

System of Indicators to Measure Eco-Innovation Potential of Ukrainian Regions

I.I. Koblianska¹, L.I. Kalachevska², Ye.V. Mishenin³ and L.I. Mykhailova⁴,

¹Faculty of Economics and Management,
Sumy National Agrarian University, Sumy, Ukraine
Email : koblianska@protonmail.com

²Faculty of Economics and Management,
Sumy National Agrarian University, Sumy, Ukraine
Email : likalachevska@gmail.com

³Oleg Balatskyi Academic and Research Institute of Finance, Economics and Management,
Sumy State University, Sumy, Ukraine
Email : eugeniy_mishenin@yahoo.com

⁴Faculty of Economics and Management,
Sumy National Agrarian University, Sumy, Ukraine
Email : lmikhaylova@yahoo.com

ABSTRACT

There are proposed the methodology and system of indicators to measure eco-innovation potential of regions in Ukraine, based on the understanding of the latter as the formation and development (environmental congruence) of structural components of the RIS, as well as taking into account the peculiarities of the national statistical database design. The methodology presupposes the grouping of measuring indicators as follows: market component, industry and technology component, knowledge component, infrastructure component, institutional component, and linkages. The proposed set of indicators provides a link with the goals of sustainable development and economic growth, allowing to identify the prerequisites for the development of eco-innovations, their dynamics, and impact on the economy, environment, and society. Taking into account the high proportion of rural population in Ukraine, particular attention is paid to the indicators characterizing rural tourism, which can act as a driving force for the development of eco-innovation in rural areas, as well as in regions where agriculture predominates.

Keywords: measurement of innovation; eco-innovation; eco-innovation potential; regional eco-innovation; regional innovation system.

JEL Classification: Q55, Q58, R58, C43.

Mathematics Subject Classification: 62J12, 62G99

1. INTRODUCTION

The "ensuring of the sustainable development of the state, carrying out structural reforms and, consequently, raising standards of living..." is a strategic goal of Ukraine's development. It is asserted that "Ukraine should become a state with a strong economy and advanced innovation ..." and it should be ensured through the "... sustainable growth of the economy in an environmentally sustainable manner ..." (On Strategy 2015). The main objectives of regions' development also go in line with the

State Strategy and include competitiveness, socio-economic integration, balanced spatial development, and effective management (On Approval 2014). Thus, the priority of the innovation and sustainable development (SD) goals for both Ukraine as a whole and its certain regions is politically determined and, therefore, undeniable.

Currently, the mutual dependence of the SD and innovation concept is being widely recognized (Lundin and Serger Schwaag 2018), in particular, the achievement of sustainable development goals is seen possible only on an innovative basis (Park et al. 2017) and, specifically, with the use of eco-innovation. In this context, the latter, traditionally being subordinated to the goals of economic growth, should be seen as the main driver of innovation policy (Reid and Miedzinski 2008). The eco-innovation form the basis for the "fourth generation" of innovation policy, where the goals of resource saving and eco-efficiency are of main importance, and the long-term sustainable development goals, instead of short-term economic ones, are central to priority (Reid and Miedzinski 2008). The eco-innovation creates new opportunities for economic development, thus being the important economic driver especially for the underdeveloped regions and rural areas (Horbach 2017).

The abovementioned substantiates the need to take into account the eco-innovation when formulating both the State and regions' development Strategies in Ukraine, even more so, in view of the existing range of unresolved environmental problems as well as the current state of socio-economic development (low incomes, low technological level of production, raw export orientation, high share of rural territories and habitants, agricultural production priority). In this regard, the measurement of the regional potential of eco-innovation development, its current state, and dynamics, becomes important in order to determine the priorities of policy intervention and regulation in this area.

2. RESEARCH BACKGROUND

Eco-innovation as a scientific category and research field is relatively new. However, existing studies in this area indicate a rather dynamic and socially significant nature of the problem. In view of the absence of the single vision about the eco-innovation content and scope, its similarities and differences from environmental innovation, "green" innovation and other similar notions, the general conception is that eco-innovation is associated with certain benefits to the environment, regardless of whether these benefits are targeted or received as a side effect of others, even purely economic measures such as cost reduction or market expansion, and also institutional transformations of values, knowledge, norms, and administrative regulations, or as a result of interactions with new stakeholders (Machiba 2009). The public benefits and market failure associated with eco-innovation determine their features: the "double externality problem", the regulatory push/pull effect, and the greater importance of institutional and social innovation (Rennings 2000).

