouse gas emissions and promoting the growth of green indicators. A negative value may indicate environmental problems and instability in environmental conservation.

Let n represent the current year being considered. Then we can rewrite this is in formulas:

$$GDP\ index(n) = \frac{GDP\ per\ capita\ (current\ US\$)(n)}{GDP\ \ per\ capita\ (current\ US\$)(n-1)}$$

$$Emissions\ index(n) = \frac{Emissions(n)}{Emissions\ (n-1)}$$

where

$$Emissions = \{Nitrous\ oxide\ \ + Methane + Total\ greenhouse\ gas + CO2\}emissions$$

$$Green\ index(n) = \frac{\{Terrestrial\ and\ marine\ protected + Forest\}area(n)}{\{Terrestrial\ and\ marine\ protected + Forest\}area(n-1)}$$

$$EGD = Green\ index(n) - Emissions\ index(n)$$

Therefore, these metrics enable an evaluation of a nation's economic and environmental status, offering insights into areas for enhancing sustainable development, including the impact on recreation and tourism.

Table 1: Environmental and Economic Development Indicators by Country (2017-2020)

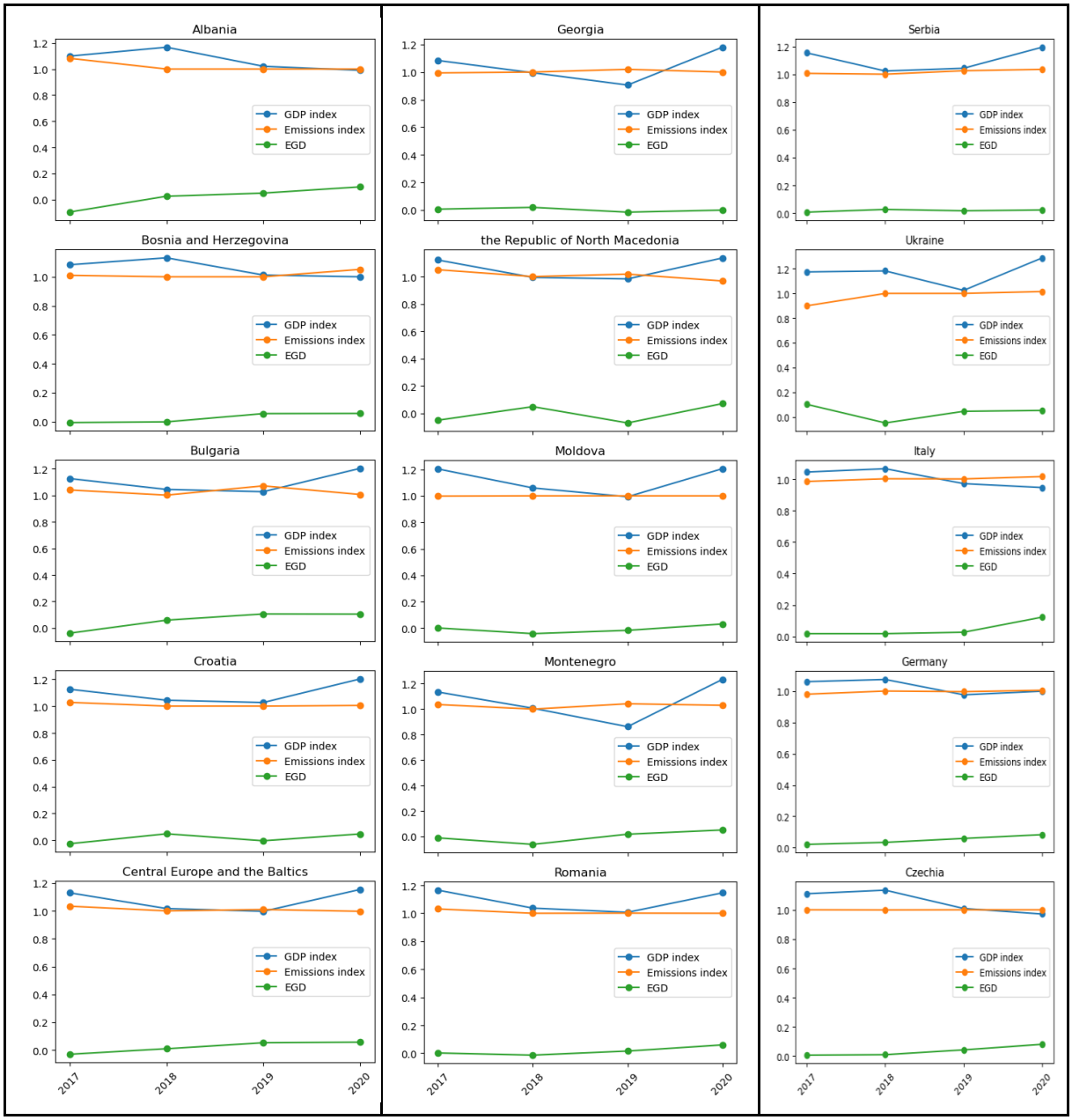
Country Name	Indicator Name	2017	2018	2019	2020
Albania	GDP index	1.099	1.167	1.021	0.99
Albania	Emissions index	1.082	1	1	1
Albania	EGD	-0.096	0.025	0.049	0.097
Bosnia and Herzegovina	GDP index	1.083	1.131	1.012	1
Bosnia and Herzegovina	Emissions index	1.01	1	1	1.051
Bosnia and Herzegovina	EGD	-0.006	-0.001	0.056	0.057
Bulgaria	GDP index	1.127	1.045	1.028	1.204
Bulgaria	Emissions index	1.041	1.002	1.072	1.007
Bulgaria	EGD	-0.039	0.059	0.106	0.105
Croatia	GDP index	1.127	1.045	1.028	1.204
Croatia	Emissions index	1.029	1.001	1.001	1.006
Croatia	EGD	-0.026	0.048	-0.004	0.047
Central Europe and the Baltics	GDP index	1.13	1.017	0.997	1.154
Central Europe and the Baltics	Emissions index	1.034	1	1.01	0.997
Central Europe and the Baltics	EGD	-0.031	0.009	0.052	0.056
Georgia	GDP index	1.084	0.995	0.906	1.18
Georgia	Emissions index	0.994	1	1.02	1
Georgia	EGD	0.006	0.019	-0.016	-0.001
the Republic of North Macedonia	GDP index	1.121	0.994	0.983	1.136
the Republic of North Macedonia	Emissions index	1.05	1	1.018	0.968
the Republic of North Macedonia	EGD	-0.05	0.049	-0.07	0.071
Moldova	GDP index	1.203	1.06	0.993	1.205
Moldova	Emissions index	0.998	1	1	1
Moldova	EGD	0.002	-0.041	-0.016	0.032
Montenegro	GDP index	1.134	1.007	0.862	1.233
Montenegro	Emissions index	1.036	1	1.042	1.03

