**Nierówności Społeczne a Wzrost Gospodarczy, nr 83 (3/2025)**
***Social Inequalities and Economic Growth, no. 83 (3/2025)***
DOI: 10.15584/nsawg.2025.3.1 ISSN 1898-5084, e-ISSN 2658-0780

*dr Lidia Kaliszczak*[1]
Department of Economics and Management
University of Rzeszów

*dr Jolanta Wojnar*[2]
Department of Quantitative Methods and Economic Informatics
University of Rzeszów

# Eco-innovation performance of the Polish economy in the European Union context[3]

*Abstract*

The article analyses and assesses the level of eco-innovation in the Polish economy in comparison with other European Union countries and identifies the main barriers and directions for supporting the development of eco-innovation in Poland. The hypothesis tested was that Poland's position in the Eco-Innovation Index (Eco-IS) and its eco-innovative performance compared to the EU average are mainly influenced by insufficient government spending on R&D as well as research and development in the fields of environment and energy. Based on a detailed analysis of the degree and dynamics of changes in the Eco-Innovation Index (EII) for EU countries in 2014–2024 and its structure, an assessment of 12 sub-indicators in the EU and Poland in 2024 showed that in the 10-year period under review, Poland improved its score from 50.2 to 69.7, which indicates a 39% increase in the index value and a move up by one position in the ranking (from 26th to 25th place). Despite the increase, the country's ranking position improved only marginally, which reveals that other countries intensified their efforts in the field of eco-innovation. As a result, Poland did not move closer to the top-ranked countries and continues to rank at the bottom of the EU list. The authors identify insufficient R&D expenditure (% of GDP) as well as insufficient government funding and spending on research and development in the fields of environment and energy as the main reasons. The proposed increase in R&D expenditure in relation to GDP as a means of reducing barriers to the growth of eco-innovation in the Polish economy should be correlated with the development of eco-innovative investments and implementations, while simultaneously sustaining high levels of human capital.

*Keywords:* eco-innovation; eco-innovation index; the European Union; barriers to eco-innovation.

[1] Correspondence address: Uniwersytet Rzeszowski, Wydział Ekonomii i Finansów, M. Ćwiklińskiej 2, 35-601 Rzeszów; e-mail: lkaliszczak@ur.edu.pl. ORCID: 0000-0002-1879-1352.

[2] Correspondence address: Uniwersytet Rzeszowski, Wydział Ekonomii i Finansów, M. Ćwiklińskiej 2, 35-601 Rzeszów; e-mail: jwojnar@ur.edu.pl. ORCID: 0000-0001-6962-4610.

[3] Source of funding: public funds for scientific research.

**Ekoinnowacyjność polskiej gospodarki na tle krajów Unii Europejskiej**

*Abstrakt*

W artykule przeprowadzono analizę i ocenę poziomu ekoinnowacyjności polskiej gospodarki w porównaniu z innymi krajami Unii Europejskiej oraz wskazano na zasadnicze bariery i kierunki wspierania rozwoju innowacji ekologicznych w Polsce. Weryfikowaną hipotezą było twierdzenie, że na pozycję Polski w rankingu ekoinnowacyjności (Eco-IS) oraz dystans dzielący ją od średniej UE w głównym stopniu wpływa niski udział wydatków rządowych na B+R oraz na badania i rozwój w dziedzinie środowiska i energii. Na podstawie szczegółowej analizy poziomu i dynamiki zmian sumarycznego wskaźnika ekoinnowacyjności (EII) w krajach UE w latach 2014–2024 oraz jego struktury, oceniając wartości 12 wskaźników cząstkowych w UE i Polsce w 2024 r., wykazano, że w badanym okresie 10 lat Polska poprawiła swój wynik z poziomu 50,2 do 69,7, co oznacza wzrost wartości indeksu o 39% oraz awans o jedno miejsce w rankingu (z 26. na 25. pozycję). Mimo odnotowanego wzrostu poprawa pozycji nie była znacząca, co wskazuje, że pozostałe państwa intensyfikowały działania w obszarze ekoinnowacji. W rezultacie Polska nie zredukowała znacząco dystansu dzielącego ją od liderów i nadal plasuje się w końcowej części rankingu krajów UE. Jako główną przyczynę tej sytuacji Autorzy wskazują niski poziom wydatków na badania i rozwój (% PKB) oraz finansowania i wydatków rządowych na badania i rozwój w dziedzinie środowiska i energii. Postulowany wzrost nakładów na B+R w relacji do PKB jako ograniczanie barier wzrostu ekoinnowacyjności polskiej gospodarki powinien być skorelowany z rozwojem inwestycji oraz wdrożeń ekoinnowacyjnych, przy jednoczesnym utrzymywaniu wysokiego potencjału kapitału ludzkiego.