The eco-innovation, being crucially reliant on political regulation (Reid and Miedzinski 2008; Pereira and Vence 2012; Díaz-García et al. 2015), requires a scrutinous approach to policy-making aimed at their development. The formation of this policy should be based on the content, drivers and barriers of eco-innovation development, its state and dynamics, as well as the results of implementation, that is, the impact on the environment, society and economic performance (Machiba 2009). It determines the special attention of scientists to the construction of eco-innovation measurement systems and appropriate methodology.

The assessment of eco-innovation serves as the basis for policy development aimed at promoting eco-innovation, providing innovative progress in the development of the region and, at the same time, achieving the goals of sustainable development (Park et al. 2017). The difference of the eco-innovation

capacity is due to the territorial specifics of the economic structure (industries and firms) and competition, as well as the peculiarities of the corresponding products / technologies / services market development. It is obvious, that political decisions must be in line with the current state of eco-innovation development, providing solutions to existing problems in this area, as well as the adequacy of the decisions and measures taken and the ability of actors to perceive them (Ghisetti and Quatraro 2017). Therefore, the assessment of eco-innovation potential is the basis for developing appropriate strategies at the different levels, aimed at increasing national (and regional) competitiveness (Park et al. 2017).

The eco-innovation are measured both directly and indirectly (Park et al. 2017). The study of Kemp & Pearson (2007) is, to some extent, pioneering in the field of eco-innovation measurement. Authors made a comprehensive analysis of existing approaches in this field and indicate the feasibility to use four types of measures for the quantitative characteristic of technological changes associated with eco-innovation: "input measures, intermediate output measures, direct innovative measures, and indirect impact measures". The main indices proposed to assess the eco-innovation progress include the following: research and development expenditures, the staff involved in the processes, the number of patents, publications and citations, sales of relevant new products, resource efficiency and productivity indicators (Kemp and Pearson 2007). The corresponding approach is highlighted in the OECD report (Machiba 2009) and used as a methodological basis for the Eco-Innovation Scoreboard used to measure eco-innovation development in the European space. The latter presupposes the assessment of "eco-innovation inputs, eco-innovation outputs, eco-innovation activities, environmental and socio-economic results of eco-innovation" (Eco-Innovation Scoreboard 2018). Another approach, compiling the ASEM Eco-Innovation Index (ASEI) proposed by ASEM (Asia-Europe Meeting) SMEs Eco-Innovation Center (ASEIC), based in the Republic of Korea (ASEM 2015) covers the measurement of an eco-innovation capacity, the environment for promoting eco-innovation, eco-innovation activities, as well as their output. Park et al. (2017) made a detailed analysis of these techniques identifying their benefits and disadvantages.

On the other hand, scholars consider eco-innovation as a kind of innovation (Hojnik 2017; Speirs et al. 2008), and therefore explore the possibilities to apply the traditional indicators used to assess innovation dynamics (Speirs et al. 2008). Speirs et al. (2008) analyzed the various conceptual approaches to the modeling of innovation systems (The Innovation Policy Terrain, The Generic Model of National Innovation Systems (OECD); The Elements of National Innovative Capacity model, and The Functions of Innovation model), highlighting those common elements that are key in terms of the innovation system performance: the firm (with an emphasis on environmental management, costs and research); conditions (financing, knowledge, and policy related to environmental practices) and linkages (interactions between actors in the environmental sphere). They also added indicators characterizing the nature of eco-innovations (radical or incremental), as well as indicators to measure their overall productivity (Speirs et al. 2008, 13-15).

The synthesis of the existing approaches shows that, despite the different scholars' positions concerning the grouping of indicators, the measurement tools usually cover a certain set of generic indicators: the research and development expenditures in this area; number of firms with environmental management systems; number of patents and publications; indicators of resource efficiency for different types of resources, etc. In other words, these tools are aimed at determining the preconditions, exploring drivers and barriers, as well as the current state and results of the eco-innovation implementation.

All of the above-mentioned approaches cover the national level of an eco-innovation implementation. These assessments are important in terms of formulating the standardized basis for gathering information, countries reporting and benchmarking, allowing identification of leaders, followers, loungers or laggards (Park et al. 2017), as well as best practices for policy reform. At the same time, it is possible and desirable to measure eco-innovation performance at the firm level (Ilyashenko 2012; Prokopenko 2010), as well as at the sector and the region (Smol et al. 2017; Chen et al. 2017; Plikus et al. 2018).

