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ENVIRONMENTÁLNE INOVÁCIE: PRÍLEŽITOSTI PRE EKONOMIKY

ENVIRONMENTAL INNOVATIONS: OPPORTUNITIES FOR THE ECONOMIES

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Predložený príspevok prispieva k lepšiemu pochopeniu podstaty ekologických inovácií a ich vplyvu na ekonomiky krajín. Článok vysvetľuje kľúčové definície ekologických inovácií. Preskúmanie úspešných prípadov v rozvinutých krajinách ukázalo, že ekologické projekty môžu výrazne prispieť k rastu zamestnanosti v zelenom a klasickom sektore ekonomiky, spusteniu inovačného procesu, zvýšeniu exportu a spôsobiť rôzne pozitívne environmentálne vplyvy. V článku bol zdôraznený vzájomný vzťah medzi prísnosťou environmentálnej politiky krajiny s rozvojom jej ekologických inovácií.[4]
Kľúčové slová: environmentálne inovácie, environmentálné tovary a služby

The present paper contributes to better understanding of the essence of eco-innovations and their influence on the countries' economies. The article explains the key definitions of eco-innovations. The review of successful cases in developed countries has shown that green projects can considerably contribute to employment growth both in green and non-green sector, trigger innovation process, increase export and cause various positive environmental impacts. In the article, the evidence of interrelationship between the stringency of environmental policy of the country with its eco-innovation development has been stressed.

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Key words: environmental innovations, environmental goods and services
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1 INTRODUCTION

Economic theory considers innovations as a process aimed to improve the competitiveness of companies, with their potential to contribute to economic growth and hike the employment opportunities of a country. A definition of innovations commonly referred to is that of Schumpeter, according to which innovations represent *„the commercial or industrial application of something new – a new product, process or method of production; a new market or source of supply; a new form of commercial, business or financial organisation"* (Schumpeter 2006). For most economists, innovations are thus first-time applications of newly acquired know-how, methods or products, new to the market or to the business itself, and can include non-technological aspects, such as changes in firm organisation or in the product design (OECD 2005).

The economic impacts of environmental degradation have become the focus of greater attention in recent decades. The aggravation of environmental problems associated with climate change and the possibility of depletion of basic natural resources has made both developed and developing countries seek (voluntarily or not) new ways to produce and consume. Furthermore, waste management should be improved.

In this scenario, the substitution or adaptation of current technological standards, towards EI, becomes an alternative to promote sustainable growth and to contribute to improvement of the quality of life of future generations.

The significance of EI is clearly being identified in the EU and worldwide. Eco-industries and EI increasingly draw attention of businesses and policymakers identically, as they assure economic, employment and environmental benefits. This is particularly important in a time of increasing economic and environmental pressures.

EI is not limited to a sector or only equated to environmental technologies, goods or services. This pervasive nature of EI makes the task of confirming its full scope more challenging using presently available statistical indicators. It also presents a particular challenge to policymakers engaged in support for EI in various policy areas.

2 ENVIRONMENTAL INNOVATIONS: DEFINITIONS

The concept of emvironmental innovations is relatively new. This could be the explanation for several distinct definitions of EI. Also, many different terms have been used to refer to it: eco-innovation, green innovation, environmnetal innovation and sustainable innovation are mostly used as synonyms (Schiederig et al. 2012).

According to Kemp and Pearson (2007), eco-innovation was the first term to appear in the literature in 1996, in the definition presented by Fussler and James: *"new products and processes which provide customer and business value but significantly decrease environmental impacts"* (Fussler & James 1996). Another definition of eco-innovation, presented by Kemp & Pearson (2007), is *"the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives"*. Related to green innovation, Driessen and Hillebrand propose that it *"does not have to be developed with the goal of reducing the environmental burden. It does however, yield significant environmental benefits"* (Driessen & Hillebrand, 2002).

