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Abstract
The development of eco-innovation is a necessary 'tool' to permanently reduce human pressure on the environment and efficient use of dwindling natural resources. Increasingly, however, literature emphasizes the role of eco-innovation as one of the basic factors of sustainable development. The article presents issues concerning eco-innovation, its later part analyses the capabilities and limitations of their introduction to the economy of selected European Union countries, including Poland. The aim of the study is to systematize the knowledge of environmental investment, and to indicate the possibility and necessity of their continuous development. The methodology used is based on an analysis of available literature and analysis of statistical data.

Keywords: *eco-innovation, Eco-IS in EU countries, eco-innovation inputs and outputs*

JEL Classification: *F23, O39, Q52*

1. Introduction

Socio-economic development has brought a number of indisputable opportunities but at the same time developed societies have never been struggling with challenges of so many kinds. Together with growing economies and societies, we have been witnessing the escalation of problems of demographic, societal (Szczygiel, Almeida, 2017) and ecological nature leading to works on economic growth, power generation and sustainability (Bento, Szczygiel and Moutinho 2017), and raising discussion on policies, methods and tools in practice. In view of increasing pollution and depletion of natural resources, environmental investments are now of interest to both researchers and decision-makers. However, some EU member states have different environmental competitive advantages and economical characteristics (Sulikova, Djukic, Gazda, Kulhanek, 2015). In all highly developed countries, it emphasizes that without the implementation of eco-innovation to the economy cannot be an effective solution to the growing environmental problems. The development of eco-innovation is a necessary 'tool' to permanently reduce human pressure on the environment and efficient use of dwindling natural resources. Already in the 90s of the twentieth century began research on eco-innovation. On their development, they influenced, among others, increase awareness of environmental threats, as well as seeking more sustainable model of economic development. The pioneers of this study were C. Fussler, P. James, R. Kemp and P. Pearson.

The concept of ‘co-innovation’ is relatively new. The prefix 'eco' comes from the word ecology, while by the ‘innovation’ we mean everything that is new. The aim of eco-innovation is the development of new products and processes that significantly reduce their negative impact on the environment. National as well as foreign literature on eco-innovation is quite poor. Increasingly, however, it emphasizes the role of eco-innovation as one of the basic factors of sustainable development. Thanks to them so-called 'clean technologies', and the economy becomes more 'organic'. The development of this kind of innovation is one of the elements of the OECD strategy which assumes encouraging companies limit their harmful effects on the environment and to finance research for this purpose.

The first part of the article presents issues concerning eco-innovation, its later part analyses the capabilities and limitations of their introduction to the economy of selected European Union countries, including Poland. It will contribute to science. The aim of the study is not only to systematize the knowledge of environmental investment, but above all an indication of the possibility and necessity of their continuous development in the European Union.

2. Methodology

The methodology used is based on an analysis of available literature and analysis of statistical data. In statistical analysis, data for the years 2010-2016 have been used. The data have been acquired from official sources about EU countries. As a preliminary tool, the descriptive method is used. It consists of isolating and describing some definitions of eco-innovation' The following part of the study presents the measurement of eco-innovativeness in Poland and in European Union countries.

Measuring the level of innovation in a country is difficult, but examining the level of eco-innovation is even more difficult. This involves difficulties related to determining the scope of research, as well as the method of measuring the effects of introducing new environmental solutions. Attention should be drawn here to the Eco-Innovation Observatory, which is an EU initiative focused on the research of eco-innovations in the European Union. On the basis of the collected data, since 2011 it has been issuing a yearly ranking called the Eco - Innovation Scoreboard (Eco -IS) (Szpor, Śniegocki, 2012).

16 indicators divided into five groups are used to measure the levels of eco-innovation. Expenditures, or ’Eco-innovation inputs are the first one of the five areas in the Eco-Innovation Scoreboard. The index for this area is calculated based on three indicators: government investments in environmental and energy R&D, green early stage investments and total R&D personnel. Eco-innovation activities are number two; the index for this area is calculated based on three indicators: Implementation of innovation activities to reduce material inputs per unit of output in companies, implementation of innovation activities to reduce energy inputs per unit of output in companies and firms with environmental management (ISO 14001) systems.