The regional level has its own specifics, primarily due to the limited policy regulation powers (for instance, as the main tax assessment belongs to the state competence), funding capabilities (due to limited local budgets and their deficiency) and because the peculiarities of the region as a more dense socio-economic space, where socio-cultural factors and relations become more significant (Kirat and Lung 1999; Mishenin et al. 2018). Upon that, different socio-economic conditions in the regions determine the diverse level of eco-innovation regional performance. Following Park et al. (2017) approach, the assessment of eco-innovation potential should serve as a basis for regions division into leaders, followers, loungers or laggards, which in turn should underlie the creation of a well-balanced regional policy at the national level and interregional integration and interaction frame. The level of eco-innovation potential also should be seen as an underlying rationale for the regional policy, in particular, decisions on a specialization (diversification), a resource use and spatial planning, aimed at enhancement of the region's competitiveness. The scientists emphasize the importance and relevance of research in this area (Diaz-Garcia et al. 2015), specifically, examining the drivers and barriers of eco-innovation development in regional space (Horbach 2013, 2017; Reid and Miedzinski 2008), although the studies on eco-innovation measurement at the regional level are few.

The system of eco-innovation measuring indices developed for the Chinese regions (Chen et al. 2017) covers four groups of indicators, assessing the role of eco-innovation for the "green" regional development: its influence on the green economy performance (through the measurement of investments in equipment, technological recovery, and pollution control projects; the value of green products and their export; the cost of full waste disposal; index of production structure); its influence on ecological society performance (measurement of employment in ecological production; level of informing about ecological services; productivity of all staff; the number of environmental protection organizations; the number of proposals from environmental institutions); its influence on the creation and accumulation of technologies (via the number and expenditures for the environmental products research and development projects; the number of green patents; patenting technology; the technology market sales); its influence on ecological performance (through the assessment of energy efficiency and standards of industrial emissions; utilization of solid industrial waste level; standards for industrial wastewater; amount of industrial sulfur dioxide emissions; the hazard level of household waste disposal processes). Another approach, where the authors (Smol et al. 2017) suggest to understand eco-innovation as the facilitator of the Circular Economy (CE) regional development, is based on the frame and indicators underlying the Eco-Innovation Scoreboard, and also include a number of indices that make it possible to measure resource direct use, reuse and recycling (as the main output of eco-innovation in view of CE concept). The methodology presupposes the measurement of "CE-eco-innovation input" (the expenditures of local authorities for environmental and energy R&D related to the CE, investments in the initial stages of green projects per capita), "CE-eco-innovation activities" (share of companies implementing projects aimed at reducing material consumption and recyclable projects), "CE-eco-innovation output" (volume of generated and recycled industrial and household waste per capita, number of firms applying LCA and implementing zero waste programs), "Resource efficiency

outcomes" (the measuring indices corresponding to the Eco-IS, applying for the regional scale), and "Socio-economic outcomes" (the same indices as used in Eco-IS, excluding export of eco-industries products). Comparing these approaches, one should indicate their significant difference in measuring the results of eco-innovations (outputs and outcomes), and the preconditions for their development. The second one (Smol et al. 2017) is more complete allowing to link the economic result of the regional complex functioning with its socio-ecological dimension directly, in particular, via the measurement of the amount of used resources per regional GDP, as well as to assess the environmental orientation of local authorities (at least due to the R&D expenditures they carry out in this area). The latter is an important driver of eco-innovation development (Andersen and Andersson 2006).

The above allows for the conclusion that development of a single, universal approach to measuring the regional eco-innovation potential and performance (and the country as well) is, to some extent, impossible, due to the specifics of each country and region, driven by the peculiarities of the statistical and analytical systems construction, organizational structures and distribution of powers, and socio-cultural determinants. This is evidenced by the difference in the frameworks of Eco-IS and ASEIM approaches, as well as the variety of regional measurement methodologies. Given that eco-innovations are contextual-specific (Doloreux and Pardo 2005), it is evident the need to develop specific methodological approaches that will best fit the conditions of the country (region) and fully serve the purposes of policy making, illustrating the most significant problems and ways to solve them. The context-specific nature of eco-innovation stipulates the specificity of the methodological basis for analysis and research (Diaz-Garcia et al. 2015). Therefore, acknowledging the existing research in the field of eco-innovation assessment, it should be emphasized the importance of developing an appropriate methodology for the measurement of eco-innovation potential for post-Soviet countries and their regions, where the differences caused by somewhat rigid organizational structures, in comparison with the European ones, will result in its specificity.

