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Eco-innovation: the profile of Poland in comparison to the European Union

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ABSTRACT

Innovativeness, determining the development potential of enterprises and economies, and hence the economic welfare of societies, became an important area of interest for both theoreticians and especially economic life practitioners. Thus, in this study of the subject there can be found numerous definitions and types of innovation, including environmental innovation, being a response to the demands of modern economy, related to the need of combining innovativeness with care for the environment. Observed increase of interest in the idea of sustainable development, and often some kind of reorientation of enterprises towards the eco-innovative strategy, are associated with the perception of the eco-innovation as both a necessity and a chance for promotion and development. Despite this, only less than 1/3 of the countries belonging to the EU can be considered as innovative and eco-innovative at the same time. Poland still does not belong to these countries - on the map of the EU innovation Poland ranks among the so-called moderate innovators (with the SII index of 0.27 in 2017, while the EU index was 0.504). With the Eco-IS score equal to 59 the level of eco-innovativeness of the Polish economy is much below the EU average (Eco-IS = 100) – in 2017 Poland obtained 26th place out of 28 European Union countries. Given the above this paper outlines the nature of eco-innovativeness with particular focus on the results recorded by Poland in this regard in comparison to the European Union.

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INTRODUCTION

Despite undertaking pro-innovation activities innovation position of Poland, allowing for positive changes in that area, is not satisfactory in comparison to other European Union countries. It is confirmed by the results of the European Commission report (European Innovation Scoreboard, 2018a), according to which the Summary Innovation Index (SII) for the European Union in 2017 was 0.504. Poland (recording SII of 0.270, next to such countries as the Czech Republic, Portugal, Malta, Spain, Estonia, Cyprus, Italy, Lithuania, Hungary, Greece, Slovakia, Latvia and Croatia) falls into the group of so-called moderate innovators. Thus, it is left behind by countries classified in the group of innovation leaders (Sweden, Denmark, Finland, the Netherlands, Great Britain, Luxembourg), and also countries of the group of innovation followers (Germany, Belgium, Ireland, Austria, France, Slovenia) (European Innovation Scoreboard, 2018a). However, relatively low level of innovativeness of Poland in comparison to the EU countries does not mean that there are no successful innovation activities being undertaken in the country, including the eco-innovation. The perception of innovation evolved over the years, resulting in various definitions presented in numerous publications, relating the issues starting from the innovativeness nature, its types, and finally new approaches and concepts, including reverse innovation as negation of the view that innovation has always be associated with high expenditures and created in highly developed countries. However it should be noted that regardless the concept being studied/implemented, the definition most commonly used in practice is the one included in the Oslo Manual, according to which for over a decade it was assumed that „an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Oslo Manual, 2005). The fourth edition of Oslo Manual issued in October 2018 states that „An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (Oslo Manual, 2018). The systematics of innovation differs in subsequent editions of the Manual. 2005 edition, indicating the fact of the implementation as a common feature, distinguished 4 types of innovation: product innovation, process innovation, marketing innovation, organizational innovation (Oslo Manual, 2005; Saridakis *et al.*, 2019). The category of innovativeness includes some sort of its specific area called the eco-innovation (De Prá Carvalho *et al.*, 2018). This concept should be associated to any forms of innovative activities which contribute to the environmental protection (Colombo *et al.*, 2019; He *at al.*, 2018; Kanda *et al.*, 2019). Those innovations are alternatively referred to as ecology innovation, sustainable development innovation (Kanda *et al.*, 2018; Kiani Mavi *et al.*, 2019), environmental innovation, green innovation or environmental technologies (Aldieri *et al.*, 2019; Mele and Russo-Spena, 2015). They consist of new or modified processes, techniques, practices, systems and products, which allow the elimination or reduction of harmful effects on the environment (Ziółkowski, 2010; Hazarika and Zhang, 2019; Kiefer *et al.*, 2017). It should be also emphasized that eco-innovation are those that result in the reduction of harmful effects on the environment (regardless such effects were intended or not) and their scope exceeds the borders of the enterprise and includes much wider social system, bringing about changes in both social and cultural standards and in institutional structures (Kruk, 2010; Ociepa-Kubicka and Pachura, 2017). Therefore the nature of environmental innovativeness is inevitably related to the avoidance or reduction of nuisance to the environment, and to the better use of natural resources. Eco-innovation are primarily perceived as chances to face challenges arising from the environment pollution and accompanying climate changes. This study has been performed in Poland in 2018.