Eco-innovation outputs are the next area in the Eco-Innovation Scoreboard. The index for this area is based on three indicators: eco-innovation related patents, academic publications related to eco-innovation and coverage of ‘eco-innovation’ in electronic media. For a detailed description of the indicators included in the Eco-Innovation Scoreboard and the calculation details. Resource efficiency outcomes are the next area in the Eco-Innovation Scoreboard. The index for this area is calculated based on four indicators: countries’ productivities in material consumption, energy use and water use as well as countries’ intensity of GHG emissions.

The index for socio-economic outcomes is calculated based on three indicators: Exports of products from eco-industries (% of total exports), employment in eco-industries (% of total workforce) and turnover in eco-industries' (http://database.eco-innovation.eu/ access: 03,01,2016).

3. Result and discussion

Eco-innovation is a very important element of modern economies increasingly decisive for their competitiveness. Therefore, it is worth paying attention to what they are and what determines that innovation is ecological. The EU countries are characterized by a fairly large variation in the level of eco-innovation, and in most cases have a fairly stable position in this ranking. Poland ranks at one of the last places, which indicates a low level of eco-innovation compared to the EU average.

3.1 The essence of eco-innovation

Eco-innovation, due to the greater complexity and different hierarchy of objectives is very different from innovation in general. In the literature there are many definitions of the term. This paper does not aim at deeper analysis of them all, but concentrates on the development of the major ones. The concept of innovation is steadily evolving, which is why it was assumed, that 'innovation is a new or a significantly improved product, process, goods or service introduced to the market or to a company. Innovation uses the results of technological developments, new combinations of existing technology or utilization of other knowledge desired by the company' (Wozniak et al., 2006).

According to the classical definition of eco-innovation, it is a new product that provides value for the customer and for business, while significantly reducing the negative impact on the environment (James, 2001). Innovations implemented by a business entity are defined as 'the implementation of a new or significantly improved product or process, a new organizational method or marketing, in practice, economic, workplace organization or external relations' (Oslo Manual, 2008). By eco-innovations, some authors understand 'all new forms of activities aimed at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy' (Prystrom, 2013). Eco-innovation is 'intentional conduct characterized by the establishment, comprising the stage of product design and integrated management during its lifecycle, which contributes to ecological modernization of the industrial age population by addressing the environmental problems in developing products and related processes. Eco-innovation leads to integrated solutions aimed at reducing energy and resource use, while improving product quality and services. Technological innovation is one way of eco-innovations' (Carley, Spapens, 2000). Moreover, ecological product innovation is an innovation that integrates ecological features of the product and technology lifecycle (from 'cradle to grave'), highlighting the same product against competitive products. Its goal is to realize the assumptions of 'environmental quality' (Chodyński, 2003).

The examples of definitions of eco-innovation presented above show that in practice it may take various forms. Despite the fact that the literature on this subject mentions three main groups of definitions; namely: environmental technologies, eco-effective innovations and system innovations, their common feature is that they all contribute to reducing environmental burdens by economic operators. As to the characteristics of these burdens, they vary quite significantly (Graczyk, Kazmierczak-Beer, 2011). Therefore, defining eco-

innovation in a synthetic way it should be stated that eco-innovation is an innovation aimed at improving relations between business and environment; and it can affect every environmental aspect of the business activity. On the level of strategic expectations of an enterprise, the activities related to the improvement of this relationship should primarily aim at such expansion of the system of eco-innovation within the economic entity, which will ensure that in the future it will be eco-efficient, by reducing the environmental (ecological) risk and bring benefits for the enterprise, as well as ensure its success (Graczyk, 2008). Eco-innovation is the innovation which seeks to reduce the burden on the environment and to achieve a specified performance environment. Eco-innovation is a policy of reducing pressure on the environment by using environmentally-friendly solutions. Eco-innovation solution is one which is innovative compared to solve the most modern (Jarża, 2013). Eco-innovation is most often understood as innovation (that is, changes in technology, organizational structure and management of the company which are designed to eliminate or at least reduce the negative impact of business on the environment (Witkowski, 2008).