There is a limited scope of research in the field of eco-innovation measurement on the regional (and national as well) scale made by Ukrainian scientists. Certain scholars (Martiychenko and Bondarenko 2015) explore the ecological dimension of regional innovation processes with an emphasis on the peculiarities of the state environmental, regional and innovation policy. Musina & Kvasha (2017) investigate the role of eco-innovation in the formation and development of a resource-efficient economy, also identifying the indicators and data sources for the eco-innovation index of Ukraine assessment, applying the Eco-IS approach. With regard to the latter, it should be pointed out that some of the suggested indicators are rather controversial. Specifically, the principle of determining "the share of enterprises engaged in ecological activities in their total number", that is the indicator of eco-innovation activity, is not clear enough due to the lack of a legally defined "ecological activity" term. It makes difficult the use of the proposed tool.

While exploring the principles of the environmentally friendly regional innovation system (RIS) formation, Plikus et al. (2018) propose the methodology for the measuring of its development. The authors highlight the interconnection of the socio-economic context of regional development and the peculiarities of innovation activity carried out within the respective territory. The indicators used to reflect the environmental dimension of the RIS functioning include the volume of emissions and wastewater, generated waste and the share of renewable energy in the total energy consumption, allowing the measurement of environmental performance of innovation activity in the region, but not the problem areas in terms of the eco-innovation development facilitation (Plikus et al. 2018).

Certain results concerning the development of eco-innovation in the regional scale were received within the framework of previously conducted research of the authors (Koblianska 2015). In particular, there were studied the essential nature and directions of the regional eco-innovation potential assessment, as well as the strategies of the regional "green" development on the eco-innovation basis. At the same time, one should emphasize the relevance of further research, given the limited domestic research in the field and the need to specify the methodology for the regional eco-innovation potential measurement.

Given the existing approaches to measure eco-innovation (Kemp and Pearson 2007; Speirs et al. 2008; Musina and Kvasha 2017; Chen et al. 2017; Smol et al. 2017), the methodology construction requires the identification of the eco-innovation nature, its typical and specific drivers and barriers, as well as the specification of set of principles to ensure the sufficient complexity, comprehensiveness and easy to use of measurement tools. The study of these aspects, with regard to Ukraine's statistics peculiarities, constitutes the range of research tasks to be solved for the development of the methodic approach for measurement of the eco-innovation potential of the region, which is the main purpose of this study.

3. RESULTS

Concerning the content of eco-innovation, we should note that in the absence of a single approach, one of the most cited (Horbach 2013, 2017; Park et al. 2017; Sarkar 2013) is Kemp & Pearson's definition: "the production, assimilation or exploitation of a product, production process, service or management or business methods 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 "(Kemp and Pearson 2007, 7). Somewhat similar is the definition of eco-innovation given in the OECD report (Machiba 2009), which additionally emphasizes the incremental innovation and institutional arrangements as a kind of eco-innovation, and the independence from the initial implementation target (environmentally driven or not). Such an approach, in which eco-innovation embrace both radical and incremental ones, is already traditional in this field of science (Machiba 2009; de Jesusa and Mendonça 2018; Illyashenko 2012; Prokopenko 2010; Europe 2013). In addition, it should be emphasized that the insignificance of the implementation target is the basis for the eco-innovation differentiation in comparison with the environmental (green) innovations (Kemp and Pearson 2007; Horbach 2017). The latter concentrates on environmental effects, while the eco-innovation are aimed at obtaining both an environmental and economic effect (Horbach 2017). Therefore, eco-innovation should not be limited to environmental goods and services. The eco-innovation is also neither sector nor technology specific but occurs in all sectors of the economy (Kemp and Pearson 2007; Reid and Miedzinski 2008). The need for the eco-innovations development and implementation has cultural and philosophical grounds: they intended to coordinate human-nature relations on the background of the resources exhaustion, environmental degradation and ecological damage (Chen et al. 2017). The eco-innovations are socially significant and desirable (Hojnik 2017); they further an improvement of life quality while minimizing the natural resources use (materials, energy and space) per unit of output and the minimum emission of toxic substances throughout the life cycle (Reid and Miedzinski 2008), thus being an important tool for improving social well-being (Pereira and Vence 2012). The understanding eco-innovation as a system tool for solving existing problems, which enables a coherent and transformative change of the current unsustainable situation (de Jesusa and Mendonça 2018) reveals the transformational content of this concept in relation to the existing paradigm of social development.

