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Eco-innovation as a Factor of Sustainable Development

Ekoinnowacje jako czynnik zrównoważonego rozwoju

Tomasz Kijek, Armand Kasztelan

University of Life Sciences in Lublin,
Department of Economy and Marketing, Akademicka 13, 20-950 Lublin, Poland
E-mail: armand.kasztelan@up.lublin.pl; tomasz.kijek@up.lublin.pl

Abstract
The article discusses the role of eco-innovations in sustainable development. The first part of the paper pertains to the essence and meaning of sustainable development, with a particular attention paid to the technical dimension. Then a qualitative model of eco-innovations, which are the main factor of green growth, is introduced. The last part of the article contains the analysis of the results of CIS 2008 survey in relation to the propensity and motivations to introduce the eco-innovations, as well as the benefits from the introduction of the eco-innovations in enterprises from EU countries.

Key words: innovations, green growth, environment, environmental protection

Streszczenie
W artykule omówiono rolę ekoinnowacji w zrównoważonym rozwoju. W pierwszej części opracowania przedstawiono istotę i sens zrównoważonego rozwoju, ze szczególnym uwzględnieniem wymiaru technicznego. Następnie przedstawiono jakościowy model ekoinnowacji stanowiących główny czynnik zielonego wzrostu. W ostatniej części artykułu przeprowadzono analizę wyników badań – CIS 2008 w zakresie skłonności, przesłanek i korzyści z wprowadzania ekoinnowacji w przedsiębiorstwach z krajów UE.

Słowa kluczowe: innowacje, zielony wzrost, środowisko naturalne, ochrona środowiska

Introduction

Problems concerning the role of innovations favoring the environment (eco-innovations) in sustainable growth are a subject of an interest for the scientific community and public authorities (Smith, 2009; Newell, 2010; Dangelico, Pujari, 2010, *Towards*…, 2011; *Fostering*…, 2011). The special significance of eco-innovations in the solution of development problems at the edge of the economy and environment results from the fact that eco-innovations are integral elements of the knowledge-based economy – KBE, since they enable partial replacement of material inputs with knowledge capital, meaning that enterprises and economies become more effective, and thus use fewer resources for added value unit manufacturing (*relative decoupling*) or maintenance of the level of resource utilization and influence on the environment at a stable or decreasing level with a constant economy growth (*absolute decoupling*). It may be concluded, in European terms, that environmentally friendly innovations belong to the concept of coupling agent in a strategies of sustainable development, i.e. those based on knowledge and innovations.

Despite the indisputable potential of eco-innovations for the generation of new growth sources, there are significant barriers to the development and diffusion of new pro-environmental solutions of a demand and supply character (Johnson, Lybecker, 2009; Jaffe, Stavins, 1995; Nijkamp, Rodenburg, Verhoefl, 2001). The fact that those market forces do not provide either sufficient support for the creation and absorption of eco-innovations thus justifying the need for public intervention, during the planning and realization of environmental policy, or innovative (technological)

policy is made difficult by the occurrence of externalities (Popp, Newell, Jaffe, 2010). In the case of eco-innovations, externalities result first of all from the character of knowledge which is a public good, and from the difficulty in internalization of the negative environmental effects of economic activity (Jaffe, Newell, Stavins, 2005). Thus, selection of a suitable set of eco-innovation policy tools and their proper coordination in order to assure sustainable development remains an open issue.

Considerations on the nature and meaning of sustainable development

According to the most recent study conducted by scientists from the University of Belgrade, the most advanced countries in terms of sustainable growth implementation are Sweden and Denmark. New members of the EU, countries such as Latvia, Hungary, Estonia, Lithuania and Slovakia, are at the opposite end of this hierarchy. Poland is situated in the middle of the group, preceding, inter alia, Austria, Italy and France (Radojicic et al., 2012).

In the realization of ecological policy Poland has accepted a strategy of sustainable development according to which environmental protection is an element of good management and may be treated as being in conflict with economic affairs, and each activity contravening this order is considered as illegal. An aim of this idea is to prevent, or at least, limitat an imbalance between economic and social growth, and also between social-economic development and the natural environment (Kasztelan, 2010).