In Poland, the concept of eco-innovations have been comprehensively for the first time defined only in 2009 by the Central Statistical Office as 'innovation that benefits the environment, as a new or significantly improved product (product or service), process, marketing method or organization that bring environmental benefits compared with the alternatives' (Activities, 2010). In contrast, at the European level to define this concept taken, among others The European Commission , the OECD and Eurostat. The European Commission defines eco-innovation as ' a form of innovation aiming at significant and demonstrable progress towards achieving the objectives of sustainable development by reducing the impact on the environment or achieving a more efficient and responsible use of natural resources, including energy' (Competitiveness, 2006). The Framework Programme for Competitiveness and Innovation eco-innovation defined as such innovations that reduce environmental impacts or have the purpose of making better use of environmental resources and thus serve sustainable development (Decyzja NR 1639/2006/WE Parlamentu Europejskiego i Rady z dnia 24 października 2006 r. ustanawiająca Program ramowy na rzecz konkurencyjności i innowacji (2007–2013), Dziennik Urzędowy Unii Europejskiej, L 310/15).

Given the above, it should be assumed that the primary objective of eco-innovation on the one hand, the environmental benefits and reduction of the negative impact of economic activities on the environment by reducing the energy intensity of consumption of natural resources or reduce emissions of harmful substances on the other (Ottoman et al., 2006). In the literature used a variety of divisions eco-innovation, including among other things for eco-innovation: product, process, organizational and marketing.

- Eco-Product, as a general category of innovation is the introduction of products or services, so that in a better way will be implemented environmental objectives. The main purpose of their introduction is to reduce the consumption of materials throughout the product life cycle (i.e. from its production process, right through to disposal at the end of life). This is made possible by the possibility of product repair, regeneration and use of materials that can be recycled.

- Eco-innovation process associated with improvement or introduction of new production technologies and new devices that serve to mitigate the negative impact on the environment, e.g. to reduce energy consumption through energy-efficient refrigerators.

- Eco-innovation are organizational changes in the company on the company's organization and management, designed for the purpose of increasing awareness and implementation

of ecological sustainability, e.g. the implementation of an environmental management system ISO 14000.

- Eco-marketing concern at the introduction of new marketing methods drawing attention to changes in the product or packaging, distribution and promotion with particular emphasis on ecological principles, for example eco-label (Matejun, 2005).

3.2 Eco-innovation level of Poland against the European Union

Analysing the state of the Polish economy, it is noted that its economy is largely dependent on other countries. Polish economy is based on coal and agriculture. Businesses are profitable thanks to low costs and low wages, not on the basis of implementing modern solutions. Poland has become an ideal expansion market for western companies, which dominate many industries. Therefore, it is important to move from labour-intensive industries to knowledge-intensive ones. Table 1 shows eco-innovative economies as ranked by the Eco-Innovation Scoreboard (Eco -IS), which measures the relative performance of eco-innovative EU countries to the EU average. Eco-gauge -IS is the basis for the division of European Union countries into three groups, i.e.:

1. eco-innovation leaders, where the value of the index is above 120 (Germany, Luxembourg, Finland, Denmark),
2. advocates of eco-innovation where the index value ranges from 81 to 119,
3. countries catching up on eco-innovation, with the index below 80 (Estonia, Poland, Cyprus, Romania, Malta, Hungary and Bulgaria) (Węgrzyn, 2013).

Table 1: Eco-Innovation Scoreboard (Eco-IS) 2010-2016

Country	2010	2011	2012	2013	2014	2015	2016
UE	100	100	100	100	100	100	100
Germany	139	123	120	132	134	129	140
Luxembourg	94	130	108	109	188	124	139
Finland	157	149	150	138	135	140	137
Denmark	155	138	136	129	185	167	126
Sweden	128	142	134	138	123	124	115
United Kingdom	103	105	102	122	100	106	110
Italy	98	90	92	95	99	106	105
Slovenia	75	109	115	74	91	96	104
Austria	131	125	112	106	106	108	104
Czech Republic	73	92	90	71	92	99	100
France	96	99	96	108	112	115	99
Spain	101	128	118	110	136	134	98
Ireland	102	118	113	95	107	106	97
Greece	55	59	67	66	72	72	96
Portugal	72	81	84	79	99	102	95
Netherlands	110	109	111	91	96	98	91
Slovakia	45	53	53	66	71	73	86
Latvia	48	52	54	47	68	72	85
Croatia	0	0	0	57	87	67	81