Given the undeniable social significance of eco-innovations, one should emphasize their crucial role in the context of transforming the meaningful aspects of economic development and the behaviour of economic agents. Understanding the eco-innovation as capable to attract green rent to the market (Andersen 2008), Andersen (2008) emphasizes that the focus of research in this area should move to problems of environmental issues integration into economic processes, i.e. the analysis of trends and dynamics of “greening” the business strategies, markets, technologies and innovation systems (Andersen 2008). Thus, conceptually eco-innovation is closely related to competitiveness (Andersen 2008; Sarkar 2013). In this context, the firm, is a key element of the innovation system, should be seen in a wider institutional and cultural context as a potential eco-innovator, and the policy should focus mainly on the organization of green production, the creation, and accumulation of green knowledge, the provision of training between firms (Andersen 2008). Consequently, systemacity is an important feature of the eco-innovation success (Reid and Miedzinski 2008), inasmuch as an individual, local innovations, even environmentally targeted, have a limited impact on the processes of greening the economy (Koblianska 2015). The systemic implementation of eco-innovation refers to the need to provide a system of related changes in all spheres along the value chain (resource extraction – production - transportation and distribution – consumption - utilization), as well as changes in the system’s external environment (Europe 2013), in particular, fundamental changes in the mode of society’s functioning and the meeting of its need (Machiba 2009, 15). Technologies can be a source for system innovations (Machiba 2009; Chen et al. 2017), but they alone cannot provide significant changes and thus must be associated with organizational and social arrangements, with human nature and culture (Machiba 2009). The implementation of such system innovation is rather difficult, although provides a sound effect (Reid and Miedzinski 2008). Therefore, regional eco-innovation should be seen as a system and organizational network that ensure close coordination between the environmental, economic, social and technological dimensions of regional development, thus contributing to the development of a sustainable development model in a certain area (Chen et al. 2017). From these positions, the level of implementation of eco-innovation in the region is a reflection of the synergistic evolution of the economy, society, technology and the environment (Chen et al. 2017), reflecting the degree of combination of different production factors and conditions that provides favourable conditions for green development and effective regional economic growth of a new quality (Chen et al. 2017). This requires a clear determination of the composition and structure of the system in which the innovations (eco-innovations) are implemented, as well as the interconnections between the elements; the provision of a common understanding of the direction of change, goals, and objectives of the system development, as well as ways to achieve them. (Koblianska 2015).

Taking into account the above, as well as the need to provide the systemic implementation of eco-innovation in the regional space, it is evident that input-output-outcomes measures (Kemp and Pearson 2007; Eco-IS 2018, Smol et al. 2017; Musina and Kvasha 2017) are not enough to illustrate the whole set of their determinants, as well as innovation system performance and success. Moreover, such an approach does not adequately reflect the non-linear nature of eco-innovation (Park et al. 2017). The formation of all system components of the regional innovation system (RIS), each of which provides the formation and the support of proper functionality of innovation drivers is the key to the success of innovation processes. From these perspectives, the region’s eco-innovation potential should be understood primarily as the existence (ecological congruence) of the RIS components and the level of their development. This approach determines the features of the indicators grouping, as well as the composition of a comprehensive system for measuring the eco-innovation potential of the region.