Sztumski claims that economic affairs still predominate over ecological ones but there is a clear tendency that ecology plays an increasing role in various areas of life, including economic activity. In an increasingly degraded environment, increasing number of people have become aware of the dramatic results of ecological threats and have been seriously worried about their future. The economy will always be the basis of social relations; however, the rules of economy will not be the only determinant of these relations. Economists are more and more aware of the ecologist's opinion, the economics of the needs of the environment and the protection of human life (Sztumski, 2009).

Definitely more critical opinions in this range are presented by Pawłowski, who claims that the modern world is not developing in a sustainable manner. The current generation seems to be living at the cost of the future generations, and the current direction of human civilizational development simply prevents poverty reduction due to the Earth's limited resources. The need for the prevention of excessive consumption induced by artificial needs created by *omnipresent, impudent advertisements* has become a key issue. Pawłowski puts a question of whether adverts should not be banned at the first stage of the realization of sustainable development (Pawłowski L., 2010).

The following dimensions of sustainable development in the European Union have been established in the *Amended Gothenburg Protocol*:

- environmental dimension: environmental protection – including: protection of life support systems, assurance of biodiversity, maintenance of high levels of environmental protection and its qualitative improvement, limitation of pollution, promotion of sustainable consumption and production;
- social dimension: social equality and integrity – incorporating a democratic, coherent, healthy, safe and just society; respecting basic human rights, cultural diversity; an equitable society and the fight against all forms of discrimination;
- economic dimension: welfare economics – pro-development, innovative, knowledge-based, competitive and eco-effective, assuring high living standards and full employment in the whole European Union (Review of the EU…, 2006).

The multidimensionality of sustainable development is emphasized by Pawłowski in his discussion, which presents the above mentioned classification widened to ethical, technical, legal and political levels. He also creates a hierarchy indicating the leading role of the ethical dimension (Pawłowski A., 2009).

The existing social order depends on the level of economic development, while the economy is to some degree dependent on the resources of the natural environment and the manner of their exploitation. Real human progress cannot be expected when human activity is ecologically unsustainable. Moreover, it is not possible to implement stable activity practices, when the general social welfare level is subject to a decrease.

The interrelation of stability and development suggests the existence of an optimum scale of human activity, referred to as the optimum macroeconomic scale, which is almost entirely omitted in the debate on sustainable development. It is possible to achieve this optimum when the physical level of an activity on a macroeconomic level and the qualitative character of capital created maximize the sustainable economic welfare of the nation, or more precisely, balance the net profits resulting from economic activity.

Logically, due to the need for acting in a sustainable way, macroeconomic scale needs to be a balanced scale. However, the maximal sustainable level of an activity does not have to be an optimal level, since it is demonstrated that stability is a necessary but insufficient condition for achieving the optimum.

Unfortunately, most observers propagating the idea of a limitation of national economic increase base

this argument mainly on ecological factors, and rarely on the concept that such an increase would be existentially undesirable. This is a pity for two reasons. Firstly, it is obvious that the need for the restriction of the physical expansion of macroeconomic systems, usually limited to arguments for sustainable development (*means-based arguments*), also concerns traditionally perceived development (*ends-based arguments*). Secondly, since the costs of non-sustainable activities will be to a high degree borne by future generations, the probability of the realization of proper reforms will be higher, the present generation will sooner understand the negative consequences of forced growth strategies.

In particular, two issues seem to be essential for achieving sustainable development on a global scale. The first is the fight against poverty. This is not only a problem of moral imperative but also a condition essential for human development, given that higher level needs cannot be met without the prior meeting of lower level basic needs.

The second problem concerning the way of achieving sustainability is the control of population growth. On the one hand, taking into account the fact that all human development is dependent on a fair allocation of capital per inhabitant, a higher population means the need for gathering suitably higher capital resources. Increasing capital accumulation may finally lead to the natural ability of ecosphere for self-restoration to be exceeded (Lawn, 2001). On the other hand, however, the problem of the control of population growth cannot be applied to Europe, a fortiori to Poland, since one of the still unsolved difficulties is the problem of low demographic growth and ageing societies in Europe. In such a situation, there is the need for a change in European demographic policy, which should lead to an increase in the quantitative and qualitative state of the population, which may be an antidote to negative economic consequences of ageing and depopulation processes in Europe.