MATERIALS AND METHODS

Paper objective

The objective of this paper is to present selected aspects of eco-innovativeness, while attempting to analyse the eco-innovation potential of Poland in comparison to the EU countries. In order to achieve the assumed purpose, the paper used the method of analysis of: literature of the subject, Eurostat and the European Commission reports published on the Internet, as well as descriptive method and the method of graphical data presentation.

SII as a measure of innovation in EU countries

The innovative standing of the European Union countries has been monitored every year, since 2001, by the European Commission using so-called Innovation Union Scoreboard (IUS). Innovation is measured based on the Summary Innovation Index (SII), which takes values between 0 and the maximum value of 1 (Svagzdiene and Kuklyte, 2016). The indicators creating the SII index are grouped into four main categories (Table 1), which are then extended to ten dimensions of innovation, covering a total of 28 different indicators (European Innovation Scoreboard, 2018b):

- framework conditions – category which currently consists of three dimensions: human resources, attractive research systems (including international publications, cited publications, and foreign doctorate students), innovation-friendly environment,
- investments, covered by two dimensions: finance and support of innovation processes (ia. R&D expenditure in the public sector) and firm investments (including R&D expenditures in the business sector),
- innovative activities analyzed in three dimensions: innovators (including SMEs introducing innovations), linkages (indicators illustrating linkages between public and private sectors), intellectual assets (indicators illustrating patent activity),
- impacts – this category includes 2 dimensions: employment impacts (indicators illustrating the level of employment in innovative sectors) and sales impacts (sub-indexes relating to the level of sales of innovation on domestic and foreign markets).

Innovation Union Scoreboard, based on the results of the Summary Innovation Index, divides countries into four categories, respectively (European Innovation Scoreboard, 2018a):

- innovation leaders – countries, where the Summary Innovation Index takes values above 120% of the average index for the European Union countries,
- innovation followers – countries, where the Summary Innovation Index takes values between 90% and 120% of the average index for the European Union countries,
- moderate innovators – countries, where the Summary Innovation Index takes values between 50% and 90% of the average index for the European Union countries,
- modest innovators – countries, where the Summary Innovation Index takes values below 50% of the average index for the European Union countries.

Eco-IS as a tool for measuring eco-innovation level

Given those environmental changes and the necessity to respond to them, some kind of „greening" the economy becomes obvious, and subsequently the fact that environmental perspective becomes more important in the politics of the countries. Therefore both on domestic and the EU levels there are actions being taken in order to create an appropriate "climate" for eco-friendly attitudes. Given the increasing importance of eco-innovation the European Commission created the Eco-Innovation Observatory (EIO) platform, which used the system of indicators to develop the eco-innovation assessment tool, called the Eco-Innovation Scoreboard – Eco-IS. Since 2010 Eco-IS has been presenting data related to eco-innovation in all European Union countries (until the end of 2012 – 27 countries, since 2013 – 28) in relation to constant average for the European Union, which makes it easier to identify strong and weak areas of eco-innovation in individual countries. Eco-IS indicator is calculated based on 16 partial indicators related to five thematic areas, presented in Table 2.