Country Name	Indicator Name	2017	2018	2019	2020
Montenegro	EGD	-0.012	-0.063	0.017	0.05
Romania	GDP index	1.165	1.037	1.007	1.146
Romania	Emissions index	1.031	1	1.001	1
Romania	EGD	0.002	-0.013	0.016	0.06
Serbia	GDP index	1.153	1.023	1.043	1.194
Serbia	Emissions index	1.006	1,000	1.025	1.035
Serbia	EGD	0.007	0.027	0.017	0.023
Ukraine	GDP index	1.174	1.182	1.025	1.287
Ukraine	Emissions index	0.9	1	1	1.015
Ukraine	EGD	0.101	-0.049	0.045	0.052
Italy	GDP index	1.047	1.068	0.973	0.948
Italy	Emissions index	0.987	1.004	1.003	1.018
Italy	EGD	0.017	0.017	0.026	0.122
Germany	GDP index	1.06	1.074	0.976	0.999
Germany	Emissions index	0.98	1	0.996	1.005
Germany	EGD	0.021	0,034	0.059	0.083
Czechia	GDP index	1.111	1.135	1.01	0.972
Czechia	Emissions index	1.001	1	1.001	1.001
Czechia	EGD	0.007	0.01	0.043	0.081

Source: prepared by the authors

The data (table 1) includes the GDP index, emissions index, and the Environmental Green Development (EGD) index for each country from 2017 to 2020.

Figure 1
Analyzing Green Growth and Economic Resilience (2017-2020)



Source: compiled by the authors

These plots (Figure 1) aim to visualize the relationship between economic growth and environmental impact. They help to assess whether countries are achieving economic growth sustainably by comparing the GDP index with the emission index and EGD values over the years. The visualizations provide a clear comparison of economic growth and environmental efforts across different countries,

helping to identify which nations are successfully expanding their green territories while managing emissions, and which may need to focus more on sustainable practices.

Since gaining independence, Georgia has pursued a trajectory of policy and legislative reforms aimed at addressing environmental concerns. Over the period spanning from 1991 to 2021, the country enacted a total of 233 environmental laws and regulations, as documented by the ECOLEX database. These measures underscore the enduring commitment of the government to address environmental issues through legislative means (Martus, 2023).

Confirmation of this is the gradual increase in expenditure on environmental protection from 1.4% of total government spending in 2007 to 1.8%. Additionally, as of 2020, Georgia had the highest expenditures on environmental measures among other post-Soviet countries. Furthermore, Georgia receives significant volumes of investment resources from the international community for nature conservation measures.

For instance, Georgia has been involved in 56 completed and ongoing projects through the Global Environment Facility (GEF), with funding exceeding US$39 million from the GEF Trust Fund allocated for national-level initiatives (Global Environment Facility GEF, 2022). Additionally, the United Nations Development Programme (UNDP) is actively engaged in various environmental endeavors in Georgia, including climate risk mitigation and resilience projects, along with the ongoing Biodiversity Finance Initiative, which is backed by a budget of US$1.2 million (UNDP Georgia, 2022). Analyzing the results of calculations obtained by the authors of this study, it can be argued that the Emissions index for Georgia remains relatively stable and shows no significant fluctuations over the past three studied years.

It is noteworthy that there has been an increase in GDP over the last studied years, indicating the implementation of green technologies in production. The Green index remains almost unchanged during the analyzed period, indicating a policy of

preserving green areas such as forests in the country. The Environmental Green Development (EGD) has a negative value for the past two studied years, suggesting insufficient intensity of measures to eco-industrialize production and implement resource-saving technologies. Additionally, the negative value of EGD may indicate that the country is increasing GDP without actively transitioning to technologies that could facilitate a gradual decarbonization process through the introduction of eco-friendly production technologies, especially through the adoption of sustainable technologies in the tourism sector.

According to the study conducted by the authors, the Green Index in Moldova did not undergo significant fluctuations during the studied years, indicating that the country is taking measures to preserve the amount of green areas, although it is not significantly expanding the forest and green plantations, which are major CO2 absorbers. Additionally, Moldova has a relatively low Environmental Green Development (EGD) index among the researched candidate countries for EU membership, and for the years 2017 and 2018, this index was negative. Meanwhile, the GDP index decreases from 2016 to 2019, but in 2020, it exceeds the level of 2017 (Figure 1).