Despite unprecedented economic growth, the world has started on a course leading to the depletion of resources and serious social crises and traditional methods of problem solving appear to be insufficient. Something must change in the philosophy of development, if society wants to reverse these negative tendencies. Albert Einstein wrote: *Today problems will not be solved, if 'we still' think in the way prevailing at the moment these problems occurred.*

Long-term stability and social prosperity are based on healthy and efficient populations. Societies functioning in conditions of anxiety, poverty and disease will not be capable of long-term development: social prosperity and economic prosperity are in a symbiosis, and the whole *game* depends on the healthy biosphere we exist in (Strange, Bayley, 2008).

Examining the reasons for the current situation, it should be emphasized that only the development of industry and the service sector have become direct determinants of change. Therefore, the technical dimension is a very important aspect in the implementation of sustainable development.

Innovations may help in the realization of environmental goals in a less costly manner, and thus contribute to developmental sustainability. For example, some innovations may lower the costs of decreasing environmental pollution, which in turn favors an increase in social prosperity. The same quality of an environment may be reached with lower engagement of production factors aimed at pollution reduction. On the other hand, the environment quality may be improved with the same amount of production outlay.

The role of eco-innovations in green growth theory

The eco-innovation concept appeared in the 1990s and was introduced, for the first time, to environmental economics nomenclature by C. Fussler and P. James in their book *Driving Eco-Innovation: A Breakthrough Discipline for Innovation and Sustainability* (Fussler, James, 1996). The authors defined eco-innovations using alternatively the terms sustainable innovations, as new products and processes creating value for enterprises and clients, and reducing (negative) environmental effects.

A similar definition to the above mentioned was introduced by R. Kemp and P. Pearson who accepted that eco-innovations are production, accommodation, and utilization of product, process, service or management method which are new for the enterprise, and which during their life cycle allow for a reduction in the risk of environmental pollution or other negative effects of resource use, when compared to alternate applications (Kemp, Pearson, 2008).

In turn, according to the position of the European Commission, eco-innovation is a new or substantially improved product (manufacture or service), process, organization or marketing method, which reduces negative influences on an environment and/or optimize the use of resources (*Better...*, 2011).

Given the presented approaches for the definition of innovations beneficial for the environment, three dimensions of the analysis of the eco-innovative activity of market entities may be distinguished, namely:

1. Target: selection of subject range of eco-innovations, i.e. product, process, marketing or organizational method, institution.
2. Mechanism: way in which the aims are realized, i.e. 1) modifications in the form of small adjustments in the product or process, 2) re-design involving considerable

changes in existing products, processes, organizational methods, 3) introduction of substitutes for previously offered products or services, 4) design and implementation of entirely new products, processes or organizational and marketing methods.

3. Impact: effect of eco-innovation on the environment, where the range of influence spreads from incremental environmental improvement to total elimination of harmfulness for the environment (*Eco-innovation*..., 2009).

A useful method illustrating the course and conditions of eco-innovative processes is the qualitative model of eco-innovation presented by M. Kanerv, A. Arundel and R. Kemp. The model includes relationships between input factors in innovative processes (i.e. R&D, patents, investments in innovative activity) and the results of eco-innovation implementation on a micro and macroeconomic level. Moreover, the model includes the influence of factors stimulating innovative activity in the form of mechanisms of environmental regulation. Finally, according to the model assumptions, eco-innovations lead to assumed economic and environmental effects, e.g. decrease in production material consumption, reduction in pollution and greenhouse gas emission (Kanerva, Arundel, Kemp, 2009). It should be noted that the occurrence of effects of eco-innovations is a special object of interest of green growth in terms of the analysis of environmental problems and the search for a sustainable paradigm of economic development.

Eco-innovations are consistent with the green growth concept articulating the need of the support of pro-growth processes, with the assumption that natural assets will still be the source of environmental resources and services forming social welfare (*Towards*…, 2011). In such a situation, green growth is a narrow category and may be perceived as a subset of sustainable growth. This results from the fact that green growth has an operational dimension and is limited to the dimension of economy-environment interactions in the sense of investment, innovation and competitive processes, which do not violate existing ecosystems. Green growth strategies are directed at the creation of premises for consumers and entrepreneurs for pro-environmental behaviors, which should result in a flow of production factors (capital, work, technology) towards more ecological activities.