Considering the methodological aspects of the design of a system of indicators for measuring the potential of eco-innovation development, one should emphasize that the formation of indicators, as a rule, combines the theory-driven and data-driven approaches (Park et al. 2017). The main principles underlying the process of the appropriate indicators selection cover, in particular: the scientificity and relevance of areas and stakeholders coverage; operationality and ability to identify changes); focus on common goals; the ability to facilitate further changes, etc. (Park et al. 2017; Chen et al. 2017). Commenting the above, it should be emphasized the need to fully cover the determinants of eco-innovation development. The main of them is the technological and regulatory pressure, and market demand (Rennings 2000). Within this framework, the certain measures at the regional scale are of main importance, namely: the green public procurement, financial schemes, consultancy services, eco-efficiency campaigns, a green forecasting, and land use planning (Reid and Miedzinski 2008). The fiscal measures are also significant, while trading schemes, subsidies, permits and prohibitions, standards, and technical norms, eco-labeling, research and technology programs, educational programs play a supporting role (Reid and Miedzinski 2008, 60). The networks development (R&D cooperation and knowledge sharing), the presence and activity of pressure groups (foreign consumers and investors, local government, community), the resource and structural parameters of the regional production also seen as important drivers of eco-innovation at the meso-level (Diaz-Garcia et al. 2015; Hojnik 2017; Horbach 2017). It is necessary to note that indicators should help policy-makers to identify the trends of eco-innovation activity, promote awareness of eco-innovation among stakeholders as well as provide the identification of ways to detach the economic growth and environmental deterioration, etc. (Sarkar 2013). Therefore, based on the main elements of IS (firm, institutions, infrastructure, linkages) and the factors underlying the eco-innovation development (Rennings 2000), it is necessary to consider the potential of eco-innovation development in the region in terms of formation and development (environmental congruence) of such RIS elements: market, knowledge, industry-technological, infrastructure, institutions (policy and socio-cultural space) and linkages (Tab. 1).

Table 1: The system of regional eco-innovation potential measuring indices

	EIRP blocks and Indicators	Data sources
	1. Market	
1.1	Value of innovation products and services (UAH) and its share in regional GDP, %	Statistics
1.2	Value of organic products (UAH) and its share in the gross regional agricultural output, %	National Register of Organic Producers, Data of certification organizations, Statistics, Organic producers' statistical reports
1.3	Value of resource-saving (including energy) products and services (UAH) and its share in regional GDP, %	Statistics (<i>to be developed</i>)
1.4	The passenger turnover of environmentally friendly transport (mln. pas. km) and its share in the total passenger turnover, %	Statistics
1.5	Volume of alternative fuel consumed (oil equivalent) and its share in the total volume of consumed motor fuel, %	Statistics
1.6	Volume of alternative energy resources consumed (oil equivalent) and its share in the total volume of consumed energy resources, %	Statistics
1.7	Sales of the reused and recycled products (UAH) and its share in regional GDP, %	Statistics: sales of wholesale of waste and scrap industry and wholesale of post-consumer goods

1.8	Sales of environmental industries (UAH) and its share in regional GDP, %	Statistics
1.9	The number of tourists in rural areas (persons) and its share in the total tourists' number, %	Statistics
2. Industry and technology		
2.1	Industry structure (share of different industries in regional GDP), %	Statistics
2.2	The number of certified organic agricultural producers (units) and its share in the total number of agricultural producers, %	National Register of Organic Producers, Data of certification organizations
2.3	The number of rural households offering tourism services (units) and its share in the total number of rural households, %	Statistics
2.4	The number of ISO 14000 certified firms (units) and its share in the total firms quantity, %	Statistics (<i>to be developed</i>), Data of certification organizations
2.5	The number of firms operating in environmental industries (units) and its share in the total firms quantity, %	Statistics
2.6	The number of firms operating in the wholesale of reused and recycled products (units) and its share in the total firms quantity, %	Statistics (see comments for the 1.7)
2.7	The employees in environmental industries (persons) and its share in the total number employees, %	Statistics
2.8	The employees in the wholesale of reused and recycled products (persons) and its share in the total number of employees, %	Statistics (see comments for the 1.7)
2.9	The share of resource-saving technologies implemented in the total number of innovation technologies, %	Statistics
2.10	The share of innovation implemented in the environmental sector in the total number of innovation applied, %	Statistics
2.11	Capital investments value (mln. UAH) and its share in regional GDP, %	Statistics
2.12	Capital and current expenditures of enterprises in environmental area (mln. UAH) and its share in regional GDP, %	Statistics
2.13	Expenditures of enterprises for the innovation activity (mln. UAH) and its share in regional GDP, %	Statistics
2.14	Regional GDP per industrial waste generated, mln. USD / ton	Statistics
2.15	Regional GDP per energy resources used, mln. USD / ths. ton oil equivalent	Statistics
2.16	Regional GDP per wastewater, mln. USD / ths. m ³	Statistics
2.17	Regional GDP per volume of pollutant emissions, mln. USD/ ths. ton (differentiated for the stationary and mobile sources of pollution, as well as by the types of pollutants)	Statistics
2.18	Regional GDP per volume of CO ₂ emissions, mln.USD/ ths. ton	Statistics
2.19	The degree of waste utilization, % (differentiated by the types of waste)	Statistics
2.20	The degree of wastewater treatment, %	Statistics
2.21	The share of agricultural land in the total land area, %	Statistics
2.22	The degree of agricultural land ploughness, %	Statistics
2.23	Index of region's competitiveness	Statistics
3.Knowledge		
3.1	The number of publications in ecological and related fields and its share in the total number of scientific publications	Survey
3.2	The number of ecologically related R&D and its share in the total number of R&D projects	Survey
3.3	The expenditures for ecologically related R&D (UAH) and its share in the total expenditures for R&D projects	Survey
3.4	The number of master and PhD graduates in ecologically related fields (persons) and its share in the total number of master and PhD graduates, %	Survey
3.5	The number of patents in ecologically related fields (units) and its share in the total number of patents, %	The National technology and patents databases