Oltra and Saint Jean define environmental innovations *"as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability"* (Oltra & Sain Jean, 2009). And finally, sustainable innovation can be understood as a broader concept, which includes social aspects such as higher satisfaction of human needs and higher quality of life (Schiederig et al. 2012).

In fact, the definition of environmental innovations is close to the conventional understanding of general innovation (or non-EI): *"implementation of new, or significantly improved, products, or processes, marketing methods, or organizational methods in business practices, workplace organization or external relations"* (OECD).

In the EU Eco-innovation Action Plan, eco-innovations (European Commission) are defined as, *"any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources".*

The Eco-Innovation Observatory (EIO) determines eco-innovations as *"the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle"*. The EIO also identifies systemic eco-innovations, which can cause systemic changes in both social (attitudes, regulations, values, etc.) and technical (production processes, tools, technology, infrastructure, etc.) areas and, most notably, in the relationships between them.

The main difference between EI and general innovation is that EI is not an open-ended concept, in the sense that it is necessarily related to the reduction of

environmental damage, regardless of whether or not the EI was intentionally developed with environmental purposes.

Therefore, the definition of EI given in this paper is the definition suggested by the Organization for Economic Co-operation and Development (OECD) in 2009: *"the implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which — with or without intent — lead to environmental improvements compared to relevant alternatives"*(OECD 2009).

Indeed, the OECD uses the term eco-innovation instead of environmental innovations (OECD). But, again, as pointed out by Rennings (2000), eco-innovation is often used as shorthand for EI, and thus we understand that these two concepts can be used interchangeably.

The definition adopted emphasizes that EI not necessarily have to be developed intentionally to preserve the environment. Rather, it includes all innovations that produce some kind of environmental gain. Hence, all new processes that are more resource efficient can be considered to be environmental innovations.

According to the Oslo Manual (OECD), environmental innovations can be classified in technical environmental innovations and organizational environmental innovations. Technical environmental innovations can be distinguished between process and product (or services) environmental innovations, and organizational environmental innovations refer to new management practices focusing on environmental issues (e.g. environmental management systems). Specifically related to process environmental innovations, we distinguish between clean technologies and end-of-pipe technologies. End-of-pipe technologies reduce the emission of pollutants by adding supplementary measures to production processes, while clean technologies reduce the use of resources and/or reduce pollution generation through the use of cleaner inputs and cleaner production methods. We can understand end-of-pipe technologies as additive solutions and clean technologies as integrated and precautionary solutions.

Therefore, clean technologies are seen as superior, both in terms of reducing environmental impacts and in economic terms, when compared to end-of-pipe technologies. However, the adoption of clean technologies requires greater coordination, integrated measures and organizational support. Examples of end-of-pipe technologies are incineration plants, wastewater treatment plants, sound absorbers, exhaust-gas cleaning equipment and air quality control equipment. Examples of clean technologies are the use of recycled materials, environmentally friendly processes (e.g. replacing organic solvents with water), modification of the combustion chamber design (integrated process), among others.

Finally, product EI are products or services that give rise to low levels of environmental impact through its use and disposal, such as eco-houses, eco-buildings, phosphate-free detergents, water-based paints, environmental consulting, testing and engineering, etc.

3 ENVIRONMENTAL INNOVATIONS CONTRIBUTION TO THE COUNTRIES´ ECONOMIES

The development of EI and eco-industries embodies a meaningful economic opportunity. There is an increasing evidence EI in companies lead to reduction in costs, promoted capacity to gain new growth opportunities, as well as opportunities to enhance corporate image in the eyes of consumers. Furthermore, EI appears to be progressively economically viable. Among the EU countries, there is a significant variety of examples reflecting great possibilities of EI to achieve both economic development and improvement of living conditions.