RESULTS AND DISCUSSION

Eco-innovation position of the European Union countries

Of the five areas, mentioned in Table 2 and taken into account while assessing eco-innovativeness, only three relate directly to eco-innovation, namely: eco-innovation expenditures, activities of companies

Table 1: Components of summary innovation index (SII)

	Categories and dimensions of SII sub-indexes (EIS 2017-2018)			
	Framework conditions	Investments	Innovative activities	Impacts
Innovation dimension	Human resources Attractive research systems Innovation-friendly environment	Firm investments Finance and support	Innovators Linkages Intellectual assets	On employment level On sales level

Table 2: Indicators used in the 2017 version of the Eco-Innovation Scoreboard (Eco-IS)

	Name of indicator
Eco-innovation inputs	1.1. Governments environmental and energy R&D appropriations and outlays (% of GDP)
	1.2. Total R&D personnel and researchers (% of total employment)
	1.3. Total value of green early stage investments (USD/capita)
Eco-innovation activities	2.1. Enterprises that introduced an innovation with environmental benefits obtained within the enterprise (% of total firms)
	2.2. Enterprises that introduced an innovation with environmental benefits obtained by the end user (% of total firms)
	2.3. ISO 14001 registered organizations (per mln. population)
Eco-innovation outputs	3.1. Eco-innovation related patents (per mln. population)
	3.2. Eco-innovation related academic publications (per mln. population)
	3.3. Eco-innovation related media coverage (per numbers of electronic media)
Resource efficiency outcomes	4.1. Material productivity (GDP/Domestic Material Consumption)
	4.2. Water productivity (GDP/Water Footprint)
	4.3. Energy productivity (GDP/gross inland energy consumption)
	4.4. Greenhouse gas emission intensity (CO^2 emission/GDP)
Socio-economic outcomes	5.1. Exports of products from eco-industries (% of total exports)
	5.2. Employment in eco-industries and circular economy (% of total employment across all companies)
	5.3. Revenue in eco-industries and circular economy (% of total revenue across all companies)

implementing eco-innovation, and achieved results. The other two areas are supposed to analyse the effects of eco-innovation implementation, including environmental and socio-economic effects. Such combination of indicators is aimed at the promotion of holistic approach of the European Union member states to the economy, environmental protection, and social aspect. Indicators presented in Table 2 constituted a basis for the development of the Eco-Innovation Scoreboard 2017 ranking, which is a significant supplement for the methods of innovativeness level measurement in the European Union. The values of Eco-IS for the EU countries are shown on Fig. 1.

In order to provide Eco-IS index easy to understand the EU average in every year of research is always set at a value of 100. The analysis of the Fig. 1 reveals that Poland with the result well below the average (59 of 100), was ranked on 26th position among 28 EU countries, ahead only of Cyprus and Bulgaria. Therefore, taking into account the results of previous studies, where in 2014 Poland was ranked last but three, in 2015 and in 2016 – last but two, it can be stated that it belongs to countries which are subject to permanent very low trend in recent years. The first place in the ranking in 2017 was occupied by Sweden and Finland with the Eco-IS value respectively of 144 and 141. The leaders also included Germany, Luxembourg, Denmark, and Slovenia.

Eco-innovation profile of Poland

As indicated by the Eco-Innovation Scoreboard report, the reason for such low values of Eco-IS indicator in recent years, similar to other Central and Eastern Europe countries results, is the not uniform development of eco-innovation areas in Poland. It is especially well visible on Fig. 2. Poland has a low effectiveness in four out of five areas of eco-innovation activity, related primarily to very low expenditures for research and development, low potential of "green" investment, as well as to economic activities related to eco-innovation. This