Belgium	114	115	118	101	96	97	81
Estonia	56	74	78	72	74	80	78
Poland	54	50	54	42	63	59	72
Cyprus	64	71	74	43	59	60	70
Romania	52	67	78	63	76	82	69
Malta	66	82	72	67	57	64	65
Hungary	70	83	73	61	79	81	60
Bulgaria	58	67	80	38	49	49	41

Source: own calculations based on Ranking Innovation Union Scoreboard 2014, www.database.eco-innovation.eu (access: 28.06.2017).

The Eco-Innovation Index shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. The Eco-IS and the Eco-Innovation Index aims to promote a holistic view on economic, environmental and social performance.

In 2010, the largest group was the group of countries catching up on eco-innovation (14 countries). In 2011 and 2012, the largest group consisted of supporters of eco-innovation (11 and 12 countries respectively), while in 2013 again the largest group were the countries catching up on eco-innovation (15 countries). In 2016, the largest group was the group advocates of eco-innovation (17 countries) - see table. 2. In that period Poland was classified as belonging to countries catching up on eco-innovation, and it held one of the lowest positions. In 2010 it held 4th place from the end, in 2011 - the last in 2012 and 2013 - the last-but-one. The last year was a little better, because Poland there is very little missing to be in the group of countries of advocates of eco-innovation. Eco-gauge-IS for Poland has significantly deteriorated in the year 2013 (it dropped by as much as 13 points), but the next years have brought about a significant improvement in the situation. Moreover, if compared to the six least innovative countries in Europe, measured by the level of eco-innovation Eco-IS Poland has shown increasing trend in the past four years. However, this does not change the opinion that Poland is one of the least eco-innovative countries in Europe. Also we need to emphasize that Polish economy is far behind the leaders of eco-innovation, as well as those catching up on eco-innovation. Such poor results stem from the weak position of the innovative trend in the country, as well as from small resources devoted to research and development activity. (Rutkowska-Podołowska, Pakulska, 2016).

4. Conclusion

Eco-innovation is the basis of the new model of development. Each EU country should promote and encourage the introduction of eco-innovative solutions by applying the relevant laws and regulations. Polish results in this area compared to other European Union countries present themselves very badly, because Poland is one of the least eco-innovative countries in Europe. In addition, Polish indicators are not improving but deteriorating. The it is an asymmetric relation between public debt and economic growth in the EU countries. Some countries creates closed "circle" consist of Austria, Belgium, Finland. Netherlands, Italy, Spain, Denmark and Sweden (Sulikova,, Djukic, Gazda, Kulhanek, 2015).

In the second part of the article we analysed in detail the various groups of indicators and their changes in the analysed period. The group of countries with the highest level of eco-innovation has been quite stable. These are countries with a high level of overall innovation. Hence, it can be assumed that in these countries there is a good system to support innovation, especially ecological. A higher changeability occurs among countries with very low eco-innovation levels. Moreover, the countries which leave the lowest positions on the list, move

only a bit higher. These are countries with low overall innovation levels. Therefore it is recommended, in order to improve the situation in those countries, they should follow the leaders' example and apply similar systems to support eco-innovation.

Polish low eco-innovation level is due to an overall low level of innovation in the country and low expenditures on R & D. Low eco-innovation levels also may be linked to structural factors , such as cooperation between science and industry, absorbency of SMEs, or lack of financial incentives for the implementation of eco-innovation. Also, compared to other EU countries and especially the leaders of eco-innovation, Polish companies do not have sufficient capital necessary for the introduction of eco-innovation. This is all the more important as eco-innovations, like innovations in general, are characterized by high costs of implementation, and associated with high risk of failure.

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