PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2022, 17(2):197-203
DOI: 10.35784/pe.2022.2.21

Eco-innovation and Sustainable Development

Ekoinnowacje I zrównoważony rozwój

Silvana Ilic*, Tanja Petrovic, Gordana Djukic*****

**Megatrend University Belgrade, Faculty of Management in Zajecar,*
Park šumakraljevicab.b., 19000 Zajecar, Serbia
E-mail: silvana.ilic@fmz.edu.rs, ORCID: 0000-0003-0634-5029
*** Megatrend University Belgrade, Faculty of Management in Zajecar,*
Park šumakraljevicab.b., 19000 Zajecar, Serbia
E-mail: takica91@yahoo.com, ORCID: 0000-0002-8226-117X
****University of Belgrade, Faculty of Economics, Kamenička 6,11000 Belgrade, Serbia*
E-mail: (Corresponding Author): gordanadkc048gmail.com,
ORCID: 0000-0001-5419-0725

Abstract

The paper aims to encourage the creation of innovation policy by individual states and state institutions, management of companies in the energy sector, with the synergy of national and interstate institutions, to apply an integrative approach to eco-innovation. The purpose of this paper is to expand the existing potential for the development of eco-innovation in the business sector and industrial enterprises. The method used is based on the descriptive method, synthesis, and analysis of data collected by international organizations, as well based on research in academic circles. Appropriate incentives from governments to innovate green business models, to reduce greenhouse gas emissions (GHG), would ensure a higher level of environmental quality, adequate quality of life for all people, and a greener future. To achieve the goals, future directions of development should be focused on the development of technology and knowledge, with an adequate policy of creating a green strategy for decarbonization and sustainable development.

Key words: eco-innovation, GHG, sustainable development, green energy, natural environment
Słowa kluczowe: ekoinnowacje, gazy cieplarniane, zrównoważony rozwój, zielona energia, środowisko naturalne

Introduction

The development of energy production and the introduction of new ones is causing increasing environmental pollution due to CO_2 emissions, which are in the largest percentage of greenhouse ingredients. The large amount of gas produced by burning fossil fuels – coal, oil, and natural gas, causes air pollution, which is a serious threat to humanity, quality of life, and sustainable development. The consequences of the use of fossil fuels are reflected in the degradation of the natural environment, climate change, human health and pose a serious threat to future generations. Numerous problems of sustainable development from the aspect of ecology are related to the environment, to the depletion of stocks of natural resources, i.e. fossil fuels, the impact on global warming, environmental pollution, waste, growing dissent towards the environment, and human health. For these reasons, the United Nations has defined global goals of sustainable development (SDG), which are political goals for the future that are in line with nature, sustainable energy system, and human needs. The UN Agenda 2030 document emphasizes the importance of sustainable energy, which is defined in SDG 7: *Ensure access to affordable, reliable, sustainable and modern energy*. In SDG 9 the global request is highlighted: *Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*. The SDG 13. calls for combating climate change and mitigating climate catastrophic consequences: *Take urgent action to combat climate and its impacts*. Sustainable development implies a responsible attitude towards the environment. The essence of sustainable development and the highest goal of development is the harmonious relationship between man and nature. The Sustainable