These results may indicate a slow transition of the country to green production technologies, regulatory problems in this area, weak incentives for businesses, particularly in terms of taxation, slow progress towards decarbonizing major economic activities, and reducing emissions into the atmosphere, water resources, and soil overall. Additionally, due to its climatic conditions, Moldova, unlike the aforementioned researched countries, does not have an exceptionally high natural potential for the development of green technologies. Moldova has limited forest cover, with estimates varying. According to the Food and Agriculture Organization (FAO), as of 2020, forest cover in Moldova was around 11.4% of the total land area. Moldova has several rivers and lakes. Moldova's major rivers include the Dniester and Prut rivers. Lake Ghidighici and Lake Strachina are among the notable lakes in the country. However, it is worth noting that Moldova's green agenda is outlined in several key documents of the country, in particular in the National Development

Strategy Moldova 2030, the Energy Strategy 2030, the SME Sector Development Strategy for 2012-2020, the Roadmap for Improving Competitiveness, the Agriculture Development Strategy 2013-2020, the Environment Strategy 2014-2023, the Programme for Promoting the Green Economy in the Republic of Moldova for 2018-2020 (Ministry of Economic Development and Digitalization of Government of Republic Moldova, 2024).

In addition to its efforts towards green production technologies and environmental sustainability, Moldova also recognizes the potential of tourism as a key sector for economic development. To further promote tourism, Moldova has been investing in infrastructure development, improving accommodation options, and enhancing marketing efforts to attract more international visitors. The government has also been working on sustainable tourism initiatives to preserve the country's natural and cultural resources while providing economic opportunities for local communities. Overall, Moldova's tourism sector has the potential for growth, offering visitors a glimpse into its unique blend of history, culture, and natural beauty, while also contributing to the country's economic development and sustainability goals (Ministry of Economic Development and Digitalization of Government of Republic Moldova, 2024).

The current economic model of Moldova relies on the service sector (61%), with an important share of agriculture (13%, compared to 2.4% in the EU), which accounts for 32% of employment, industry 26%. Despite some improvements, Moldova’s CO2 and energy productivity remains one of the lowest among the EaP countries and well below the EU level (EU4Environment Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, Ukraine, 2020). The Moldovan economy heavily depends on Small and Medium-sized Enterprises (SMEs), which constitute over 97% of all businesses. These SMEs contribute to over 50% of employment and generate more than 30% of the country's income. Greening the operations of SMEs would diminish their environmental impacts and facilitate access to international markets, particularly the EU, where consumers are increasingly prioritizing environmental considerations. Thus, the investigated country actively implements a

policy to support small businesses and agriculture in the transition to using resource-saving production technologies, alternative energy sources to achieve the declared EU principles of reducing emissions of pollutants, which serves as one of the factors facilitating Moldova's further integration into the European Union.

As research (Prendi, 2024; Dhoska *et al.*, 2024) indicates, the technology of producing electricity from wind energy does not emit greenhouse gases in the environment whereas the conventional technologies in energy production contributed 78% of total EU emissions. Albania can now be considered a country with a high level of green economy. Albania receives investments from international organizations to implement green technologies, for example, the EBRD allocated over €416 million to Green economy financing commitments; €742 million Net cumulative investment in the energy sector; €59 million Net cumulative investment in the municipal and environmental infrastructure sector. The climatic features of the country contribute to the greening of business. Albania has a large number of sunny days each year (ranging from about 290 in the north east to 325 in the southwest), making it well placed to benefit from low solar power prices (The EBRD in Albania, 2024). However, in urban areas, air quality is an issue, especially in the capital, Tirana. Waste management collection systems are also weak, and wastewater treatment covers only a limited percentage of the population. Alongside this, research conducted by the authors has enabled the identification of Albania's relatively stable expansion of "green" territories and a positive Environmental Green Development (EGD) index (one of the highest among the researched countries), confirming that the country is investing in green technologies.

Tourism in Albania is making significant strides towards developing a "green" economy, with a focus on sustainable practices and green technologies. The country benefits from investments from international organizations like the European Bank for Reconstruction and Development (EBRD) to implement environmentally friendly initiatives. These investments include substantial funding for green economy financing commitments, as well as investments in the energy sector and municipal and environmental infrastructure. Albania is expanding its "green" territories and has

a positive Environmental Green Development (EGD) index, showcasing its commitment to eco-friendly technologies. By emphasizing green initiatives and sustainable development, Albania is establishing itself as a country focused on environmental conservation and renewable energy sources (The EBRD in Albania, 2024).

According to the research (Prendi & Murrja, 2023), Bosnia-Herzegovina and North Macedonia performed poorly in terms of renewable energy supply and renewable electricity. This is also evidenced by the results of the studies conducted in the article, as Bosnia and Herzegovina have shown slight growth and one of the lowest Environmental Green Development (EGD) indices among the researched candidate countries for EU membership. In April 2021, Bosnia and Herzegovina submitted its enhanced NDC under the Paris Agreement to the UNFCCC, which is more ambitious than the first NDC. It pledges to reduce GHG emissions by 33.2% to 36.8% by 2030 and by 61.7% to 65.6% by 2050 (compared with 1990 levels) (OECD, 2022). However, in 2019 62.7% of electricity in Bosnia and Herzegovina was generated from coal. Emissions reduction efforts focus on power, district heating, buildings, industry, transport, tourism, forestry, agriculture and waste. Bosnia and Herzegovina's enhanced NDC also foresees adding new wind, solar, biomass and hydro capacity by 2030. The Tourism Growth Index for a 10-year period, with a forecast until 2027, indicates that the average growth rate is 35% in Bosnia and Herzegovina and North Macedonia, the growth rates are 28%, respectively (Porfido, 2020). Consequently, the greening of recreationally attractive territories is of paramount importance. However, Bosnia and Herzegovina's enhanced NDC also encompasses the construction of 1 050 MW of new coal-fired TPPs until 2030. Going forward, it would be important to start phasing out subsidies for coal in Bosnia and Herzegovina (OECD, 2022). At EUR 2.1 per megawatt hour (MWh), subsidies for coal in Bosnia and Herzegovina are the highest in the region. Bosnia and Herzegovina should consider increasing excise taxes on fuels. At present, Bosnia and Herzegovina has among the lowest excise taxes on both diesel (EUR 0.28 per litre (/l)) and petrol (EUR 0.31/l) in the Western Balkan region, both of which are below the minimum prescribed (EUR 0.33/l) by the EU Energy Taxation