Eco-innovations are a basic source of green growth, since the introduction of innovations profitable for an environment allows for an outward shift of the production-possibility frontier without the need for natural capital depletion. Growth strategies based on eco-innovations require the application of various instruments and tools supporting market mechanisms. Market failure in the case of eco-innovations results first of all from the occurrence of externalities being a matter of issue for environment pollution (Rennings, 2000; Popp, Newell, Jaffe, 2010). Problems with the internalization of environmental externalities, such as making them fully respected in economic calculations of manufacturers and consumers of goods, lead to suboptimal levels of innovations induced by the market.

According to the theory of induced innovations formulated by J. Hicks, an increase in the price of production factor is an impulse for the design and the implementation of inventions allowing the economization of an application of a relatively more expensive factor (Hicks, 1932). The lack or improper valuation of externalities, e.g. an overly low fee for pollution emission, may lead to limitation of work on innovations allowing environmental problems to be solved. It is worth emphasizing that according to the reasoning of I. Wing, the key issue in an analysis of the influence of solutions allowing internalization of negative externalities on innovative behaviors of the enterprises, is the need to respect the degree of substitution between *dirty* and *clean* production factors (Wing I., 2006).

Paradoxically, even the occurrence of a decrease in the costs of production factors induced by inventions does not constitute sufficient condition for absorption and diffusion of innovations, an example of this are energy-saving technologies which appear to be cost-effective, but are not commonly used (Gillingham, Newell, Palmer, 2009). This observed aberration may be explained by the occurrence of the phenomenon of information asymmetry in the field of the assessment of the environmental benefits of specified technological solutions, as well as network externalities, or dynamic economies of scale.

The dominant opinion in the literature, i.e. that a stronger influence of environmental instruments of a market character on eco-innovations, e.g. taxes or tradable emission allowances, when compared to instruments of a *command and control* type, e.g. environmental performance and technology standards, is not unequivocally confirmed by the results of empirical studies (Johnstone, Hascic, Popp, 2010). Thus, the key issue for the enforcement or inducement of innovations is not the form of regulations, but their range and restrictiveness (Lanoie et al., 2011), and, as proved by R. Innes and J. Bial, technological leaders prefer stricter environmental regulations, since such requirements cause an increase in costs for technologically less advanced competitors (Innes, Bial, 2002).

An issue as significant as the analysis of barriers and premises for the introduction of eco-innovations is the measurement of the effects of the implementation and diffusion of environmentally friendly innovations. This is a difficult task, since not only the eco-innovation effects on the micro level need to be taken into consideration, but also the effects in the context of the quality of the

whole environment and society should be considered.

Environmentally, an assessment of eco-innovation effects on a micro level is usually limited to an analysis of changes in energy efficiency, e.g. measurement of fuel consumption by vehicles due to the application of advanced technologies (Pakes, Berry, Levinsohn, 1993).

In order to determine the potential possibilities of eco-innovations in the field of a leveling of the relationship between economic growth and degradation of the natural environment, integrated 3E models are the most often used (Energy, Economy, Environment). Particular models applied in analysis and simulations, inter alia, of climatic changes, resource availability etc., differ mainly in their approach to the modeling of technical progress, which may be of an endogenous or exogenous character (Kijek, 2010; Popp, Newell, Jaffe, 2010).

Socially, the effects of the implementation of novel pro-environmental solutions are usually considered with respect to improvement of social welfare as a result of changes in employment levels on the labour market. In such a scenario, eco-innovations may be treated as a way to overcome poverty, under the assumption that as a final effect they contribute to the creation of new workplaces, and thus an increase in societal income levels. It should be emphasized that any relationship between the introduction of eco-innovations and employment levels is not unequivocal and depends mainly on the kind of eco-innovations implemented – process or product (Pfeiffer and Rennings, 2001).

In the case of the implementation of process eco-innovations both their positive and negative effects may be demonstrated by the range of demand for labour coming from market agents. Thus, rationalizations in production processes (e.g. production automatization) often leads directly to increased labour productivity, which with constant production levels means a reduction in employment. On the other hand, increases in labour productivity contribute to an improvement in the cost competitiveness of market agents, and thus indirectly is reflected in an increased demand for enterprise products and thus labour.