Development Strategy emphasizes the need for a harmonious relationship between all human beings, as well as between humanity and nature. In 1987, in the document *Our Common Future* of World Commission on Environment and Development (WCED) was given the definition: *Sustainable development is development that meets the current needs of society without compromising the ability of futuregenerations to meet their own needs*. Sustainable development includes three dimensions of sustainable development: economic, environmental, and social: 1. an economicsystem is sustainable when agricultural and industrial production is balanced and continuous; 2. an ecologicalsystem is sustainable when non-renewable resources are not endangered and their excessive exploitation is not applied; the stability of biodiversity, atmosphere, and other ecosystems is maintained; 3. the social system is sustainable when it provides adequately social services, such as health (SDG 3: *Ensure healthy lives and promote well-being for all at all ages*), education (SDG 4:*Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*, etc. (Rajković, 2020). According to Udo, Pawlowski (2011) sustainable development can be viewed from three aspects of sustainability: 1. social sustainability (global human rights, human transparency, human development, human survival, income equity, human freedom), 2. technological sustainability (energy efficiency, industrial balance, research resources) and development, basic human existence, disaster management), and 3. environmental sustainability (clean air, water use, land conservation, environmental protection, resource use, sanitation/health) (Udo, Pawlowski, 2011). There are expectations in the world that the application of appropriate international legal regulations and standards in the field of environmental protection will reduce the burning of fossil fuels. It is estimated that a large number of premature deaths will be achieved and billions of euros will be saved, increasing energy efficiency in the use of fossil fuels, i.e. reducing carbon dioxide emissions, which is a global environmental problem (Stepanović, Kokić-Arsić, 2011).

1. The concept of eco-innovation

The concept of eco-innovation is the development with the application of innovative business models and innovative business strategies, with a top-down management process, to enable sustainable development based on the impact assessment on the production cycle, in cooperation with stakeholders. Along with eco-innovations, new solutions and connections between products (goods and services), production processes, organizational structure markets are modified and adopted, to improve the quality of business of a company or enterprise and competitiveness.

Unlike environmental technologies, technological eco-innovations are all innovative environmental technologies that are more efficient and have a less harmful effect on the environment than existing alternatives. In addition to technological eco-innovations, there are other types of eco-innovations, such as: 1. production of innovative products (insulation materials, compostable plastics, etc.); 2. innovative production processes and methods, e.g. car clubs, use of interchangeable chemicals; 3. development of new resources in the supply chain, e.g. use of waste that is in the second production process of raw materials; 4. collaborative recycling, etc. (OECD, 2009). Calza et al., (2017) emphasize that green eco-innovations are important for sustainable environmental protection, through which improvements in production processes and product portfolio are achieved. The effect of innovative green products is reflected in the achievement of environmental goals. Innovations can be applied to the green product portfolio in the green industry; in recycling and storage companies or sectors; in companies for the production of renewable energy sources, but also in companies that do not belong to the green industry, i.e. in a portfolio of non-green products.

Innovations can be technologically related to institutional or organizational innovation, or marketing, or be guided by the interests of shareholders or stakeholders. There are innovations according to the specific purpose: 1. environmental technologies – which are for wastewater treatment, i.e. pollution control, 2. green energy technologies, for cleaner production, 3. organizational innovations which are for new methods and management systems related to protection environment and production and products, 4. innovations of green products and services that contribute to the environmental benefits of green development (Kemp, Pearson, 2007). The authors of Calza et al. considered the importance of eco-innovation. They pointed out that all technologies that manage pollution (air control, water control, waste disposal, monitoring equipment, solar energy, hydropower, environmental protection equipment) and processes and ways to more efficiently manage water supply, energy, saving technology, represent green energy that is, ecological green technology.

Based on a case study, Calza et al., suggest that cooperation of large companies with other business partners and companies is important for the sustainability of eco-innovation in the green growth sector, i.e. useful for achieving better environmental performance. In addition, cooperation facilitates access to innovative business models for small and medium-sized enterprises, to develop technological or green innovations at lower costs. Eco-innovation management should enable all firms to access different technological competencies and share knowledge through digital networks to develop a green innovation process (Calza et al., 2017). According to Vicanova et al. (2017), eco-innovation shows significant progress towards sustainable development with reduced use of environmental resources, including water and energy, through their more responsible use. The concept of eco-innovation, according to Kemp, Pearson (2007), is a broader concept than the concept of technological innovation, which is often equated. However, technological innovation is only one aspect of eco-innovation, while eco-innovation is viewed

from multiple aspects of innovation and technology (Kemp, Foxon, 2007). Eco-innovation means technological, organizational, or institutional innovation and development that takes place by companies or non-profit organizations, where there are conditions for trade in the markets (Cai, Zhou, 2014).