Directive. As noted, the excise tax on diesel is lower than on petrol, even though diesel is more polluting (World Bank, 2020).

In May 2020, North Macedonia achieved a significant milestone by becoming the first Western Balkan economy to present its National Energy and Climate Plan (NECP) to the Energy Community for assessment. Following this, in February 2020, it approved its Energy Development Strategy 2040. Additionally, in May 2021, North Macedonia further solidified its commitment to combating climate change by enhancing its Nationally Determined Contribution (NDC), with a target of reducing greenhouse gas (GHG) emissions by 30% by 2030 (OECD, 2022). In the Western Balkan region, North Macedonia maintains one of the lowest excise taxes on diesel, set at EUR 0.25 per litre (/l). This rate stands in contrast to EUR 0.48/l in Serbia, EUR 0.36/l in Kosovo, and EUR 0.29/l in Albania. Notably, North Macedonia's diesel tax is 25% below the minimum outlined by the EU Energy Taxation Directive, which mandates EUR 0.33/l. Despite diesel's higher pollution levels compared to petrol, North Macedonia's excise tax on diesel remains lower than that imposed on petrol, which is set at EUR 0.36/l (OECD, 2022) .

Additionally, along with Bosnia and Herzegovina, North Macedonia faces the issue of abolishing subsidies to enterprises for coal-based electricity production. In 2019, renewable energy sources contributed to 22.9% of electricity generation in North Macedonia, with hydropower dominating the landscape with a significant share of 86.6% (Eurostat, 2021). Further analysis reveals that 77.9% of hydropower production stems from large hydropower plants (>10 MW), while 22.1% is attributed to small hydropower plants (SHPPs) (<10 MW) (Eurostat, 2020). Wind energy constitutes a mere 7.8% of renewable electricity generation, with biogas contributing 3.8% and solar photovoltaic (PV) systems contributing 2.7% (Eurostat, 2020). Emissions reduction efforts focus on power, district heating, buildings, industry, transport, tourism, forestry, agriculture, and waste.

Despite these figures, it's important to note that North Macedonia possesses substantial untapped potential for solar energy, which is among the highest in the region (OECD, 2022). According to the research conducted by the authors, North

Macedonia has shown a slight decrease in the Green Index over the past two studied years and has a relatively low Environmental Green Development (EGD) index among the researched candidate countries for EU membership. Additionally, for the years 2017 and 2020, this index was negative. Meanwhile, the GDP index for the last studied year (2020) indicates a trend towards growth. These results may confirm the aforementioned data regarding the country's insufficient efficiency in implementing green production technologies and the presence of legislative/governmental regulation issues in this area.

However, in 2021, North Macedonia implemented a program aimed at encouraging the adoption of renewable energies and enhancing energy efficiency within households. This initiative allocates a total budget of EUR 840,000, with a specific provision directing EUR 130,000 towards subsidies for renewable energy producers (prosumers). These subsidies cover 30% of the expenses associated with the procurement and installation of solar thermal collectors. Notably, for households with low income, the subsidy rate is increased to 70%. This initiative is expected to benefit approximately 650 households in total (OECD, 2022).

Air pollution, inadequate access to clean energy, and unsustainable environmental practices have been highlighted as significant challenges in Serbia and the wider Western Balkan region in the Initial Assessment. Serbia's elevated carbon intensity, coupled with insufficient energy efficiency measures, contributes to significant levels of air pollution and greenhouse gas (GHG) emissions. Moreover, the utilization of solar and wind energy in Serbia's energy composition remains limited (OECD, 2022). Efforts to reduce emissions in North Macedonia target power, district heating, buildings, industry, transport, tourism, forestry, agriculture, and waste.

In 2019, 29.9% of electricity in Serbia was generated from renewables, with hydropower accounting for the vast majority (90.6%) and much smaller shares of wind energy (8%), biofuels (1.2%) and solar (only 0.1%) (Eurostat, 2021; OECD, 2022). Currently, inflexible coal-fired thermal power plants (TPPs) generate 68% of electricity in Serbia. These plants are slow to shut down and restart. While Serbia

has significantly decreased coal subsidies in recent years, dropping from EUR 95.5 million in 2015 to EUR 41.4 million in 2019, they still remain substantial. Estimated at EUR 1.92 per megawatt hour (/MWh), they rank as the second-highest in the Western Balkan region.

One study suggests that these subsidies could be even higher (Bjelić & Molnar, 2021; Miljević, 2020; Miljević *et al,* 2019). District heating systems in Serbia rely mostly on natural gas for heat production (80%), combined with coal, petroleum products and a limited amount of biomass (20%). Other renewables make up only 1% of fuels used for district heating. According to the research conducted by the authors, Serbia demonstrates non-significant but increasing Green Index over the past two studied years, indicating effective measures taken to increase green areas within the country, which in turn should have a positive impact on reducing CO2 emissions, as trees are its main absorbers. In addition to these energy-related challenges, tourism in Serbia also played a significant role in the country's economy in 2019-2020.