*Słowa kluczowe:* ekoinnowacje, sumaryczny wskaźnik ekoinnowacyjności (EII), Unia Europejska, bariery ekoinnowacji.

JEL: O30, O01, P47.

## INTRODUCTION

Eco-innovations constitute a key factor in the implementation of the widely recognised concept of sustainable development. Also, they contribute to the growth of competitiveness among businesses and economies. The role of eco-innovations is underscored in the context of efficient use of resources, job creation, and the development of significantly improved products, processes, organizational structures, and institutional solutions, leading to the improvement of the natural environment (Rutkowska, Pakulska, 2023, p. 551). The implementation of eco-innovations is an important element in the strategies pursued by many industries and can constitute a barrier to market entry (Nowaczek, Kowalski, Kulczycka, Makara, 2025, p. 1). However, many enterprises identify limitations in the creation of innovative solutions, which translates into Poland's relatively low position in the EU Eco-Innovation Index of EU. In addition, the authors emphasise the fact that R&D spending is one of the main factors determining the degree of innovativeness, including eco-innovation. Greater investment inputs usually increase the capacity to create and implement eco-innovations.

The aim of the study is to analyse and assess Poland's performance in terms of eco-innovation in comparison with other EU Member States, identify constraints and barriers, and point to directions for supporting the development of ecological innovations in Poland.

In the ensuing paper, an attempt was made to test the following hypothesis: Poland's position in the Eco-Innovation Index (Eco-IS) and its eco-innovative performance compared to the EU average are mainly influenced by insufficient government spending on R&D as well as on research and development in the fields of environment and energy.

In pursuing the objective of the study and verifying the research hypothesis, the degree and dynamics of changes in the Eco-Innovation Index were examined in detail in EU Member States in the years 2014–2024. Furthermore, the values of the sub-indicators of the overall Eco-Innovation Index in the EU and Poland in 2024 were assessed. In addition, the level of expenditure on R&D (% of GDP) as well as government funding and spending on environmental and energy research and development were compared. The comparative analysis was based on statistical data from the Eco-Innovation Scoreboard and Eurostat. The comparison covered eco-innovation indicators for all EU Member States. The research is deductive in nature and draws on the relevant literature, reports, and existing research on eco-innovation.

## The essence and significance of eco-innovations in the development of contemporary economies

In the face of growing environmental threats and problems related to the availability of natural resources, eco-innovations represent an opportunity not only to maintain economic growth, but also to enhance its environmental sustainability, which is a prerequisite for reducing pressure on the environment. It is not possible to completely eliminate the negative impact of human activity on the environment, but thanks to eco-innovations, it is being systematically reduced. Currently, environmental innovations constitute one of the most important factors in the development of EU Member States and, at the same time, one of the key areas supported by its policy.

Many researchers emphasise the relationship between innovation and economic competitiveness and claim that innovations are a tool for enhancing competitiveness (Węgrzyn, 2013; Korkosz-Gębska, 2015; Urbaniec, 2015; Kowalik, 2016; Oleksy, 2017; Pakulska, 2018; Chmielewska, Sławiński, 2021; Burzyńska, Hajdys, 2021; Wach, Głodowska, 2022;). Eco-innovations are a special type of innovations in that they involve the creation and implementation of new products and processes that benefit both businesses and the environment (Rutkowska, Pakulska, 2023,

p. 550). In an article published in 2023 entitled *Exploring the Nexus of Eco-Innovation and Sustainable Development: A Bibliometric Review and Analysis*, eco-innovation is approached as a tool that simultaneously "supports sustainable economic growth and mitigates environmental impacts" (Fatma, Haleem, 2023). The role of eco-innovations is underscored as one of the key factors in implementing the concept of sustainable development. Eco-innovations promote the development of an environmentally friendly economy and facilitate the dissemination of the so-called clean technologies (Burzyńska, Hajdys, 2021, p. 63). In this context, it is postulated that eco-innovations stem from mutual social interactions, technological advancements and the application of new knowledge. Thanks to eco-innovations, new products and processes are developed that reduce negative environmental impacts (Flis, 2010, p. 27). Although previous research has often focused primarily on eco-innovative environmental implications, their transformative potential encompasses the economic, social, and environmental dimensions of sustainable development (Fatma, Haleem, 2023). However, recent approaches emphasize the need to integrate all three dimensions of sustainable development in explaining the role of eco-innovations, which simultaneously promotes economic growth, improves social welfare, and protects the environment (Rađenović, Janjić, Talić, 2024, p. 189; cited in: Sopińska, 2025, p. 128).