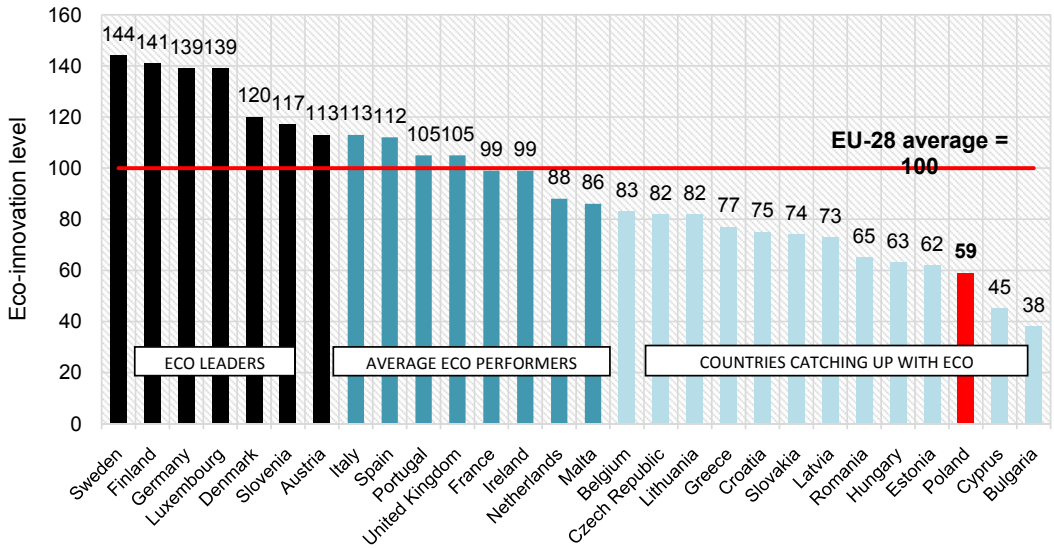


Fig. 1: Eco-Innovation Scoreboard of EU-28 in 2017

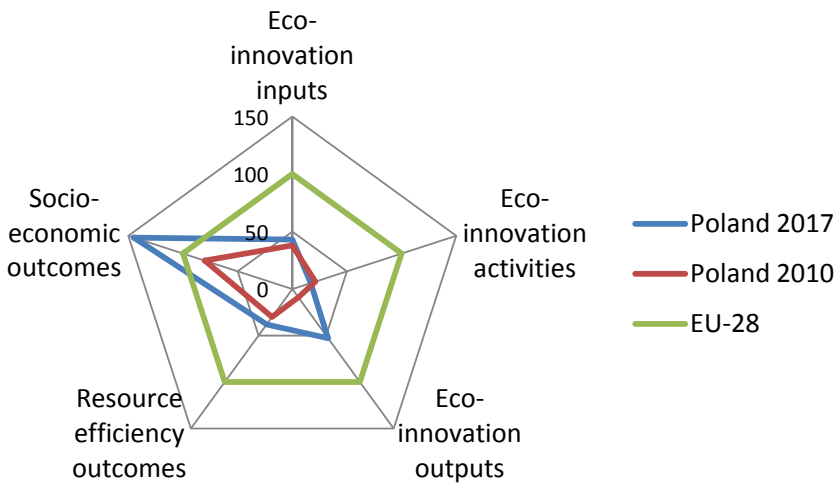


Fig. 2: Components of the Eco-Innovation Scoreboard index for Poland in 2010 and 2017

also reflects barriers to the implementation of eco-innovation, perceived by Polish enterprises and listed in the report. Those include in particular:

- general low innovativeness level of Polish economy,
- underestimated potential of the public funding (mostly from EU structural funds) to develop environmental technologies,
- eco-innovations not perceived as a source of competitive advantage – economic benefits of introducing eco-innovative solutions not fully visible,
- relatively high costs of eco-innovative technology implementation,
- difficult access to capital,
- uncertain return on investment,
- weak system of economic and fiscal incentives encouraging eco-innovation,
- insufficient knowledge on potential economic benefits from the implementation of an eco-innovation.