However, the country has a low Environmental Green Development (EGD) index against the backdrop of GDP index growth over the last three analyzed years. These results may indicate that the country inadequately implements policies to reduce emissions of pollutants. It's crucial to recognize that Serbia's pursuit of a green transition isn't solely motivated by its desire to join the EU. The government has reiterated its dedication to global climate efforts through the Paris Agreement, adjusting its goal for reducing emissions by 2030 to 33.3% from 1990 levels. Additionally, Serbia has embraced regional obligations outlined in initiatives like the Green Agenda for the Western Balkans, such as the Sofia Declaration.

This broader framework emphasizes not only decarbonization but also emphasizes the significance of depollution, fostering a circular economy, preserving biodiversity, and promoting sustainable food systems. Currently, Serbia lacks a comprehensive strategy for renewable energy development and faces obstacles for renewable self-consumers. There's a need for an investment-friendly environment,

including flexible electricity systems and market-driven pricing. Energy efficiency policies for buildings are fragmented, lacking a financing strategy for improvements.

In Montenegro at 2,670.01 Gg, CO2 constituted 73.7% of the overall national greenhouse emissions in 2019. The rest of the emissions was CH4 (16.7%), N2O (1.7%), and other GHGs make up the remaining difference. Montenegro's total GHG emissions in 2019 equalled 3,623.25 Gg CO2eq and are 3.2% more than the 2018 levels (UN, 2024). The net GHG emissions in 2019 were 1,119.31 Gg CO2eq – 13.0% less than the 2018 levels. Montenegro has set the target of reducing its GHG emissions by 35% by 2030, compared to 1990 (excluding LULUCF), i.e. reducing its GHG emissions by 2,117 Gg CO2eq by 2030. Analyzing the results of calculations obtained by the authors of this study, it can be argued that the Emissions index for Montenegro fluctuates over the past two studied years, increasing in 2019 compared to 2018, and decreasing in 2020 compared to the previous year.

Alongside this, there is fluctuation in the GDP index over the last studied years, with a significant decrease in 2019 compared to 2018, and a considerable increase in 2020 compared to 2019. Such indicators of these indices may indicate that the country has begun an active transition to the principles of a green economy and the reduction of emissions of harmful substances formed during economic activities, both by economic entities and households, into the atmosphere, water resources, and soil.

The Green index remains almost unchanged over the past two analyzed years, and compared to 2018, it increases, indicating the effectiveness of government policy in preserving green areas. Environmental Green Development (EGD) had negative values in 2017 and 2018; however, a fairly rapid growth trend can be observed for 2019-2020. Analyzing the values of the calculated indices, conclusions can be drawn that Montenegro has significantly intensified measures over the past two studied years to gradually transition to resource-saving practices, and the government policy has a clear direction towards decarbonizing the economy and moving towards zero emissions of pollutants into the atmosphere (Prendi & Murrja, 2023).

It is worth noting that favorable climatic conditions can play an important role in the process of transitioning to a policy of reducing emissions of pollutants (Jacimovic & Korohodova, 2023). Data from the National Forest Inventory prepared in 2010 shows that forests cover 60% of the territory of Montenegro, while forest soil covers an additional 9.7%, which represents a significant part of the country's territory. Water resources cover approximately 13% of the territory of Montenegro. The Tourism Growth Index for Montenegro over a 10-year period, with a forecast until 2027, indicates an average growth rate of 36.9% (Porfido, 2020). Therefore, the greening of such recreationally attractive areas is crucial for the sustainable development of society.

In general, Western Balkan region exhibits low energy efficiency, which is a cause of significant CO2 emissions. In the Western Balkans, energy use and CO2 emissions remain high relative to economic output. Although these economies have reduced their energy and carbon intensity per unit of GDP since 2010, they still surpass the averages for most regional peers, as well as for EU and OECD countries. Carbon intensity levels in Serbia, Kosovo, and Bosnia and Herzegovina are two to three times higher than the OECD average. Albania stands out positively in the region due to its hydropower electricity generation.

Conversely, CO2 emissions per capita are below the EU and OECD averages, reflecting lower levels of industrial activity per capita (OECD, 2022). The region's heavy reliance on burning coal, combined with outdated technology for power generation and heating, are the main drivers of high pollution and low efficiency. In 2020, the 18 coal-fired power stations in Serbia, Kosovo, Bosnia and Herzegovina, North Macedonia, and Montenegro emitted 2.5 times more harmful sulphur dioxide (SO2) than the combined emissions from all 221 coal plants in the EU. Despite the aging fleet of thermal power plants (TPPs), there are few plants planned for decommissioning, while new plants are being developed. Since 2016, installed TPP capacity has remained steady, although the share of fossil fuels in total installed capacity decreased from 52% in 2016 to 48% in 2020 due to some increase in renewables capacity (OECD, 2022) .

The Western Balkans region holds a substantial portion of renewable energy sources. According to the definition outlined in the 2009 EU Renewable Energy Directive (RED) (2009/28/EC), renewables, including biofuels, constituted 18.2% of final energy consumption in the Western Balkans in 2019, compared to only 10.2% in the EU (Eurostat, 2021). Thus, the Western Balkan countries have the potential and favorable climatic conditions for the development of green production technologies and the gradual achievement of economic decarbonization goals. However, this requires investment in this area, incentives for enterprises using resource-saving technologies, as well as adaptation of social infrastructure and households to the principles of energy efficiency.