For instance, there is a good example of creating multi-functional climate buffers and "ecological hubs" in the Netherlands. The Netherlands is a delta country and as such is acutely aware of the impacts of climate change, wedged between a rising North Sea and swelling rivers. In a joint initiative, a number of Dutch conservation organisations and the state forest board have proposed the development of multi-functional natural climate buffers, which should increase the amount of space available in this densely populated country to deal with more water while at the same time providing opportunities for recreation and innovations in housing such as floating houses. Part of this initiative is a set of projects which will restore the connections between the Netherlands' largest forest complex, the 100,000 hectares Veluwe. The other "ecological hubs" and important nature areas for the Netherlands are in the neighbouring countries of Germany and Belgium.

Over the last 20 years, eight green bridges have been constructed in the Netherlands, including the longest green bridge in the world (800 meters), with another 26 planned to be built by 2018. This has significantly increased the living space for wildlife such as red deer, wild boar, badgers, foxes and semi-wild cattle, thereby also increasing the attractiveness of the region for tourism (Raymant et al. 2009).

Another good example of the economic growth is the case of the development of eco-industry in Germany in terms of resource productivity, environmental tax reform and sustainable growth in Europe project (PETRE) (Table 1). In the course of the project, four selected cases of best practice of eco-efficient innovation in Germany were examined to illustrate the win-win potential and the role of policy intervention. The German eco tax has contributed to innovation and growth in the field of (1) low-energy buildings and (2) fuel-efficient diesel cars. In both cases, additional supporting instruments came into effect: Energy minimum

performance standards for buildings together with subsidies for energy-saving investments and a tax differentiation for new cars stimulating fuel-efficiency were additional instruments in the policy mix. (3) Recycling is dominated by regulation but in the case of industrial recycling the rapid increase of material prices has also stimulated more efficient solutions. The fourth case concerned (4) renewable energies, where monetary mechanisms – here subsidies as feed-in-tariffs – have stimulated rapid innovation. Again, a policy mix with additional instruments was relevant.

Table 1: Eco-industry: four German success stories

	Fuel-efficient diesel cars	***Low-energy buildings***	***Recycling***	***Renewable energies***
Taxes/price mechanism Other dominant instruments	Car tax, eco tax, Oil price	Eco tax, oil price Standards, subsidies	Raw material prices Regulation	Oil price Feed-in tariffs, subsidies
Growth employment	++	+	++	++
Innovation	+	+	++	++
Export	++	+	++	++
Environmental impacts	+	+	+	++

*+ = above average; ++ = far above average

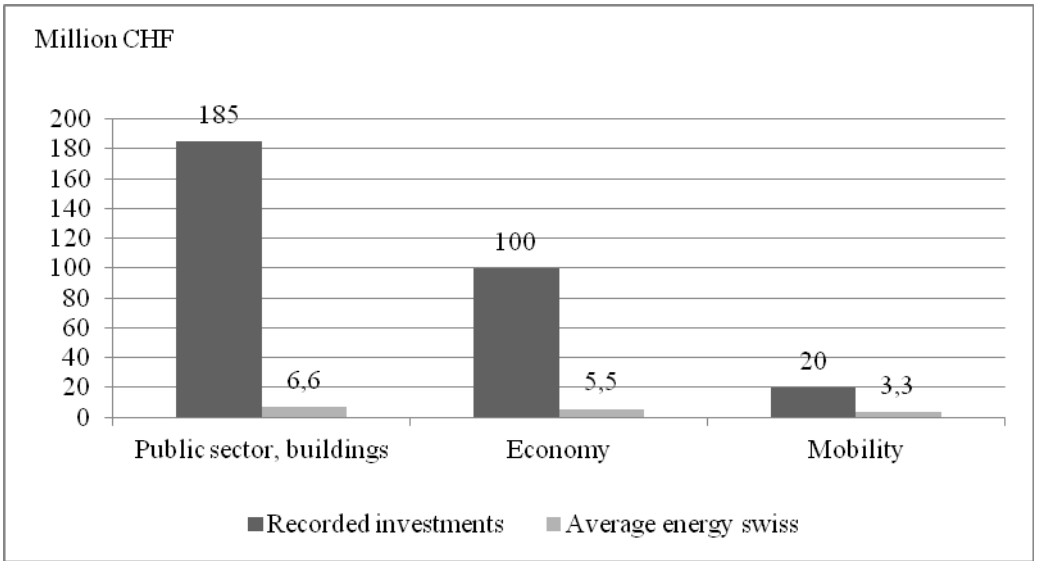
Source: Rayment et.al., 2009

Important project outcomes were:

- There is a multiple win-win potential of strict technology-based environmental policy. The cases show economic co-benefits of the growth, successful export and employment.
- Strict and calculable environmental policy measures can also stimulate innovation, especially the feed-back of the innovation cycle from diffusion to invention.
- Government intervention was essential, generally through a policy mix of different instruments. The combination of the price mechanism and regulation was crucial.
- Sustainable growth was not only policy-driven but also depended on an innovative type of industry, the resource management sector of the environmental industry.

One of the successful examples of the development of eco-industry in the non-EU member-states is also the case of Switzerland, in particular the country's success in terms of the project Energy Switzerland. Five key areas of intervention (buildings, renewable energies, energy-efficient appliances, rational use of energy and waste heat, mobility) were chosen. The programme has turned out to be a driving force for innovations in the Swiss economy. The results were impressive as in 2006, the allocation of CHF 39 billion by the Swiss Government and CHF 35 billion by the cantons triggered private investments of CHF 1065 billion in energy-related projects. Approximately CHF 315 billion were invested in energy-efficiency, mainly in the public authority and buildings sectors (Figure 1).

Figure 1: Energy Switzerland: operated investments in efficiency measures



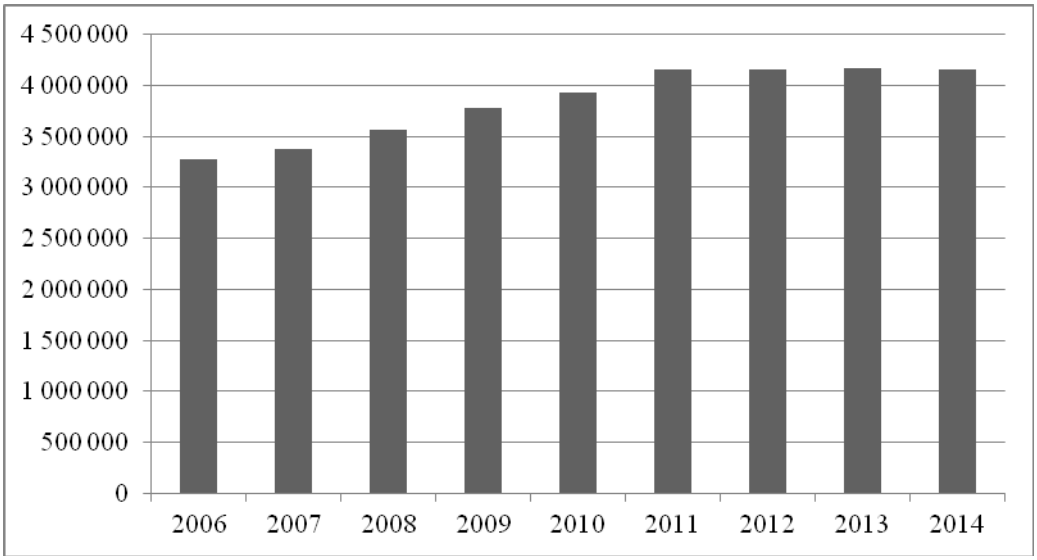
Source: Rayment et.al., 2009

The growth of the market of eco-innovative goods and services defines another broad category with an economic opportunity. There are expanding markets for environmental goods and services, as well as for cleaner production, technologies for pollution management, etc. In the EU countries, the increase in employment in the environmental goods and services sector (Figure 2), output of green sector and value added (Figure 4). Output of environmental goods and services in 2014 was assessed for EU-28 at EUR 710 billion (5.1% of EU-28 GDP) and the employment in green sector was 4.2 million full-time equivalents (FTEs).