3.6	The number of research organizations and high education institutions (per 100 ths. of population)	Statistics
3.7	The number of employees in ecologically related R&D (persons) and its share in the total employees, %	Survey
3.8	The index of region's human development	Statistics
4. Infrastructure		
4.1	The share of hard-top roads in the total highway distance, %	Statistics
4.2	The Internet coverage, %	Statistics
4.3	Housing and communal services coverage (centralized watersupply and sewage disposal; centralized gas-supply; centralized heat supply), % (differentiated for rural and urban areas)	Statistics
4.4	Network of waste processing enterprises (number) and their capacity sufficiency (planned volume of waste processing to the total waste generated), %	Survey, Statistics
4.5	The coverage of household waste gathering and transportation services (number of abonents to the total population), %	Survey
5. Institutions		
5.1	The number of ecologically related strategic objectives (units) and its share in the total number of strategic objectives of region's development, %	Survey
5.2	The number of active environmental NGOs, units	Statistics
5.3	Regional (local) budget expenditures for the environmental measures (mln. UAH) and its share in total annual budget expenditures, %	Statistics
5.4	The number of public events in the area of ecological education and training, the number of persons involved (persons) and its share in the total population, %	Survey
5.5	The number of ecologically related public information issued (advertising, locally published reports) and its share in the total number of public information issued, %	Survey
5.6	The value of eco-innovation products and services publicly purchased (UAH) and its share in the total value of public procurement, %	Survey (organic products; resource-saving design work; alternative energy and fuel; resource-saving equipment)
5.7	The regional order for the education and training in the ecologically related fields on the budget financing (persons) and its share in the total regional education and training order, %	Survey
5.8	The number of public investment projects in ecologically related fields (units) and its share in the total number of public investment projects, %	Survey
6. Linkages		
6.1	The number of joint (business-government-research and education-society) projects implemented in the environmental and eco-innovation field (units) and its share in the total number of joint projects	Survey
6.2	The number of joint events held in the ecologically related field and the number of persons (organizations) involved; the share of its in the total number of joint events, %	Survey
6.3	The presence of business incubators and consultancy service for the eco-innovation implementation (units)	Survey

Source: authors' development

Commenting on the set of indicators, it should be noted that the "eco-innovation sector", in particular, based on the UNEP approach (UNEP 2018) involves the most important sectors for the development of the green economy, i.e.: construction, fisheries, forestry, agriculture, energy, transport, water management, waste management, production and processing, tourism. At the same time, it is not necessary that the innovation activities of those industries' actors have the eco-innovation character. Moreover, as Pereira & Vence (2012) point out, the innovation activity in low-tech sectors is not accompanied by environmental benefits, as a rule. Given the low technological level of the manufacturing sector in Ukraine, the consideration of all these industries does not necessarily illustrate