In 2020, Ukraine contributed approximately 7% of total carbon dioxide emissions in Europe, ranking among the countries with the greatest impact on the greenhouse effect in the region (World Bank, 2023). Ukraine has pledged an ambitious goal to reduce greenhouse gas emissions by 65% by 2030 compared to base year emissions (1990). Nitrous oxide is a much stronger greenhouse gas than CO2 in terms of its 'warming potential'. The Agriculture sector remains the primary source of nitrous oxide emissions in Ukraine, accounting for 87.9% of total emissions in 2021, consistent with previous periods. These emissions stem from agricultural soils and the management of manure (Ministry of Environmental Protection and Natural Resources of Ukraine, 2023).

In 2021, the IPPU sector ranked as the second largest emitter of nitrogen oxides, accounting for 5.7% of the total emissions. Primary sources include the production of nitric and adipic acid, along with the use of nitrous oxide for medical purposes. Within the Energy sector, N2O emissions comprised 3.5% of the total gas emissions. Additionally, N2O emissions were recorded in the Waste sector, constituting 2.5% of total emissions (Chekurda, 2021) .

Today, there are unusual and very dangerous environmental pollution factors in Ukraine. Russia's invasion of Ukraine on February 24, 2022, took place along the whole common border and partially from the territory of Belarus. Significant negative environmental impact is caused by the burning of destroyed military equipment.

According to approximate estimates, the total CO2 emissions from the destroyed Russian equipment as of November 1, 2023, are about 80 thousand tons. In the structure of CO2 emissions, the largest part of the structure is contributed by: tanks - 29%, armored combat vehicles - 21%; artillery systems - 18%; aircrafts - 17%.

When buildings and infrastructure are being hit, this leads to fires that emit dangerous combustion products into the air. So, the area of fires has increased from 35.6 thousand hectares to 495.1 thousand hectares since the beginning of the Great War. This is 460 thousand hectares more than the average annual area of all fires in the EU in 2006-2021. A significant amount of greenhouse gas emissions is generated by the production of ammunition and related raw materials, and additional emissions are generated during their usage.

According to approximate estimates, by February 2023, the total emissions from the usage of munition were about 1.6 million tons of CO2 equivalent (Ecobusiness Group, 2023). Thus, as research shows, Ukraine exhibits a high level of emissions of pollutants into the atmosphere, and Russia's full-scale invasion of Ukraine significantly exacerbates this issue. The results of the research conducted by the authors of the article reflect the situation only up to 2020, allowing for a comparison of its indicators in the transition to principles of green economy before the start of full-scale war. The Emissions index for Ukraine tends to increase over the study period, indicating a rise in environmental pollution and overall negative impact of economic activities of enterprises and households on the environment.

Additionally, there is fluctuation in the GDP index; in 2019, compared to 2018, it decreases, while in 2020, compared to 2019, there is a significant increase. The Green index remains almost unchanged during 2017-2019, but in 2020, it increases, indicating the preservation and slight expansion of green areas, which is a positive aspect for reducing the impact of pollutant emissions on the atmosphere, soil, and public health, as plants are the main absorbers of CO2. Environmental Green Development (EGD) significantly decreases in 2018 compared to 2017 and has a negative value, but for 2019-2020, a rapid increase in its dynamics can be observed. A comprehensive analysis of index data allows us to conclude that Ukraine has

experienced economic growth over the past two researched years and is on the path to a gradual transition to resource-saving, environmentally friendly technologies in both production and household management.

However, the increase in the Emissions index indicates that the transition policy is still not sufficiently effective, and the creation of an effective mechanism for interaction between the state, government, and society in this area is an extremely important aspect of the country's further development and its success on the path to Eurointegration. This issue will be particularly acute after the end of hostilities in Ukraine, as the war has significantly worsened the environmental situation in the country.

Additionally, industrial facilities of metallurgical plants, waste processing enterprises, and energy infrastructure have been destroyed. Therefore, the post-war reconstruction policy of Ukraine must be based on the principles of resource conservation, achieving decarbonization goals, and transitioning to green production technologies. Ukraine has significant natural potential and favorable climatic conditions for transitioning to the principles of a green economy. Ukraine’s rich natural resources are under pressure from overuse and pollution. About 16% of Ukraine’s territory is covered by forest with only about 15% of this area under sustainable management certification (OECD, 2020).

It is worth to note that Since the Revolution of Dignity and the signing of the European Union-Ukraine Association Agreement in 2014, Ukraine has accelerated its efforts to tackle these environmental challenges (OECD, 2022). The country has taken many steps to restore and preserve its natural capital, to integrate environmental concerns into economic development and to accelerate the transition towards a green and low-carbon economy. The updated Nationally Determined Contribution, a non-binding plan to contribute to fulfilling the global goals of the Paris Agreement required cutting Ukraine’s greenhouse gas (GHG) emissions by 65% in 2030 compared to 1990 and reaching carbon neutrality by 2060. Plans to end coal mining in a socially responsible manner have been launched, accompanied by efforts to improve the energy efficiency of buildings (Saha, 2022).

Regarding the principles of green economy and resource conservation, despite the significant number of regulatory acts in this field and the declaration of decarbonization principles aiming for zero emissions of pollutants, not all countries have high indicators of environmentally friendly production and energy-efficient household consumption. Key targets for the EU include reducing greenhouse gas emissions by 55% by 2030 compared to 1990 levels, increasing energy efficiency by 32.5%, and raising the share of renewable energy in the energy mix to 42.5% (with a long-term goal of 45%). Additionally, the EU aims to decrease primary and final energy consumption by 11.7% by 2030 compared to 2020 projections, achieve at least 15% interconnection of electricity systems, and reach net-zero greenhouse gas emissions by 2050. Therefore, let's analyze the experience of some EU countries covered by this study and conduct a brief overview of the general situation in the EU countries on this issue.