Generally, in EU-28, a significant amount of the output in green sector – above 80% of the total – is sold on the market. A smaller proportion of green sector output is

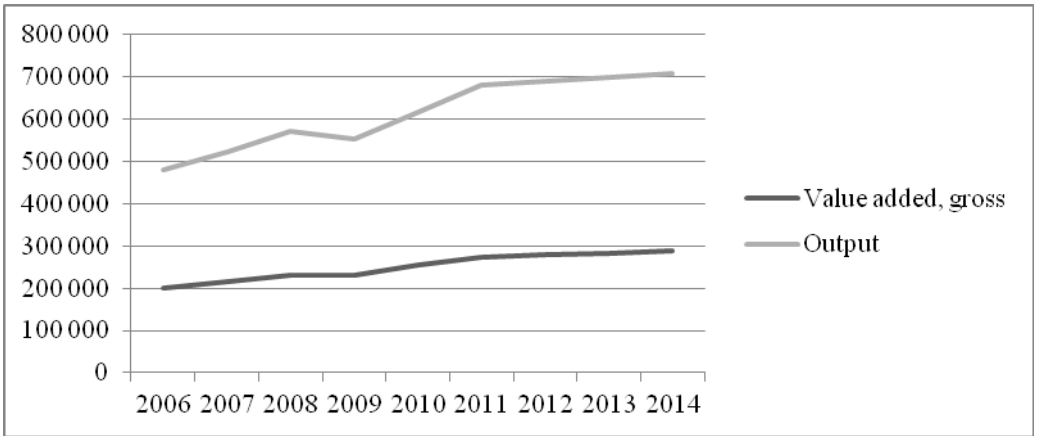
proposed for free or is provided at economically meaningless prices (as "non-market output"). Non-market output chiefly consists of environmental services supplied by general government, including supervision and regulating activities for managing natural resources (European Commission).

Figure 2: Employment in the environmental goods and services, in millions EUR



Source: Eurostat, 2017

Figure 3: Value added and output in green sector in the EU



Source: Eurostat, 2017

4 THE INTERACTION BETWEEN ENVIRONMENTAL POLICY AND ECO-INNOVATIONS

In order to assess the eco-innovation performance among the EU Member States, a composite index by the Eco-Innovation Observatory - Eco-Innovation Index

and Scoreboard has been developed. This index aims at covering the various aspects of eco-innovation by applying 16 indicators grouped into five areas.

- eco-innovation inputs contain investments (financial or human resources), which aim at generating eco-innovation activities;
- eco-innovation activities, representing to what extent companies in a selected country are active in eco-innovation;
- eco-innovation outputs, evaluating the outputs of eco-innovation activities in terms of patents, academic literature and media contributions;
- resource efficiency outcomes, putting eco-innovation performance in the context of a country's resource (material, energy, water) efficiency and GHG emission intensity;
- socio-economic outcomes, reflecting to what extent eco-innovation performance causes positive outcomes for social aspects (employment) and economic aspects (turnover, exports).

The indicators of Eco-Innovation Index are presented in the Table 2.