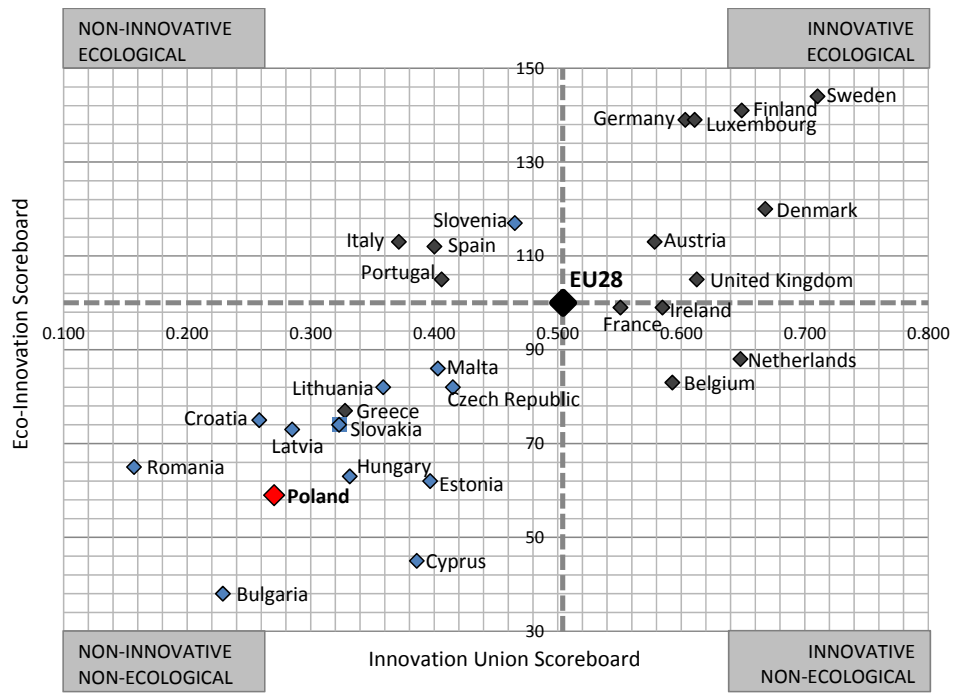
Decomposition of the Eco-Innovation Scoreboard index indicates which areas of eco-innovative activity

in Poland are relatively well developed. Results of Poland in five thematic areas included in Eco-IS in 2017 and 2010 are presented in Fig. 2.

When analysing the structure of individual indicators calculated for Poland in two border years of the analysis (with indicator value of 100 as the average for the European Union) it can be noticed that almost all areas require intensified actions, especially because their development in time is very uneven. The strongest part of Polish eco-innovativeness includes socio-economic area, related to innovative products exports, employment level in the sector, or return on investment. With a socio-economic outcome index of 145, Poland ranks the 1st place among all EU countries in 2017 in comparison to 16th place in 2010. The score is particularly high for employment in eco-industries and circular economy. As well as socio-economic area, also the results of undertaken eco-innovation outputs in the field of obtaining patents and publications (increase of Eco-IS indicator from 9 to 53 in 2017) is visible. An alarming observation is the deterioration of Poland's position in relation to the European Union average in the area of eco-innovation activities in the field of increasing the number of enterprises implementing eco-innovation, improving materials and energy effectiveness, earning ISO 14001 certificate – in this case there was a decrease of the indicator from 21 to 17 in 2017. Very low score of Poland here is due to the relatively low value for the indicator "ISO 14001 registered organisations" and "Enterprises that introduced an innovation with environmental benefits obtained within the enterprise".