In turn, introduction of *end-of-pipe technologies* may concurrently cause a need for the employment of additional, specialized staff for new appliance operation, and also lead to a decrease in cost competitiveness, and in consequence to a decrease in demand for enterprise products and workplace reduction. Thus, the total effect of eco-innovation implementation with respect to the change in demand for labour depends on the strength of the relationship between opposite partial effects. Empirical studies conducted by J. Horbach and K. Rennings demonstrate that eco-innovations connected to implementation of more effective technologies integrated with production leads to an increase in enterprise competitiveness and employment levels as opposed to the effects of the introduction of *end-of-pipe technologies* (Horbach, Rennings, 2012).

With regards to product eco-innovations and their influence on creation of new workplaces, it should be noticed that the process of the introduction of environmentally friendly innovative products is connected to the creation of new economy sectors included in eco-industry. According to the results of the studies presented in the *Eco-innovation Scoreboard*, the number of people employed in eco-branches is increasing in Europe, and also export of these sectors of the European economy is increasing (The Eco-innovation…, 2011).

Ecological innovations in EU countries

In the light of the theoretical considerations presented above, the determination of the inclination for eco-innovation application as well as the motives and effects of their implementation in enterprises from European Union countries are interesting cognitive issues. The analyses presented below are based on the results of examinations of innovative activity in the industry and services sectors in the years 2006-2008, based on a questionnaire and the methodology of an examination of the *Community Innovation Survey 2008*. Innovations bringing benefits for an environment were examined for the first and, simultaneously, last time in such a wide range in the 2006-2008 edition of the study.

Among the member countries of the EU, the highest inclination for innovation realization (see Fig. 1) in 2008 was noted in Germany (79.9 % of all enterprises) and Luxembourg (64.7 %). These were the only member countries of the EU in which over 60 % of enterprises were accepted as innovative ones. The mean for EU-27 countries (except Greece) was 51.6 %. The lowest level of innovativeness was noted in Latvia (24.3 %), Poland (27.9 %) and Hungary (28.9 %). These were the only member countries in which the percentage of innovative enterprises was below 30 %.

Benefits for the environment resulting from innovations may occur during the process of the production of goods and services or at the stage of making use of goods or services by final users. Table 1 presents the percentage of innovative enterprises which recorded environmental profits. Six kinds of profits connected to the production of innovative goods and three kinds of profits connected to their use are presented.

Among the production benefits resulting from the introduction of eco-innovations, the frequent decrease in energy consumption and increase in recycling level were mentioned, with the exception of Estonia and Lithuania where the most often occurring environmental benefit was a decrease in resource and material consumption.

Figure 1. Proportion of innovative enterprises, 2008 (in % of total enterprises). Source: own calculations based on Eurostat data.

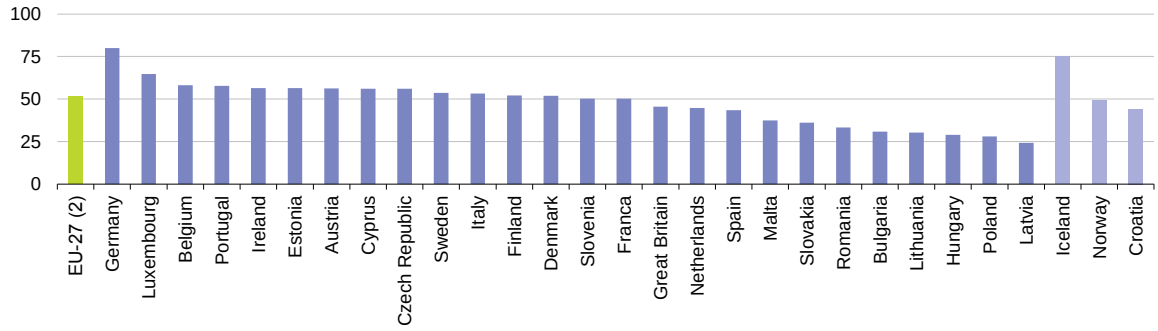

Table 1. Innovations with environmental benefits – proportion of innovative enterprises introducing innovations with specified benefits, 2008 (% of innovative enterprises). Source: Eurostat.