As the research shows, Bulgaria is one of the countries that successfully implements the transition to renewable energy sources. With effective state policies in this area, it could have fully achieved its goals in green energy by 2020 (Andreas, 2018). However, considering a number of policy and legal barriers, as of 2023, the Total Final Energy Consumption in renewable energy is reported to be 21% (Tracking SDG7, 2023).

According to the same statistics source, in 2022, Germany represents 44% of the total brown coal consumption (131 million tons) followed by Poland (19%), Bulgaria (12%). While in Albania this indicator stands at 45%, and in Bosnia and Herzegovina at 38%. However, according to the calculations conducted by the authors, Bulgaria has a high indicator of expansion of green territories and a positive Environmental Green Development (EGD) index (the highest among the investigated candidate countries for EU accession), indicating that the country actively invests in green technologies and implements a policy of transitioning to environmentally friendly renewable energy sources. Such discrepancies in research results and data from international financial institutions may be attributed to the fact that the country is in an ongoing process of transitioning to green technologies.

Moreover, as seen from the figure, the GDP growth rates still exceed the growth rates of EGD, indicating that measures to use resource-saving technologies and renewable energy sources are being implemented rather slowly. In this context, it is important to mention the concept of sustainable development of tourism in Bulgaria, as elaborated in paper (Bozhinova, 2023), which highlights significant trends in this sector.

Croatia, as an EU member, stands in a promising position to achieve decarbonization, green development, and climate neutrality goals. The Tourism Growth Index for Croatia over a 10-year period, with a forecast until 2027, shows that the average growth rate is the highest among all countries in the Western Balkan region, at 36.9% (Porfido, 2020). The country has demonstrated political commitment, notably pledging at COP26 in November 2021 to cease deforestation by 2030, phase out coal by 2033, and decrease methane emissions by at least 30% from 2020 levels by 2030. Additionally, Croatia surpasses the EU-27 average in renewable energy usage, with renewables constituting 28.5% of its total energy consumption compared to the EU-27's average of 19.7%.

Croatia's per capita CO2 emissions peaked in 2007 at 5.7 tonnes and decreased to 4.14 tonnes by 2020, while energy intensity, measuring energy consumption per unit of GDP, has steadily declined from 1.91 kWh in 1993 to 1 kWh in 2016. These trends underscore Croatia's favorable trajectory towards green energy adoption (Kotarski, 2022). Croatia currently imports about 56.2% of the total energy consumed annually: 82,6% of its oil needs, 53,2% of its natural gas, 32.5 % of its electricity, and 100% of its coal needs (Eurostat, 2021).

Analyzing the results of calculations obtained by the authors of this study, it can be argued that the Emissions index for Croatia shows a decreasing trend, while the Green index remains almost unchanged throughout the analyzed period. This suggests that the country is implementing a policy of preserving green territories, such as forests, which are major absorbers of CO2. Environmental Green Development (EGD), reflecting the difference between the green development index and the emissions index, has a positive, albeit not very high value.

This may be associated with the country's GDP growing at a faster pace than investments in the green economy, and decarbonization policy primarily implemented not through transitioning to environmentally friendly production technologies, but through the adoption of resource-saving technologies and environmentally friendly solutions for households and the population. Additionally, the country benefits from a favorable climate for resource conservation and transitioning to renewable energy sources, as it has a significant number of sunny days and the potential to harness wind energy.

Approximately 2.4 million hectares of Croatia's territory are covered by forests, representing about 47% of the country's land area. Also, the presence of a significant amount of water resources is an additional CO2 absorber.

Romania is a participant of the European Union, and Romania has ratified numerous international and EU agreements pertaining to environmental and climate issues, including the Paris Agreement. However, significant disparities exist between Romania and the EU average across various sectors covered by environmental legislation, highlighting areas where Romania falls short in meeting environmental standards. As of the year 2020, according to the research data (Felea *et al.*, 2023; Hebda, 2023), in terms of greenhouse gas (GHG) emissions, Romania performs significantly better than the EU average, with an emission intensity of 537.6 grams equivalent CO2 per euro, compared to the EU average of 266.5 grams equivalent CO2 per euro. Regarding energy efficiency, Romania's energy productivity stands at 5.2 euros per kilogram, in contrast to the EU average of 8.57 EUR per kilogram.

When considering the utilization of renewable energy resources, Romania's gross final consumption index of renewable energy resources (RER) is 24.48%, slightly higher than the EU average of 22.09%. However, Romania lags behind the EU in municipal waste recycling, with a recycling rate of 13.7% compared to the EU average of 47.20%. Referring to the research conducted by the authors of this study, it is worth noting at the outset that the area of forest and water resources in Romania in relation to the total area is approximately: forest area: Around 27% of the total land area; water resources: Cover about 3% of the total land area. Analyzing the results

of the calculations conducted in the study, several observations can be made regarding Romania. The Emissions index for Romania remains relatively stable, showing no significant fluctuations over the past four years. However, it is noteworthy that the GDP index decreased in 2018 and 2019, while experiencing significant growth in 2020 compared to the previous year. This suggests that starting from 2020, the country has begun to more actively implement policies aimed at transitioning to green technologies. This is further evidenced by the discussion regarding the problems created by the increasing influx of tourists, which contributes to environmental degradation (Shtefanica, 2021).

The Green index remains almost unchanged throughout the analyzed period, indicating that the country is implementing policies aimed at preserving green areas. However, there is no expansion of forest and green zones.

