Kucher A.
Professor of Department of Management of Organizations,
Lviv Polytechnic National University;
Chief Scientific Researcher at National Scientific Center
"Institute for Soil Science and Agrochemistry Research
named after O. N. Sokolovsky",
Doctor of Economic Sciences, Senior Researcher
Czajka A.
Independent Researcher

DOI: https://doi.org/10.36059/978-966-397-573-3-7

TRENDS IN LOW-CARBON TRANSITION ECONOMIES IN EU COUNTRIES

The issue of low-carbon economic transformation is not only a topical area of research [1–4], but also a central element of the European Union's strategic course aimed at achieving climate neutrality by 2050 [5; 6]. This transition is based on the European Green Deal [5] and encompasses a set of measures aimed at reducing greenhouse gas emissions, developing sustainable technologies and ensuring social justice. The low-carbon transformation of the European Union's economy is a multidimensional strategic process comprising four key interrelated components: achieving climate neutrality, implementing the energy transition, decarbonising the transport sector and establishing institutionally balanced social support. The combined effect of these areas determines the EU's ability to achieve its long-term goal of climate neutrality by 2050.

The aim of this report is to identify trends in the low-carbon transformation of the economy in EU countries, with a focus on Poland and land use.

An analysis of trends for 2018–2023 shows significant progress in reducing anthropogenic emissions: total greenhouse gas emissions have fallen by 37.3% compared to 1990. The most significant results have been achieved in the energy sector, where emissions have fallen by 31.4%. This is consistent with the increase in the share of renewable energy sources in gross final consumption to 24.6%, confirming structural changes in the EU's energy balance.

The transport sector is characterised by rapid electrification, with the share of zero-emission vehicles increasing from 1.0% in 2018 to 14.5% in 2023. At the same time, there are still significant territorial disparities: some member states, in particular Poland, remain among the most carbon-intensive economies in the region, indicating uneven transition rates. The financing of the low-carbon transition, whose total needs are estimated at USD 10–15 trillion by 2050, is provided through a multi-level system of EU instruments.

In particular, the Emissions Trading System (EU ETS), the EU Sustainable Finance Taxonomy, support mechanisms for sectors with high decarbonisation difficulties, and programmatic instruments for mobilising private capital play a key role. The social dimension of the transition is implemented through the Just Transition Fund and special compensation mechanisms aimed at mitigating the socio-economic impact on vulnerable groups and regions.

However, the efficiency of these mechanisms is being tested on the path to a key priority – ensuring climate neutrality, which requires overcoming structural imbalances between member countries. The European Union has set a legislative target of achieving net-zero greenhouse gas emissions by 2050, with an interim target of reducing net emissions by at least 55% by 2030 compared to 1990 levels [5]. By the end of 2023, EU countries had achieved a 37.28% reduction in emissions (Fig. 1).

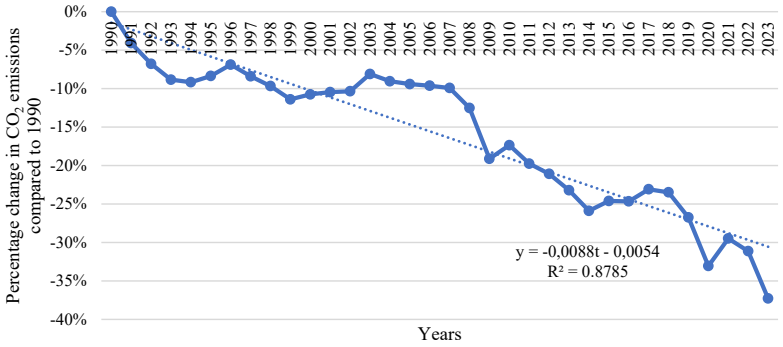


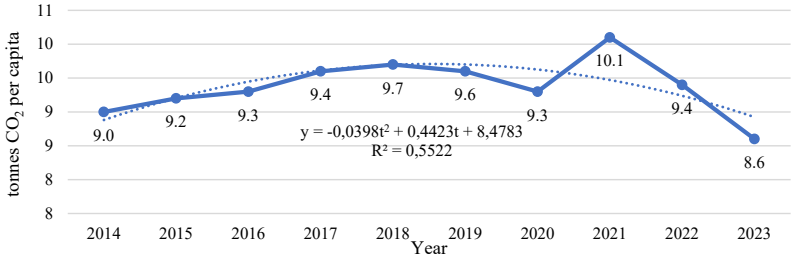
Fig. 1. Dynamics of percentage change in greenhouse gas emissions (in CO_2 equivalent) compared to 1990 in European Union countries, 1990–2023

Source: authors' visualisation based on Eurostat data [6]

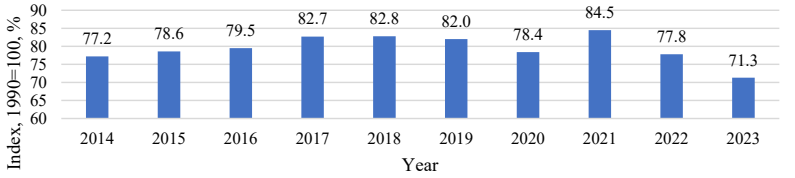
Accordingly, in order to achieve a 55% reduction by 2030, emissions must be further reduced by 17.72% over 7 years, which will amount to approximately 2.53% annually. It is important to determine the role of each country or group of EU countries in generating CO_2 emissions. The analysis shows a relatively equal distribution of countries in terms of greenhouse gas emissions in the European Union. In particular, the largest emitters (137,162 to 432,053 thousand tonnes) are Spain, Poland, France, Italy and Germany, which is explained by the location of large industrial and energy facilities on their territory. Slovakia, on the other hand, is at the top of the distribution scale with emissions ranging from 8,230 to 22,034 thousand tonnes.