Country	Environmental benefits from the production of goods or services within the enterprise						Environmental benefits from the after sales use of a good or service by the end-user		
	Reduced material use per unit of output	Reduced energy use per unit of output	Reduced CO_2 footprint (total CO_2 production)	Replaced materials with less polluting or hazardous substitutes	Reduced air, water, soil or noise pollution	Recycled waste, water, or materials	Reduced energy use	Reduced air, water, soil or noise pollution	Improved recycling of product after use
Belgium	22,8	30,3	26,6	25,7	28,8	35,7	27,0	20,8	24,0
Bulgaria	11,6	13,6	6,0	10,0	10,5	8,6	8,8	8,1	6,1
Czech Republic	28,6	33,1	17,1	20,1	27,0	41,3	30,7	27,5	29,7
Denmark	:	:	:	:	:	:	:	:	:
Germany	38,8	46,4	38,5	25,5	41,7	41,2	44,0	35,5	30,8
Estonia	27,4	11,7	13,4	22,3	10,0	10,6	15,0	10,2	10,4
Ireland	28,2	33,5	33,1	30,9	27,1	54,3	33,1	23,8	37,1
Greece	:	:	:	:	:	:	:	:	:
Spain	:	:	:	:	:	:	:	:	:
France	27,6	28,2	21,0	26,5	24,7	38,8	23,9	17,6	17,7
Italy	13,0	16,5	13,4	15,3	23,8	25,8	23,5	23,5	23,3
Cyprus	10,8	13,6	8,6	8,2	13,5	13,2	5,4	6,1	5,6
Latvia	19,9	23,5	11,5	19,7	27,9	14,3	21,7	27,9	12,6
Lithuania	29,3	29,3	20,7	25,6	21,3	18,2	22,9	20,0	18,7
Luxembourg	20,8	24,8	27,1	26,6	22,6	41,4	30,1	18,3	29,2
Hungary	31,8	36,3	17,3	29,4	27,6	26,1	19,1	16,9	13,4
Malta	23,0	27,0	13,7	19,8	12,5	27,8	19,8	6,9	16,9
Netherlands	17,1	21,1	15,9	22,3	19,3	21,5	19,8	15,9	13,8
Austria	26,9	30,7	25,1	27,4	30,9	23,6	28,9	23,1	17,2
Poland	23,5	25,3	16,1	24,9	28,2	23,7	24,8	25,3	17,0
Portugal	37,8	41,5	31,5	41,3	46,2	58,5	39,1	38,8	41,8
Romania	31,3	32,8	22,7	21,1	31,5	32,3	30,3	29,6	20,1
Slovenia	:	:	:	:	:	:	:	:	:
Slovakia	20,2	23,7	9,2	19,5	21,9	29,3	26,2	21,0	19,0
Finland	32,0	32,9	25,9	24,0	22,8	32,2	33,0	20,3	22,2
Sweden	24,0	28,6	23,7	24,2	23,0	21,8	28,1	23,6	18,5
Great Britain	:	:	:	:	:	:	:	:	:
Croatia	28,8	32,7	18,1	30,4	39,2	36,1	32,6	36,1	31,2

Table 2. Motivation to introduce environmental innovations – proportion of innovative enterprises reporting specified motivations, 2008 (% of innovative enterprises). Source: Eurostat.

Country	Existing environmental regulations or taxes on pollution	Environmental regulations or taxes expected to be introduced in the future	Government grants, subsidies or other financial incentives for environmental innovation	Current or expected market demand from customers for environmental innovations	Voluntary codes or agreements for environmental good practice within sector
Belgium	20,1	16,3	7,8	13,6	26,1
Bulgaria	8,6	5,4	2,4	4,0	5,2
Czech Republic	40,6	26,8	9,5	13,6	24,3
Denmark	:	:	:	:	:
Germany	20,8	19,0	7,7	18,3	18,8
Estonia	24,1	19,3	4,4	17,2	26,3
Ireland	27,2	19,9	9,1	25,3	28,5
Greece	:	:	:	:	:
Spain	:	:	:	:	:
France	24,0	15,0	6,4	17,6	23,9
Italy	22,9	16,3	12,8	13,0	14,8
Cyprus	7,2	5,3	3,1	3,9	13,1
Latvia	19,1	11,3	8,3	13,6	34,0
Lithuania	39,3	31,8	12,5	26,8	24,5
Luxembourg	10,1	11,4	4,4	15,0	43,2
Hungary	41,3	34,5	4,1	31,9	32,8
Malta	23,8	23,8	8,1	11,3	13,3
Netherlands	10,5	9,2	6,7	13,8	12,7
Austria	:	:	:	:	:
Poland	24,1	16,1	4,9	12,7	13,3
Portugal	31,6	18,3	7,0	21,9	42,0
Romania	37,6	20,4	9,3	17,6	17,7
Slovenia	:	:	:	:	:
Slovakia	37,0	27,3	4,7	11,7	18,9
Finland	15,8	17,8	6,2	30,3	29,1
Sweden	8,4	12,3	2,7	14,7	15,1
Great Britain	:	:	:	:	:
Croatia	35,7	28,0	8,4	19,6	30,3