2. Drivers of eco-innovation and sustainable growth

Internal drivers, according to Cai, Zhou (2014), are the ability, i.e. the capacity of the company to introduce eco-innovation: 1. physical capital, i.e. the internal knowledge base and education of employees; 2. investment in research and development R&D; 3. technology 4. environmentally friendly products that are acceptable to the market: such as the design of green products; 5. organizational activities: reduction of pollution sources and recycling, which has positive effects on reduced costs; 6. activity management and management's commitment to environmental innovation, because it influences companies to align their business with social norms, values, and expectations for building a *green image* of the company. The integrative capacity of the company includes internal and external drivers that are connected, where the external regulatory framework has a positive impact on the development of eco-innovation (Cai, Zhou, 2014).

External drivers are external pressures that include environmental regulations, green requirements, and competitiveness. The competition of successful companies, which have innovative products, technologies, or equipment, encourages other companies to apply innovative technologies to their internal capabilities. External pressures of eco-innovation competition are driving other companies to improve their environmental performance, i.e. product quality, which has positive effects on the growing demand for eco-innovation to improve their innovative capabilities. External competitive pressures that require improved environmental performance and product quality are contributing to the growing demand for companies' internal eco-innovation capabilities (Hicks, Dietmar, 2007).

According to Stajić et al., 2021., there are significant concerns in the world about the emission of greenhouse or carbon dioxide caused by the use of fossil fuels. Natural gas, i.e. green gas is the main source of energy in many economies in the world because it is a cleaner source of energy than other fossil fuels, such as oil and coal. It has an environmental advantage over other fossil fuels, and because of that replaced oil at the beginning of the twenty-first century (Stajić et al., 2021). To make innovative progress in the industrial sector and the environment, social awareness and responsibility are important. If external pressures on companies/enterprises are greater, if they are more exposed to external pressures, companies/enterprises will have a higher level of awareness and a greater willingness to allocate more financial resources, to improve their business and environmental performance. Cleaner products, an adequate strategy for cleaner production, and pollution prevention contribute to accelerated sustainable development (Hicks, Dietmar, 2007). Financing is a key driver for new innovative ventures, as it drives a company to undertake innovative projects, which has positive implications for its productivity and efficiency, for the working capital of the company, and market satisfaction. Due to insufficient financial resources, there is a financial gap between companies, where small companies, which are in the initial phase of innovation development, are exposed to high risk in the capital market (Madžar, 2021).

Sotiriadis et al. (2018) suggest that the driving factors of eco-innovation are: customer requirements, legislation, and regulations, company reputation, savings in the form of reduced operating costs, corporate social responsibility, and commitment to successful results. Positive results are achieved through appropriate financial performance and investments for eco-innovation. In addition, successful companies are motivated to adopt eco-innovation and have better business performance than non-eco-innovation companies that are *non-eco-innovative* (Sotiriadis et al., 2018). Bossle et al. (2016), pointed out that in addition to motivation, in academic circles, the regulatory framework and efficiency are mostly cited as very important driving factors. Besides, government incentives and the green market with innovative products are emphasized, as conditions are created for the green market with eco-innovation to become a motivation for many other companies. External factors have a positive impact on internal capabilities such as knowledge and skills and motivation, which creates the conditions for the adoption of eco-innovations that have a positive impact on company performance (Bossle et al., 2016).