The domestic net greenhouse gas emissions index (Fig. 2) measures total national emissions of the so-called 'Kyoto basket' of greenhouse gases, including

carbon dioxide, methane, nitrous oxide and so-called F-gases from all sectors of the GHG emissions inventory.



a) CO_2 emissions per capita, t



b) index of domestic net greenhouse gas emissions, %

Fig. 2. Dynamics of domestic net greenhouse gas emissions in line with EU climate policy and targets in Poland for 2014–2023

Source: authors' visualisation based on Eurostat data [6]

Estimated emissions from international aviation and maritime transport are excluded. The indicator is presented in two forms: as net emissions, including land use, land-use change and forestry (LULUCF), and excluding LULUCF. Using the individual global warming potential (GWP) of each gas, they are integrated into a single indicator expressed in units of CO2 equivalents. GHG emission inventories are submitted annually by EU Member States to the United Nations Framework Convention on Climate Change (UNFCCC). For example, key trends in the decarbonisation of the Polish economy over the last decade are considered (Fig. 2).

Data analysis shows that Poland's domestic net greenhouse gas emissions index has shown a moderate downward trend, but remains higher than the European average. This confirms Poland's position as one of the most carbon-intensive economies in the EU, where emissions intensity in the energy and manufacturing sectors is more than twice the EU average. In terms of CO_2 emissions per capita, the indicator shows a more significant decline, which may indicate some progress in energy efficiency and structural changes in the economy. However, per capita emissions remain among the highest in the EU, reflecting the country's continued dependence on coal in the energy sector. The overall trend shows gradual but insufficient progress towards achieving the EU's targets, indicating the need to intensify efforts to decarbonise and accelerate the green transition in the context of ensuring compliance with the requirements of the European Green Deal.

The dynamics of net greenhouse gas emissions in the LULUCF sector of the EU countries for the period from 2000 to 2023 are considered separately (Fig. 3).

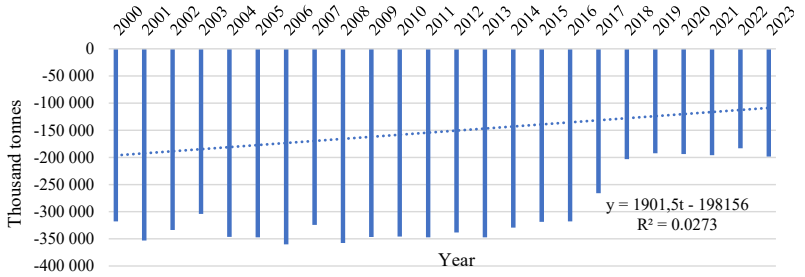


Fig. 3. Net greenhouse gas emissions from land use, land use change and forestry (LULUCF) in the European Union, 2000–2023

Source: authors' visualisation based on Eurostat data [6]

Analysis of the data in Figure 3 reveals a negative trend – since 2018, there has been a significant reduction in net greenhouse gas absorption by this sector. The absorption capacity indicators for LULUCF remain significantly below the level required to achieve the EU's climate goals. This sector is crucial for offsetting emissions from industry and energy. The deterioration in performance is due to a combination of factors, including changes in land use, reduction in forest cover, intensification of agriculture and the effects of climate change on ecosystems.

References:

1. Butrym, O., Zaruba, D., Yehorova, T., Hranovska, L., & Shablia, O. (2023). The role of fiscal instruments in the implementation of low-carbon agriculture. *Agricultural and Resource Economics*, 9 (4), 141–167. https://doi.org/10.51599/are.2023.09.04.07

2. Krysovatyy, A., Maksymova, I., Kurilyak, V., Radin, M., & Kurilyak, M. (2024). International convergence towards a climate-neutral economy: modeling the agricultural sector. *Agricultural and Resource Economics*, 10 (2), 52–79. https://doi.org/10.51599/are.2024.10.02.03

3. Kucher, A., Kucher, L., & Broiaka, A. (2021). Conceptualizing of sustainable management of soil organic carbon. *Soils Under Stress*; eds. Y. Dmytruk, D. Dent. Cham: Springer, 3–16. https://doi.org/10.1007/978-3-030-68394-8_1

4. Kucher, A. (2020). Economics of soil carbon sequestration and development of low-carbon land use. *Scientific Papers: Series "Management, Economic Engineering in Agriculture and Rural Development"*. 20 (1), 301–308. https://doi.org/10.13140/RG.2.2.20468.68480

5. The European Green Deal. Striving to be the first climate-neutral continent. URL: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

6. Greenhouse gas emission footprints (in CO2 equivalent, FIGARO application). URL: https://ec.europa.eu/eurostat/databrowser/view/env_ac_ghgfp/default/table?lang=en