In the relevant literature, the main objectives of introducing eco-innovations in organizations are identified and include: reduction or elimination of negative environmental impacts, improved economic performance e.g. through the reduction of operating costs, strengthened company's image among its stakeholders, the general public, and environmental organizations, as well as an increase in the company's perceived value among current and potential investors (Ryszko, 2014; Poznańska, Janiszewski 2024). Paipa-Sanabria, Montoya, and Hernandez (2025) also draw attention to a broader understanding of eco-innovation that goes beyond the environmental perspective. While analyzing eco-innovation theories and tools, the authors approach them as the key element leading to the achievement of "social sustainability". They emphasise that eco-innovation encompasses not only technological solutions, but also a broad set of activities (technological, organizational, social) aimed at balanced economic, social, and environmental development.

## ANALYSIS AND ASSESSMENT OF POLAND'S PERFORMANCE IN TERMS OF ECO-INNOVATION IN COMPARISON WITH EU MEMBER STATES

Eco-innovation is measured using 12 indicators grouped into five thematic areas: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outputs, and socio-economic outputs.

Based on the Eco-Innovation Scoreboard (Eco-IS), which is calculated as an unweighted arithmetic mean of the sub-indicators and then compared with an average value for the European Union as a whole, a ranking of eco-innovations in EU Member States is created. Using the Eco-Innovation Scoreboard, EU Member States were divided into three equally sized groups. Thanks to this classification, individual Member States may be assigned to one of the three categories: eco-innovation leaders (9 EU countries), average eco-innovation performers (countries ranked 10–18), and countries catching up in terms of eco-innovation (ranks 19–27).[4] Table 1 presents the changes in the Eco-Innovation Index scores for all EU Member States in 2024 and, by way of comparison, in 2014.

The eco-innovation performance varies greatly across EU Member States. The average eco-innovation index for the EU-27 increased from 100 to 127.5, indicating a 28% increase. This constitutes a clear sign that EU Member States have been gradually investing in green technologies, renewable energy innovations, circular economy, and other aspects of sustainable development.

**Table 1. Eco-IS in EU Member States in 2014 and 2024**

| 2014 | | | 2024 | | | Change 2024/2014 | |
|---|---|---|---|---|---|---|---|
| EU Member States | Eco-Innovation Index in 2014 | Rank | EU Member States | Eco-Innovation Index in 2024 | Rank | Index values (%) | Change in the ranking |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| Finland | 161.9 | 1 | Finland | 180.8 | 1 | 12% | 0 |
| Denmark | 154.0 | 3 | Denmark | 177.5 | 2 | 15% | 1 |
| Austria | 141.0 | 5 | Austria | 177.1 | 3 | 26% | 2 |
| Luxembourg | 154.9 | 2 | Luxembourg | 175.1 | 4 | 13% | –2 |
| Sweden | 145.2 | 4 | Sweden | 165.2 | 5 | 14% | –1 |
| Italy | 110.9 | 6 | Italy | 150.1 | 6 | 35% | 0 |
| France | 106.0 | 8 | France | 144.0 | 7 | 36% | 1 |
| Germany | 108.3 | 7 | Germany | 140.7 | 8 | 30% | –1 |
| Netherlands | 94.6 | 10 | Netherlands | 133.1 | 9 | 41% | 1 |
| Spain | 101.5 | 9 | Spain | 127.2 | 10 | 25% | 1 |
| Czechia | 89.1 | 12 | Czechia | 125.6 | 11 | 41% | 1 |
| Slovenia | 85.4 | 13 | Slovenia | 121.5 | 12 | 42% | 1 |
| Ireland | 71.1 | 18 | Ireland | 121.2 | 13 | 70% | 5 |
| Estonia | 90.0 | 11 | Estonia | 116.5 | 14 | 29% | –3 |
| Latvia | 76.4 | 17 | Latvia | 114.7 | 15 | 50% | 2 |
| Lithuania | 61.4 | 22 | Lithuania | 114.7 | 16 | 87% | 6 |
| Portugal | 79.0 | 16 | Portugal | 113.2 | 17 | 43% | –1 |

[4] European Commission 2024.

| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
|---|---|---|---|---|---|---|---|
| Belgium | 81.2 | 15 | Belgium | 109.2 | 18 | 34% | –3 |
| Malta | 53.2 | 25 | Malta | 99.2 | 19 | 86% | 6 |
| Slovakia | 63.9 | 21 | Slovakia | 98.9 | 20 | 55% | 1 |
| Cyprus | 64.0 | 20 | Cyprus | 97.6 | 21 | 53% | –1 |
| Croatia | 64.9 | 19 | Croatia | 96.6 | 22 | 49% | –3 |
| Greece | 56.4 | 24 | Greece | 91.0 | 23 | 61% | 1 |
| Romania | 84.7 | 14 | Romania | 80.2 | 24 | –5% | –10 |
| **Poland** | **50.2** | **26** | **Poland** | **69.7** | **25** | **39%** | **1** |
| Hungary | 59.4 | 23 | Hungary | 64.4 | 26 | 8% | –3 |
| Bulgaria | 29.8 | 27 | Bulgaria | 58.8 | 27 | 97% | 0 |
| EU27 | 100.0 | | | 127.5 | | 28% | |

| | |
|---|---|
| | Eco-Innovation Leaders |
| | Average Eco-Innovation Performers |
| | Eco-Innovation Catching Up |

Source: author's own elaboration based on (European Commission 2024).

Based on the data presented in the table it is noticeable that the increase is not uniform across individual Member States, which points to regional disparities as regards the development of eco-innovations. Several countries recorded impressive progress, while Romania reported a decline (–5%) and a significant drop of 10 positions in the ranking.

In the periods compared, the Scandinavian countries (Finland, Denmark, Sweden) and several Western European countries (Austria, Luxemburg, Italy, France, Germany) are at the top of the ranking. A detailed analysis revealed that Finland ranks first in the scoreboard, despite the fact that the index recorded only a slight increase of 12% during the period under study. This implies that the country already had a highly developed eco-innovation sector in 2014. Denmark advanced from third to second place with a moderate increase in the index (15%). Austria moved up from fifth to third place due to an increase in the index of 26%. These Member States are characterised by a stable and high level of investment in research and development, strong policies supporting green technologies as well as effective environmental regulation. Some countries, starting from a lower baseline in 2014, recorded spectacular progress. Bulgaria observed the most dynamic growth (97%), however its position in the ranking remained unchanged (27th place), which shows that also other countries developed eco-innovations dynamically. Lithuania recorded an increase by 87% and moved up from 22nd to 16th place. Malta registered an increase by 86% and moved up by six places, whereas Ireland went up from 18th to 13th place – an increase of 70%. These

countries demonstrate high potential for the development of green technologies in a relatively short period of time, which may result from new government strategies, EU funding or a dynamic private sector.

Poland improved its score from 50.2 to 69.7, i.e. by 39% and moved up by one place (from 26th to 25th place). Despite the increase, the country's ranking position improved only marginally, which reveals that other countries intensified their efforts in the field of eco-innovation. As a result, Poland did not move closer to the top-ranked countries and continues to rank at the bottom of the EU list.

Figure 1 illustrates the dynamics of changes in the synthetic eco-innovation index for Poland over the period 2014–2024 against the EU average.

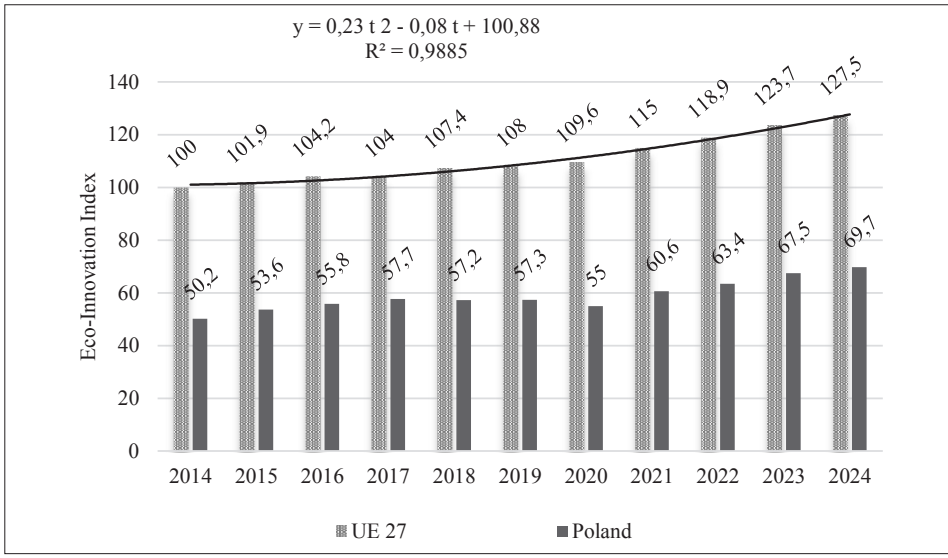


**Figure 1. Eco-Innovation Index in the EU-27 and Poland in 2014–2024**

Source: author's own elaboration based on: (European Commission 2024).