The Environmental Green Development (EGD) index had a negative value in 2018 but shows a tendency to increase in 2019 and 2020. This trend may indicate the activation of the transition process towards alternative energy sources, the implementation of resource-saving technologies, and overall progress towards achieving economic decarbonization and reducing emissions of pollutants.

The EU's target, as established by GEP Environmental, to achieve climate neutrality by 2050 is essential (Tiseo, 2023). This objective necessitates an economy where greenhouse gas (GHG) emissions balance out to zero net emissions, indicating that any emissions produced will be counteracted by CO2 sequestration. This goal gains particular significance considering the EU's current position as the world's third-largest emitter of GHGs. Overall, as indicated by statistical data, emissions of pollutants in EU countries have significantly decreased from 1990 to 2021. However, most of the EU member states are still relying on a significant share of fossil fuels (solid, liquid or gas) (Todorov *et al*., 2024) .

Nevertheless, legislative and social pressures on the coal and mining sector have been steadily increasing. Concerns about coal's resurgence have emerged due to the energy crisis in Europe and conflicts in various global hotspots, especially in

Ukraine. Recently, a few CFPPs in the EU were temporarily placed on standby, with limited impact on net emissions and climate commitments. Data for 2020 highlight coal's continued primary role in global electricity production, despite a record-high global coal consumption in 2022. However, European statistics for 2022 and 2023 show a lower-than-expected demand for coal in electricity generation within the EU. In 2023, there was a record decline in coal, gas, and emissions, with fossil fuels accounting for less than one third of the EU's electricity generation (Brown, 2022; Jones *et al.*, 2023; Brown *et al.,* 2024).

The slightly delayed nuclear phaseout in Germany sparked discussions on social media. Some organizations and politicians argued for keeping nuclear power plants in reserve, citing concerns about relying on gas and coal, which are not cleaner options for the country's energy balance. According to (Ainger, 2022), commercial banks in the USA directed approximately USD 1.5 trillion into coal between 2019 and 2021 (Jermain *et al.,* 2022) revealed the presence of 2400 power plants operating across 79 countries, with a combined capacity of 2100 GW. The same authors noted the operation of around 8500 coal-fired power plants worldwide, with new capacity (approximately 1706 GW) under construction at more than 189 plants, and plans for an additional 280 GW of capacity at existing power plants.

Despite the European Union's reduction in consumption of major solid fossil fuels by 25% between 2018 and 2021, fossil energy sources including oil, coal, natural gas, and uranium continue to contribute to over 80% of the world's energy production (Todorov, 2024). GGFR estimates that in 2022 gas flaring released 357 million tonnes of CO2e, 315 million tonnes in the form of carbon dioxide, and 42 million tonnes CO2e in the form of methane (Todorov, 2024).

Therefore, it can be concluded that the implementation of decarbonization policies requires a balanced approach aimed at achieving common policy goals for all EU countries, as well as candidate countries, and substantial investment resources. However, it should be noted that there cannot be a single model for transitioning to the principles of a green economy for EU candidate countries, as this

group of countries has significant differences in the level of economic development, climatic conditions, population size, and GDP levels.

Moreover, Ukraine currently requires a specific model for reducing CO2 emissions, as the ongoing military conflict on its territory significantly increases the emissions of pollutants into the atmosphere, water resources, and soil. The combustion of forests, fields, civilian and military infrastructure objects, explosions of rockets, ammunition, and military equipment, as studied by the authors in previous articles, releases a significant amount of not only CO2 but also other pollutants. Therefore, for Ukraine and other EU candidate countries, there are different priorities, means, and approaches to building a decarbonization model, which will be part of the strategy for post-war reconstruction of industrial and civil infrastructure.

Conclusion

The tourism and recreational potential of countries worldwide is becoming increasingly dependent on the state of the environment and the implementation of green technologies each year. In conclusion, this study provides valuable insights into the dynamics of the green transition and emphasizes the importance of efficient utilization of economic potential in ecological terms. Based on the results of the conducted research, the authors have improved the scientific and methodological approaches to evaluating the implementation of green technologies. Specifically, they proposed a coefficient for the expansion of green territories, which characterizes the change in the area of territories that absorb CO2 through the increase of land and marine protected areas and forested areas. A high level of the green territories expansion coefficient indicates economic development in the country without the deterioration of its environmental situation, an increase in GDP per capita, and an enhanced level of responsibility for the environment. This also reflects the expansion of resource-saving and environmentally friendly production technologies. A comparative analysis of the green territories coefficient was conducted across several countries, revealing Bulgaria and Albania as leaders in green territory expansion. Given the interdependence between a country's tourism

potential and the condition of its natural resources, the use of the proposed coefficient allows for the evaluation of green tourism initiatives in relation to the state of the environment. Through rigorous analysis and formulation of the green territory coefficient, policymakers and stakeholders can make informed decisions to foster sustainable development and combat environmental challenges effectively. The experience of European countries in implementing renewable energy sources has been analyzed, allowing for the identification of problematic aspects of decarbonization, green development, and climate neutrality. This analysis also enables the formulation of a comprehensive set of necessary actions to enhance the effectiveness of the transition policy to environmentally friendly energy sources.

The authors plan to extend their research by focusing on the implementation and impact assessment of sustainable tourism practices in various EU candidate countries, particularly those with coastal regions. Future studies will explore the effectiveness of policy interventions and stakeholder collaborations in achieving green transition goals. Additionally, it is aimed to develop comprehensive frameworks for monitoring and evaluating the long-term outcomes of sustainable tourism initiatives, ensuring that these efforts contribute to both environmental preservation and economic resilience in the face of global environmental changes and increasing tourism activities.

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