Innovative versus eco-innovative standing of Poland

Implementing innovation by enterprises operating in any country brings about numerous benefits, in the form of using new technologies, expanding sales markets, final lowering of operating costs, or meeting the needs of customers. Also the demand for innovative solutions in technologies and processes of environmental protection is ever higher (Lee and Trimi, 2016). Eco-innovation can contribute to the sustainable development and to the increase



Legend:
EU-15
New EU members

Fig. 3: Eco-innovativeness versus innovativeness in European Union (2017)

of market value of products and processes, while energy-efficient and resource-efficient products, processes and services will secure greater competitive advantage for many enterprises and sectors as well as energy security. Therefore it is important to link the innovative potential of domestic economies with their eco-innovative potential. Fig. 3 compares the results of innovativeness indicator SII (X-axis) for 28 EU member states with the results of Eco-IS indicator (Y-axis) recorded in 2017. Adopting the division criterion of the average result for the EU in that year the intersection of the axes for SII = 0.504 and Eco-IS = 100 determined the categorization of the member states across four characterological groups:

- non-innovative/non-ecological, for SII ∈ (0; 0.504) and Eco-IS ∈ (0; 100),
- innovative-non/ecological, for SII ∈ (0.504; 1) and Eco-IS ∈ (0; 100),
- non-innovative/ecological, for SII ∈ (0; 0.504) and Eco-IS > 100,
- innovative/ ecological, for SII ∈ (0.504; 1) and Eco-IS > 100.

That division was additionally expanded by indicating new member states, which joined the European Union after May 1, 2004.

The analysis of the matrix indicates that in 2017 71% of the EU member states fell in only two border groups of innovativeness: non-innovative/ non-ecological states and innovative/ecological states. Only Italy, Spain, Portugal and Slovenia were categorized in the group of eco-innovative countries, yet with the low percentage of total innovation, and the increase of the risk of moving into the group of non-innovative/non-ecological countries in following years is especially high for Portugal with results of SII=0.406 and Eco-IS=105. The result of that negative move is the innovative position of France in 2017, which in previous year belonged to the group of countries both innovative and ecological. About 29% of the EU member states can be considered as both generally innovative and focusing on eco-innovation, which is indicated by high values of SII and Eco-IS indicators. Unfortunately, as much as 13 member states still remained in the group of both non-innovative and non-ecological, out of which 92% were countries that joined the EU after 2004. Poland with results of SII=0.270 and Eco-IS=59, ranks well below the EU countries average, which proves that despite eco-innovation becoming one of the strategic activities in recent years in Poland, the country is still characterized with insufficient utilization of the EU funds for stimulating the eco-innovation potential. Therefore it would be advisable to place the innovation as a whole, including also eco-innovation, in the centre of the state policy, and also to create proper system of creating knowledge of the benefits emerging from investing in environment-friendly technologies.

CONCLUSION

As evidenced in the presented data, the development of eco-innovativeness, just as of the whole innovativeness, in Poland is slow. Polish economy is one of the worst resources-using and the least energy-efficient economies in the EU, and in addition it ranks high in terms of greenhouse gases emission. The factor explaining such situation can be the high dependence of Polish economy on the consumption of coal in the process of electricity generation. Therefore eco-innovation may become a key strategy for policy-makers, however, as indicated by the studies presented in this paper, it is not adequately used. The most recent ranking of the European Commission, showing the eco-innovativeness level of the European Union member states, Poland recorded the 26th position, ahead only of Cyprus and Bulgaria. The reason may surely be the generally low level of the economy innovativeness, existing research and development base, conservative approach of Polish entrepreneurs towards the implementation of innovative solutions, especially in the field of ecology. However the main reason should be identified as the lack of systematic support for eco-innovation area. Changes in these areas and gradual implementation of environmental innovation in enterprises, however, can bring about many benefits, related primarily to the reduction of costs and increasing the competitiveness of enterprises, and at the same time determining the increase in the competitiveness of Polish economy in comparison to Europe and world economies.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

ABBREVIATIONS

%	Percent
CO_2	Carbon Dioxide
Eco-IS	Eco-Innovation Scoreboard
EIO	Eco-Innovation Observatory
EIS	European Innovation Scoreboard
EU	European Union
GDP	Gross Domestic Product
ISO	International Organization for Standardization
IUS	Innovation Union Scoreboard
mln	million
R&D	Research and Development
SII	Summary Innovation Index
USD	United States Dollar

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