An analysis of numerical data in 2014–2024 reveals that Poland systematically narrowed the gap and moved closer to the EU-27 average in terms of eco-innovation. In 2014–2016, the difference between Poland and the EU average remained relatively stable, however in the years that followed the gap gradually widened. The EU average presented a steady increase, which was well captured by a polynomial trend function with a goodness of fit of 99%. At the same time, the pace of improvement in Poland was slower and less pronounced. In 2014, Poland lagged behind the EU-27 by 49.8 points in the eco-innovation index, whereas in 2024 the country reached a peak of 57.8 points, the highest level observed during the study period, which points to Poland's growing lag in the field of eco-innovation.

The results show that the pace of improvement proved insufficient to reduce the disparities between Poland and the EU-27. Poland does not keep pace with the rate of development of eco-innovations observed in most EU Member States. When examining the causes of Poland's poor eco-innovative performance – compared to other EU countries – an analysis of the structure of the Eco-Innovation Index was conducted and involved an assessment of 12 sub-indicators in the EU and in Poland in 2024. The data presented in Figure 2 demonstrate clear disparities across individual areas between Poland and the EU-27.

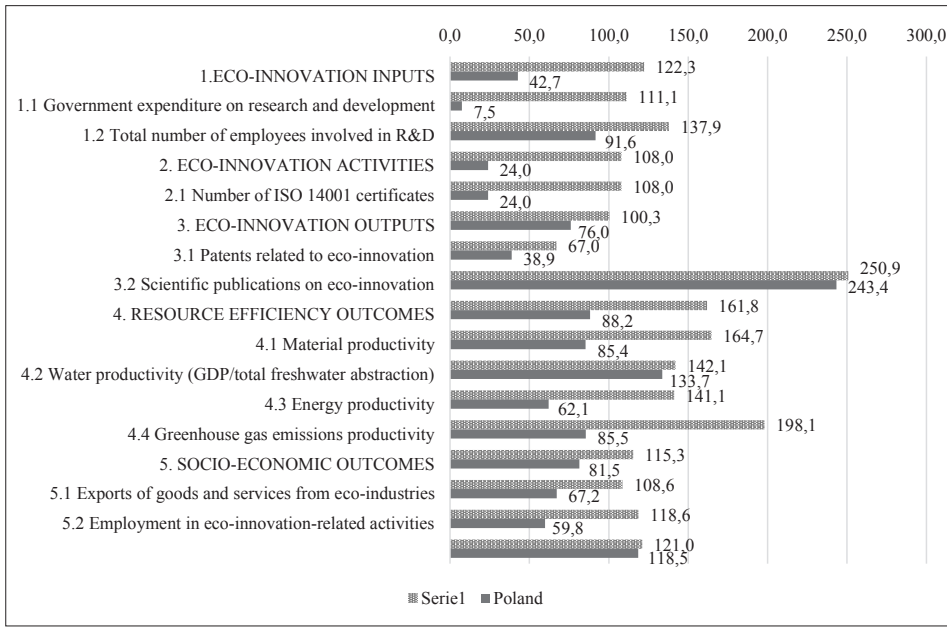


**Figure 2. Sub-indicators of the Eco-Innovation Index in the EU and in Poland in 2024**

Source: author's own elaboration based on: (European Commission 2024).

A comparative analysis of the eco-innovation indicators for Poland and the EU-27 revealed significant differentiation in terms of inputs, outputs, and socio-economic impacts related to eco-innovation processes. The data show that Poland is characterised by a relatively low level of eco-innovative investments and implementations, while at the same time maintaining moderate, and in some categories high scientific potential. Poland's position in the Eco-Innovation Index in 2024 is largely determined by low efficiency across all indicators, except for three categories:

1 – Scientific publications related to eco-innovation,

2 – Water productivity (GDP/total freshwater abstraction), which is used to assess the efficiency of water resource management,

3 – Added value in environmental protection and resource management activities.

A comparison of this kind reveals that despite investment and implementation constraints, Poland possesses certain strengths in the scientific and environmental domains that may form the basis for further development of eco-innovations.