Analyzing the interrelationships of: 1. physical resources, competencies, and dynamic capabilities of enterprises – RCCs (Resources, competencies, and dynamic capabilities), and 2. eco-innovation (EIs), Kiefer et al. (2018), found that different RCCs have different effects on different types of EIs; that radical and systemic EIs differ from those that develop successively. The drivers are considered to be physical RCC, green supply chains, corporate culture, market attraction, and technology advancement. Kiefer et al., distinguish the following eco-innovations according to the type of EIs: 1. Systemic, characterized by a high degree of environmental innovation, leading to increased competitiveness and greater environmental benefits; 2. Externally managed EIs, which were introduced under pressure from society and regulatory measures and have non-specific characteristics in the field of ecology and technology; 3. Radical and technological EIs, which under radical and technological pressures of science and technology have abolished obsolete technology and introduced radically innovative technological solutions; 4. Continuously improved EIs, created within the company, have improvements in business solutions and non-specific environmental and technological characteristics; 5. Environmentally efficient EIs are those that affect the increased efficiency of a product, service, or process and which contribute to the benefits of a better environment and sustainable development.

Fernando and Wah (2017) stated that eco-innovation has a positive impact on the environment, based on research by Malaysian company GreenTech, where they found that there is a positive correlation between the dynamics of eco-innovation and environmental impact. Regulations, technology, and market orientation have positive effects on life, i.e. resource savings, pollution prevention, and adequate recycling (Yurdaku, Kazan, 2020). The business conceptual model of eco-innovation indicates that eco-innovation contributes to improving the financial performance of the company, which includes: 1. economic performance, such as market, profitability, quality of new products, and 2. cost performance, such as energy and materials costs per product of the enterprise. The authors assessed the environmental impact as part of resource savings, pollution prevention, and recycling in the observed 500 companies in Turkey as a developing country. Thus, Yurdaku and Kazan proved that the introduction of eco-innovation reduces material costs and reduces energy consumption, thereby reducing pollution and affecting the improved quality of life and the environment and sustainable development.

Yawson (2009) pointed out that innovation models generally do not include a comprehensive view, as policy attention is focused on input factors, such as human resources, R&D, capital, which are represented by GDP per capita. However, although the important policy position that indicates the above factors for the introduction of innovation, new models of innovation are needed, which are developed by national centers for science and technology policy around the world, or innovation have different names depending on the specifics of the national environmental innovation system (ESI – Ecological System of Innovation). The development of environmental innovation should be initiated with a goal that contains competencies and perspectives: 1. government, 2. academic circles/researchers, 3. public, and 4. industrial sector. EIS should be based on an assessment of success factors, indicators for all four perspectives. The creativity of citizens, exchange of knowledge, formal and non-formal learning, are just some of the main drivers of eco-innovation. Governments have a great influence on the innovation process and a decisive role in various domains, in terms of: 1. types of research and development; 2. uncertainty; 3. education; 4. technological innovation; 5. funding; 6. national competitiveness; 7. wealth of all citizens, and 8. strategies and line policies (Yawson, 2009).

Costantini et al. (2015) determined, during an empirical analysis, how the internal political mix and foreign policy regarding the introduction of eco-innovation in the energy sector are correlated. They came to the following conclusions: 1. that if there is too large a set of complementary policy measures without sufficient funding for environmental innovation in the energy sector, there is increased imports of technology from abroad, because there is no development of the domestic financial capacity to introduce innovative technology; 2. innovative environmental technologies are negatively affected by an unbalanced policy mix and therefore additional efforts are needed to achieve balance through different policy instruments; 3. adopting innovative strategies to balance instrumental policy leads to a positive response from the creative society to embrace eco-innovation. Foreign countries have a positive impact on national *innovation patterns and innovation behavior* because domestic policy, through interaction with foreign policy, embraces eco-innovation and technological dynamics (Costantini et al., 2015). The pressure of international institutions is growing in all countries of the world, on the introduction of environmental policies and regulations for environmental protection, following the United Nations Sustainable Development Goals (SDG) and other documents.