In Latvia, Austria and Poland (and also in Croatia) a significant decrease in pollution emission was demonstrated, while in Holland a considerable utilization of less pollutogenic or dangerous materials was emphasized.

Among the utilitarian benefits, decreased energy consumption was demonstrated the most often, but on Cyprus, Latvia and Poland (and also in Croatia) a significant decrease in air pollution was emphasized, while in Ireland and Portugal an improvement in the area of the recycling of products.

The most often noted reason for the introduction of ecological innovations by enterprises were existing environmental regulations, fees and taxes connected to pollutant emission and voluntary codes or agreements aimed at implementation of so-called good environmental practices (Table 2).

In Holland and Finland, the main motive for changes was the current or expected demand from customers. In turn, expected future environmental regulations or taxes were cited as a source of motivation on Malta.

It is worth noting that among five motivation factors, which could have been demonstrated by the enterprises, the availability of government financial incentives for environmental innovations was chosen the least often.

Summary

The theoretical considerations and the analysis of empirical studies presented above allowed for the formulation of the following conclusions:

1. The problems of eco-innovations are not emphasized enough in current discussion on sustainable development. The need for wider scientific discourse on the issues of the conditions of the implementation and the absorption of environmentally friendly innovations results from the fact that they are a basic source of green growth connected to the undertaking of activities directed towards economic growth and development, maintaining the environmental functions of natural assets shaping social welfare.

2. In the presence of existing barriers to the implementation and the diffusion of eco-innovations (intensified by market failure), the key issues for the creation of suitable environmental are regulations stimulating market agents for the absorption of eco-innovations. Measurement of the effectiveness of the application of tools creating conditions for eco-innovation implementation requires a quantification of their effects, which is the task with a large degree of difficulty due to the need for measurement of net profits taking into account direct and indirect effects.
3. In the social sphere, the effects of the implementation of eco-innovations may be considered from the point of view of changes in social welfare levels. On the one hand, the introduction of the eco-innovations of a product character causes the creation of new economy sectors attached to eco-industry, which is reflected in the growth of employment and an improvement in the material situation of society. On the other hand, the implementation of process eco-innovations may have both positive and negative impacts on the demand for labour, while the final effect depends on the relations of partial effects. The positive effects of process eco-innovation implementations include reduction in manufacturing costs, which may be indirectly reflected in an increased demand for enterprise products, and also in increased demand for labour. It should be emphasized that an increase in production levels (cost decrease) connected to the introduction of new technologies may concurrently negatively affect demand for labour resulting from the phenomenon of work substitution by capital. Therefore, not only technological, environmental and economic aspects should be considered in discussion about eco-innovation process in the context of sustainable development, but societal aspect should be taken into consideration as well.
4. Analysis of the results of the study of the innovative activity of enterprises – CIS 2008 demonstrates, that the highest inclination to eco-innovation realization was noted in Germany and Luxembourg, while the lowest level of eco-innovativeness was noted in Latvia, Poland and Hungary. Among the production benefits resulting from the introduction of eco-innovations, the frequent decrease in energy consumption and increase in recycling levels were mentioned. In turn, among utilitarian benefits, decreased energy consumption was the most often demonstrated. The most often noted reason for the introduction of ecological innovations by enterprises were existing environmental regulations, fees and taxes connected to pollution emission and voluntary codes or agreements aimed at implementation of so-called *good environmental practices.*

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