## Discussion – Barriers to eco-innovation in Poland

The values of the sub-indicators in the Eco-Innovation Index for Poland and relative to other EU Member States in 2024 (Figure 2) point to insufficient government spending on research and development in the fields of environment and energy as the primary constraint on the development of eco-innovations. The value of this indicator is the lowest among all 12 sub-indicators and deviates significantly from the EU-27 (7.5 for Poland and 111.1 for EU Member States). This indicator should be analysed in conjunction with the level of gross domestic expenditure on R&D (GERD) as a percentage of GDP.

In EU Member States, the expenditure on research and development amounts on average to 2.27% of GDP (2022). However, countries such as Germany, Sweden, Belgium and Austria achieve significantly higher levels, exceeding 3% of GDP.

Following the data from Statistics Poland (GUS), in Poland the expenditure on R&D was at the level of 1.45% of GDP in 2022, 1.56% of GDP in 2024 and 1.41% of GDP in 2024[5]. As the comparative analyses have shown, if the general expenditure on R&D (relative to GDP) are low or relatively lower than the EU average, part of the financial means is probably not allocated to R&D in the fields of environment and energy. This reduces the availability of technologies, know-how, research resources and projects intended for commercial use, which, in turn, translates into a low level of eco-innovation.

Furthermore, the relative level of R&D expenditure alone (as a percentage of GDP) is not sufficient. The structure is also important, showing what proportion of funds is allocated to green R&D, environmental protection, and green technologies. If the expenditure is too low, the effects on eco-innovation will be limited, as illustrated by the cases of Poland, the Czech Republic and Slovakia. Many analyses published in the context of the Eco-Innovation Index show that countries with low expenditure on R&D (including the green environmental R&D) need considerably more time to narrow the gap and move closer to the top-ranked Member States as far as eco-innovation is concerned (Hajdukiewicz, Pera, 2024, pp. 32–33; European Commission, 2024).

[5] In 2024, the upward trend reversed for the first time – the value of the index in 2024 takes Poland back to 2021, when R&D expenditure accounted for 1.42% of GDP (Statistics Poland).

The analysis of data presented in Table 2 showed that only six EU Member States reached a level of expenditure exceeding 3% of GDP. The highest intensity of these expenditures was recorded in Sweden (3.64%), Belgium (3.27%), Austria (3.26%), Germany (3.13%) and Finland (3.09%). The lowest values were noted in Romania (0.52%), Malta (0.64%), Cyprus (0,68%) and Bulgaria (0.79%).

Poland is one of the three EU countries that recorded the most considerable increase in R&D expenditure over the past decade. Despite that fact, in 2023 the expenditure amounted to only 1.56% of GDP, which ranks the country 13th among the total of 27 Member States (Table 2).

**Table 2. Government funds and expenditure on research and development in the fields of environment and energy (the value of the EII sub-indicator) and expenditure on R&D (%GDP) (2023)**

| EU Member States | Government funds and expenditure on research and development in the fields of environment and energy[6] | Expenditure on R&D (%GDP) |
|---|---|---|
| *1* | *2* | *3* |
| Finland | 155.8 | 3.09 |
| France | 155.8 | 2.18 |
| Germany | 155.8 | 3.13 |
| Slovenia | 155.1 | 2.13 |
| Denmark | 109 | 3.07 |
| Netherlands | 108.3 | 2.3 |
| Austria | 92.7 | 3.26 |
| Latvia | 87.3 | 0.82 |
| Sweden | 81.7 | 3.64 |
| Italy | 79.9 | 1.38 |
| Spain | 75.2 | 1.49 |
| Czechia | 65 | 1.82 |
| Portugal | 42.7 | 1.69 |
| Belgium | 33 | 3.27 |
| Slovakia | 32.3 | 1.03 |
| Luxembourg | 29.7 | 1.06 |
| Estonia | 28.9 | 1.83 |
| Lithuania | 28.2 | 1.05 |
| Greece | 27.5 | 1.49 |
| Hungary | 26.2 | 1.38 |
| Romania | 21.5 | 0.52 |
| Ireland | 18.8 | 1.54 |

[6] The value of the EII sub-indicator.

| *1* | *2* | *3* |
|---|---|---|
| Malta | 13.7 | 0.64 |
| Croatia | 10.7 | 1.39 |
| Poland | 7.5 | 1.56 |
| Bulgaria | 6.7 | 0.79 |
| Cyprus | 2.6 | 0.68 |

Source: author's own elaboration based on: (European Commission 2024; Eurostat).