Flachenecker et al. (2021) suggested that public financial support through subsidies, tax credits, grants, etc. was effective in achieving eco-innovation and economic ambitions, thus reducing negative pressures on the environment. Targeted financial support focused on supporting eco-innovation makes a major contribution to regional development. Adequate national programs create the conditions for achieving the triple dividend: environmental sustainability, sustainable economic growth, and territorial cohesion, thus reducing regional disparities between countries and potential EU members (Flachenecker et al., 2021).

Policy-technology interactions in the diffusion of eco-innovation play an important role in initiating technological eco-innovation concerning climate change (Janicke, 2013). Political activities have an impact on the spread of innovation. Accelerating the diffusion of pure innovative technology is a potentially powerful option for tackling the effects of climate change. There are four mechanisms of the diffusion pattern, such as: the mechanism of innovation in politics, the mechanism of technological innovation, the mechanism of political diffusion, and the mechanism of technological diffusion. Also, there are some other climate policy mechanisms, such as e.g. falling prices of renewable sources with the simultaneous growth of fossil fuel prices, which contribute to the introduction of innovations (Janicke, 2013).

3. Eco-IS (European Innovation Scoreboard) - EU Eco-Innovation Index

The Eco-Innovation Index is a composite index that measures the level of application and development of eco-innovation technology and green energy. The index contains certain thematic areas: 1. Inputs*;* 2. Activities; 3. Outputs; 4. Socio-economic results; 5. Resource efficiency results; 6. Environmental results of resource efficiency. *Inputs* include: a) the total value of green investments in the initial phase in USD per capita, b) investments in R&D in the field of energy and environment (in % of GDP), and c) the total number of employed researchers in the field of R&D, % total employees. *Activities* include: a) existing number of sustainable SME products, % of surveyed enterprises, b) existing number of ISO 14001 certificates (per million inhabitants), and c) implemented

activities related to energy and renewable energy efficiency. *Outputs* are: a) publications that are thematically related to eco-innovation, per million inhabitants, b) media coverage, per million inhabitants, and c) patents for eco-innovation, per million inhabitants. *Socio-economic results* have the following components: a) employment in the environmental sector, in %, b) value-added in the environmental sector, in% of GDP, and c) export of products resulting from eco-innovation (% of GDP-a). *Resource efficiency results* include: a) commodity productivity (GDP/domestic consumption of goods), b) water productivity (GDP/total freshwater abstraction), and c) GHG greenhouse gas emission intensity (CO_2e/GDP). 6. *Environmental results of resource efficiency* include: a) material productivity (GDP/domestic material consumption), b) water productivity (GDP/total freshwater intake), c) energy productivity (GDP/gross domestic energy consumption), and d) emission intensity GHG (CO_2e / GDP) (EIS, 2022).

In the European Union, many countries have recognized the importance of the harmful effects of greenhouse and taken appropriate measures to mitigate their effects on human health and the environment. The governments of successful countries have responsibly committed themselves to support eco-innovation to decarbonize and to make eco-innovation policy central to the strategic planning of their economies. The progress made and the performance of Member States on eco-innovation is measured by the composite Eco-Innovation Index, which ranks countries at three levels: highest, average, and lowest. The leading European countries, in terms of the Eco-Innovation Index in 2021, as stated on the portal of the European Commission, are: Luxembourg, which is in the first place, and the eco-leader, whose value is ECO-I, 175, followed by Finland, Austria, Denmark, Sweden, Germany, France, Spain, and the Netherlands. Countries with average values were Italy, Portugal, Slovenia, the Czech Republic, Ireland, Belgium, Greece, Estonia, and Latvia. Countries in the *catching up below of EU counties in Eco-EIS* phase are in the phase of catching up with the eco-innovations of EU countries, which are below average, namely: Lithuania, Croatia, Slovakia, Cyprus, Romania, Hungary, Malta, and Poland, while Bulgaria has the lowest value of Eco-I, 50. The results obtained through the indicators show the achieved efficiency of eco-innovation of EU countries. Eco-innovations have positive effects on the efficiency of natural resources, because they increase the generated economic value and reduce the harmful impact on the environment, i.e. the natural environment (EIS, 2022).