Table 2: Sub-indicators of Eco-Innovation Index 2016

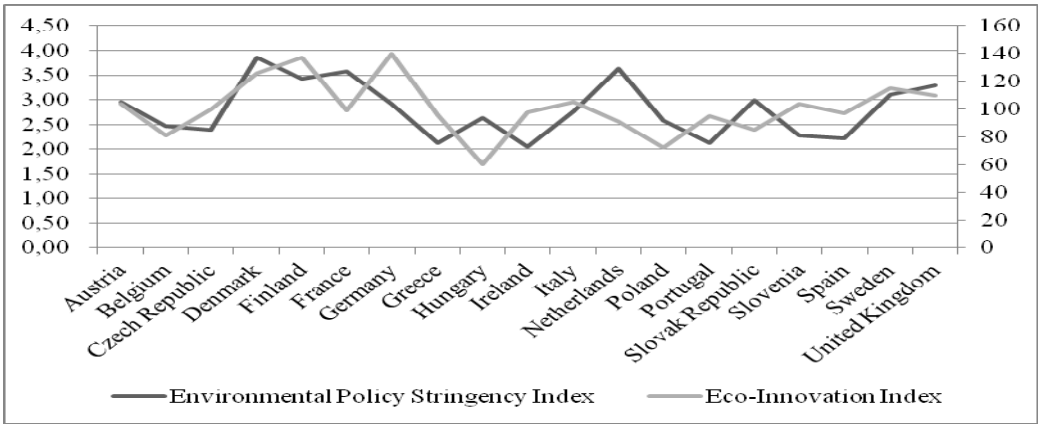
Sub-indicators	***Components***
Eco-innovation inputs	- Governments environmental and energy R&D appropriations and outlays (% of GDP) - Total R&D personnel and researchers (% of total employment) - Total value of green early stage investments (USD/capita)
Eco-innovation activities	- Firms declaring to have implemented innovation activities aiming at reduction of material input per unit output (% of total firms) - Firms declaring to have implemented innovation activities aiming at reduction of energy input per unit output (% of total firms) - ISO 14001 registered organisations (per mln population)
Eco-innovation outputs	- Eco-innovation related patents (per mln population) - Eco-innovation related academic publications (per mln population) - Eco-innovation related media coverage (per

	numbers of electronic media)
Resource efficiency outcomes	- Exports of products from eco-industries (% of total exports) - Employment in eco-industries and circular economy (% of total employment across all companies) - Revenue in eco-industries and circular economy (% of total revenue across all companies)
Socio-economic outcomes	- Material productivity (GDP/Domestic Material Consumption) - Water productivity (GDP/Water Footprint) - Energy productivity (GDP/gross inland energy consumption) - GHG emissions intensity (CO2e/GDP)

Source: authors by Eco-innovation Action Plan, 2018

For many years, it has been discussed whether environmental policy can contribute to innovation development of the countries, in particular, various results of testing Porter's hypothesis were received (Porter & Van der Linde, 1995). Generally, there is a strong evidence of positive influence of effective environmental policy of economic development of the countries. Environmental Policy Stringency Index developed by the OECD contributes considerably to evaluating this dependency (Figure 4).

Figure 4: Environmental Policy Stringency Index and Eco-Innovation Index in the selected EU economies



*the last available data

Source: developed by authors by the OECD and EIO 2017

As it can be seen from the Figure 5, the indicator of environmental policy stringency among the EU countries comes along with eco-innovation one, thus, environmental policy can trigger eco-innovations. Availability of such data considerably contributes to better understanding of these interactions, to which the further research will be devoted.

5 CONCLUSIONS

The present paper contributes to better understanding of the essence of eco-innovations and their influence on the countries' economies. Key definitions of eco-innovations were discussed. The review of successful cases in developed countries has shown that green projects can considerably contribute to employment growth both in green and non-green sector, trigger innovation process, increase export and cause various environmental impacts. The data demonstrate that green market is growing in the EU countries, as well as its value added.

The evidence of interrelationship between the stringency of environmental policy of the country with its eco-innovation development was stressed.

In the economic literature, the concept of EI is often vague. There is still no well-established definition of EI, as it often goes along with the quite numerous terms in the literature, like environmental innovations, green innovations, less-polluting innovations, sustainable innovations, etc., which often contribute to generating further confusion. But there are more and more developments in this research area, both in terms of theoretical foundations and practical findings. And nowadays it is certain that EI may contribute to sustainable pathways of development.

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