According to the data provided by Eurostat, in 2023 The European Union has allocated €389 billion to research and development, which corresponds to 2.26% of GDP. More than two thirds of these expenditures (66%) originate from the business sector, and the average expenditure per capita amounted to EUR 862. However, research conducted by other authors emphasises the significant role of the state (and public support) in the development of eco-innovation. The analysis reveals that the contribution of public R&D is often more important than that of enterprises (Krupnik, Szczucka, Lisek, 2022). As confirmed by numerous studies, limited access to funding and high costs associated with eco-innovative methods in particular are frequently identified as barriers faced by enterprises. (Nowaczek et al., 2025). Low expenditure on research and development (R&D) constitutes one of the most serious constraints on eco-innovation because the process of developing, testing and implementing new technologies is capital-intensive, lengthy and associated with a high risk of failure. Eco-innovations – especially these of technological nature – require intensive laboratory work, investing in prototypes, environmental testing and pilot phases. This implies that the initial costs quite frequently exceed the financial capacity of many enterprises, especially small and medium-sized ones that do not have their own R&D resources.

At the same time, companies face limited access to external sources of financing or to equity financing. Banks perceive eco-innovative projects as risky, because these relate to new technologies untested so far in the market and frequently with an uncertain rate of return. This further hinders the acquisition of the capital necessary to start or continue R&D activities, thereby deepening the so-called innovation financing gap.

Furthermore, insufficiently developed infrastructure supporting the commercialization of R&D results constitutes another constraint and encompasses, among others, technology transfer centres, specialised laboratories, green technology incubators and specialised advisory institutions. Without access to such resources, enterprises cannot successfully apply research findings in economic practice, which weakens the dynamics of eco-innovation development at the national level.

The above analyses confirm therefore the research hypothesis formulated in the article which assumes that Poland's position in the Eco-IS Index and the

degree to which the country diverges from the EU average is largely determined by insufficient government spending on R&D as well as on research and development in the fields of environment and energy. Poland, similarly to other countries with low public expenditure on R&D as a percentage of GDP, should strive to increase investment in R&D – both public and private – because inadequate government funding for R&D is widely documented as constraining innovation (Häggmark, Elofsson, 2022, pp. 6–8).

## CONCLUDING REMARKS

The results of the conducted analysis indicate that in almost all five themes (eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes, socio-economic outcomes) it is necessary to intensify efforts to improve Poland's score in the eco-innovation ranking. In 2014, countries with a high eco-innovation performance score demonstrated moderate growth and maintained their position in the ranking. At the same time, countries starting from a lower baseline have the potential for rapid growth, provided that the technological gap is bridged. Poland has improved its level of eco-innovation, however the pace of this process is insufficient to reach the EU-27 average. The growing distance between Poland and the EU confirms Poland's persistent structural lag in the field of eco-innovation.

An improvement in Poland's eco-innovation performance score requires intensified efforts supporting environmental innovations, increased expenditure on research and development and a more effective use of EU policy instruments. Financial support remains the key determinant of successful eco-innovation, which emphasises the need to introduce systemic changes to public policy. Sustained efforts, a well-developed R&D infrastructure and the formation of human capital and strategic frameworks are necessary for the available funding to translate into real growth in eco-innovation.

Grants, financial instruments, cooperation networks, inter-entity collaboration as well as successful and efficient policy for socio-economic development based on rational and responsible financial management may also constitute an important factor. Finally, the development of eco-innovation should not be constrained by excessive regulatory burdens such as complex administrative procedures, lengthy permit approval processes, legal instability or high costs associated with regulatory compliance. Rather than encouraging the adoption of environmentally friendly technologies, regulations most frequently complicate investment processes and lower enterprises' readiness to take risks associated with innovations. The presented results and the conclusions drawn from the research and statistical data analyses provide relevant and up-to-date knowledge that may

be useful particularly for decision makers responsible for formulating Poland's national environmental policy as well as defining the opportunities and directions for the country's continued socio-economic development. Therefore, the findings provide justification for further research and analyses of this kind primarily for the purpose of their verification and updating.

## Bibliography

Burzyńska, D., Hajdys, D. (2021). Eco-innovations in the Enterprises–Determinants and Sources of Funding. *Acta Universitatis Lodziensis. Folia Oeconomica*, *1*, 63–86. DOI: 10.18778/0208-6018.352.04.

Chmielewska, A., Sławiński, A. (2021). Climate crisis, central banks and the IMF reform. *Economics and Business Review* (EBR), *21*(4), 7–27. DOI: 10.18559/ebr.2021.4.2.

European Commission (2024). *The Eco-innovation Scoreboard and the Eco-innovation Index*. Retrieved from: https://ec.europa.eu/environment/ecoap/indicators/index_en (2025.12.15).