4. Future drivers of eco-innovation

Al-Aylani et al. (2021), concluded that there are interrelationships between holistic sustainable growth, natural environment, and well-being, as well as the priority importance of eco-innovation in the European agenda. Eco-innovation is key to monitoring the progress of innovative (green), EU competition policy, and the carbon neutrality of all Member States and candidate countries. It was concluded that the leading countries of eco-innovation had the support of the government, which was committed to eco-innovation and decarbonization of the country. In the ten years, the countries that have invested the most in the R&D sector show significant improvements in some of the *inputs* of eco-innovation. Government support is important in the field of research in the ecology and energy sector, as it contributes to its engagement, improvement of results, especially with (green) investments in the initial phase of research, as well as engagement of expert team and academic researchers (Al-Ajlani et al., 2021).

Machiba (2012) concluded that innovation is a driver of economic and social progress at the national macro-level, or a driver of business success and competitive advantage at the micro-level of the company. The report *The Future of eco-innovation* emphasized the promotion of specific areas of innovation, which contribute to an ecologically healthier and more prosperous society. In this way, opportunities are created for solving environmental problems, reducing the consumption of energy and resources such as fossil fuels, thus establishing an economic activity called eco-innovation or green innovation (Machiba, 2012). Eco-innovation requires certain activities, a political mix, which is related to adequate policies that have a wide range of actions. Innovation policy should focus on stimulating economic growth and development of new technologies, productivity, and innovative functional areas (Sustainable manufacturing and eco-innovation, 2009).

According to the Technology Executive Committee (TEC, 2021), future directions of climate technology development should be based on the following activities: 1. to inspect existing green technologies, i.e. the state and potential impact on climate change mitigation and adaptation; 2. to analyze the existing possibilities for solving the problem of introduction of technology, its development, application; 3. to analyze social acceptability; 4. to analyze access to new markets; 5. to identify potential possibilities of national policy for support for the application of technologies, which includes continuous analysis for access to new technologies, innovation, commercialization; 6. to take actions to reduce market risks, thus creating conditions for the sustainability of new offers for technologies. These activities aim to provide all relevant information to policy-makers and stakeholders to establish an energy green transformation in the field of eco-innovation and green technology. It is necessary to adopt innovative regional/national strategies for the accelerated introduction, application, and expansion of innovative technologies. Thus, decarbonization technologies for energy use would have positive effects on the environment, reducing CO_2 and reducing greenhouse gas (GHG) emissions. In this way, multiple social, environmental, and economic benefits would be achieved, such as revenues at the local and regional/national level, employment in the

field of green economy/energy, reduced impact on air, water, land, biodiversity, that is, the benefits of the entire ecosystem and sustainable development would be realized. (TEC, 2021).

5. Conclusion

At a time of global energy shortages and the COVID-19 pandemic, gas prices have risen, leading to the conclusion that action is needed as soon as possible to develop a green economy, energy efficiency, and renewable energy sources. Regarding green transformation, trends in the world are increasing towards decarbonization, clean energy, and eco-innovation, which contributes to a more economical perspective on the use of energy fuels and sustainable development. All countries as signatories to the Paris Agreement have committed themselves, under Article 4, to make efforts within their nationally determined contributions (NDCs) to reduce the greenhouse and CO_2 effects. Achieving ambitious climate and low-carbon goals is important for ecosystem adaptation and sustainable development over a certain period. All countries should be guided by the guidelines of the Agreement; to eliminate the greenhouse effects through gas sinks or CO_2 storage; to develop long-term strategies for accelerating the green transition, taking into account that some less developed and poorer countries need more time to apply modern scientific knowledge and climate technology. In that way, all countries would contribute to the achievement of global goals regarding climate change for the benefit of the population and all humanity.

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