Fatma, N., Haleem, A. (2023). Exploring the Nexus of Eco-Innovation and Sustainable Development: A Bibliometric Review and Analysis. *Sustainability*, *15*, 12281. DOI: 10.3390/su151612281.

Flis, R. (2010). Ekoinnowacyjność produktów i usług. In: L. Woźniak, J. Strojny, E. Wojnicka (eds.), *Ekoinnowacje w praktyce funkcjonowania MŚP* (pp. 98–112). Warszawa: Polska Agencja Rozwoju Przedsiębiorczości.

Hajdukiewicz, A., Pera, B. (2024). Eco-innovation performance in the European Union economies: Perspective on outcomes. *International Entrepreneurship Review, 10*(3), 21–36. DOI: 10.15678/IER.2024.1003.02.

Häggmark, T., Elofsson, K. (2022). The drivers of private and public eco-innovations in six large countries. *Journal of Cleaner Production*, *364*(1), 132628, 6–8. DOI: 10.1016/j.jclepro.2022.132628.

Korkosz-Gębska, J. (2015). Znaczenie innowacji ekologicznych w budowaniu przewagi konkurencyjnej regionu na przykładzie województwa podlaskiego. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, *83*, 283–292.

Kowalik, J. (2016). Ekonomiczne uwarunkowania innowacyjności przedsiębiorstw w UE. Analiza przestrzenno-czasowa. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, *97*, 169–180.

Krupnik, S., Szczucka, A., Lisek, K. (2022). The Effects of Supporting Business Innovation and R and D Activities from European Union Funds in Poland: A Review of Evaluation Studies. *Journal of Public Governance*, *58*(4), 27–37. DOI: 10.15678/ZP.2021.58.4.03.

Nowaczek, A., Kowalski, Z., Kulczycka, J., Makara, A. (2025). Ecological Innovations Supporting Sustainable Development: *The Case of the Polish Tire Industry. Sustainability*, *17*, 7210. DOI: 10.3390/su17167210.

Oleksy, M. (2017). Innowacyjność i konkurencyjność przedsiębiorstw i krajów. Krytyczna Analiza Metod i Rankingów Międzynarodowych. *Kwartalnik Naukowy Uczelni Vistula*, *3*(53), 173–188.

Paipa-Sanabria, E.G., Montoya, D.G., Hernandez, J.C. (2025). Understanding Eco-Innovation: A Critical Examination of Theories and Tools for Achieving Societal Sustainability. *Journal Sustainability Research*, *7*(1), e250013. DOI: 10.20900/jsr20250013.

Pakulska, J. (2018). Wskaźniki innowacji ekologicznych dla polski w latach 2010–2017. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, *532*, 237–247.

Poznańska, K., Janiszewski, J. M. (2024). Zrównoważony rozwój a ekoinnowacyjność przedsiębiorstw w Polsce. *Studia i Prace*, *197*, 27–37.

Rađenović, Ž., Janjić, I., Talić, M. (2024). Targeting Eco-innovation Performance among EU Countries: Cluster Outcome. *SCIENCE International Journal*, *3*(1), 189–194. DOI: 10.35120/sciencej0301189r Corpus ID: 268476304.

Rutkowska, M., Pakulska, J. (2023). Resource efficiency index and the level of eco-innovation in EU Member States – a theoretical and cognitive study. *Journal of Modern Science*, *1*(50), 548–564. DOI: 10.13166/jms/162679.

Ryszko, A. (2014). Motywacje i bariery działalności ekoinnowacyjnej przedsiębiorstw w Polsce. *Modern Management Review*, *XIX*, *21*(1), 127–138. DOI: 10.7862/rz.2014.mmr.11.

Sopińska, A. (2025). Ekoinnowacje w MŚP jako element zrównoważonego rozwoju. Determinanty działalności ekoinnowacyjnej. *Studia i Prace Szkoły Głównej Handlowej w Warszawie. Zeszyt Naukowy*, *200*, 127–145. DOI: 10.33119/SIP.2025.200.8.

Urbaniec, M. (2015). Sustainable Development Indicators in Poland: Measurement and System Evaluation. *Entrepreneurial Business and Economics Review*, *3*(1), 119–134. DOI: 10.15678/EBER.2015.030109.

Wach, K., Głodowska, A. (2022). Entrepreneurship research in economics and management: Understandingthe term and the research trends. *International Entrepreneurship Review*, *8*(4), 7–24. DOI: 10.15678/IER.2022.0804.01.

Węgrzyn, G. (2013). Ekoinnowacje w Polsce na tle krajów Unii Europejskiej. *Ekonomia i Środowisko*, *3*(46), 138–149.