the eco-innovation nature of the changes. It is also difficult to distinguish the individual spheres and activities where the innovation activity directly has the "eco-innovation" nature, within the framework of these industries. Therefore, it is needed to analyze both the overall innovation activity and the innovation activity in the environmental sectors. According to the Ukrainian Classifier of Economic Activities (Classifier 2010), the latter includes water management and waste management (Section E, classes 36-39) and eco-innovation services (codes 71.1; 74.90; 81.30; 82.30; 62.02; 63.9). In our view, the special attention also should be given to the agri-tourism development as a marker of eco-innovation preconditions and performance, due to the fact that one-third of the population in Ukraine lives in rural areas. Thus, agri-tourism state and dynamics reflect the potential and trends of eco-innovation progress in rural areas (and those where agricultural production predominates in the structure of the regional GDP), since this activity seen is an accelerator of other sectors development on an eco-innovative basis. In particular, the benefits of agri-tourism include, among others: the use of farm products on a new, innovative basis; the development of new consumer markets; an increased awareness of the need for rational use of land resources; a job creation; the stimulation of improvements in housing and communal services in rural areas; the creation of opportunities for the strengthening entrepreneurship and developing managerial skills; the knowledge creation and sharing; improving the long-term sustainability of agribusiness; improving the qualitative parameters of the natural environment (Irshad 2010). The agri-tourism, being an eco-innovation strategy for farms related with the transformation of product-oriented production for the sustainable production of services (Liu et al. 2017), forms the environment for the development of other eco-innovation activities along the entire supply chain, including agrarian and non-agrarian sectors of the countryside. Given the results of empirical studies of Ukrainian scholars (Kudla 2013), agri-tourism contributes to the creation, dissemination and accumulation of knowledge (development of entrepreneurial skills, assistance in compiling a business plan, etc.), that is, forms the necessary space (knowledge and linkages) for the further development of eco-innovation (Andersen 2008).

4. DISCUSSION AND CONCLUSION

The proposed approach to the construction of the system of measuring indices for the assessment of region's eco-innovation potential presupposes the grouping of measuring indicators as follows: market component, industry and technology component, knowledge component, infrastructure component, institutional component, and linkages. This way it corresponds with the generic understanding of the structural elements of the IS, reflecting the level of their environmental orientation. It provides for the use of both existing statistical assessments and conducting qualitative research (in particular, for quantifying the indicators of the "knowledge", "institutional component", and "linkages" blocks). The need to use qualitative data creates certain difficulties while using the proposed methodology due to the complexity of gathering, to a certain extent lack of credibility and accuracy, as well as subjectivity of qualitative survey and the appropriate information. However, making allowance for these parameters provides the relevance of the important RIS components and eco-innovation determinants coverage, and thus ensures the synergy of their performance. In particular, the socio-cultural factors represent one of the most significant factors of eco-innovation development (Reid and Miedzinski 2008). In this regard, the environmental orientation of regional authorities, proposed to be measured through the existence of strategic environmental goals, environmental public events and public informing, and expenditures on the environmental activities, is a significant factor for the formation of ecological awareness of the society in the regional space, and a prerequisite for the implementation of eco-innovation activities by firms (Horbach 2017; Ghisetti and Quatraro 2017; Chen et al. 2017). The methodology also comprises the calculation and analysis of indicators of productivity of regional GDP

in terms of resource and energy use, illustrating the impact of industrial and economic processes on the environment. These parameters traditionally are considered as indicators of eco-innovations outcomes (Kemp and Pearson 2007; Eco-IS 2018; Musina and Kvasha 2017). In our view, they illustrate not only the impact but also the most problematic areas for further improvement of production and economic processes (in comparison with other regions) towards the achievement of common goals and thus form the “industry and technological” block of indices. The scholars argue that chemical and metal processing is the most prominent and dwelling industries for eco-innovation development in a region, however, rural areas, traditionally lack these sectors. Therefore, it is proposed to take into account the state and dynamics of agri-tourism development to provide the adequacy of eco-innovation potential measurement and appropriate policy-making for the underdeveloped (in particular, rural) areas, where the eco-innovation creates new and significant opportunities for economic growth.

Finally, it should be pointed out the need for further systematic improvements to ensure the proper measurement of eco-innovation potential of Ukrainian regions, in particular:

- the improvement of the statistical reporting of manufacturing enterprises in order to keep track of eco-innovation products and their characteristics (low-waste, resource-saving, energy-saving);
- the establishment of the National register of producers certified with the ISO 14000 (similar to the register of organic agricultural producers), etc.

The application of the proposed methodology is necessary for making decisions on the definition of strategic directions of the regional economic complex development, the justification of directions and sum of budget expenditures, the formation of tools for stimulating eco-innovation activity (differentiation of local taxes rates, regulation and market assistance, pricing in housing and communal services and passenger transportation, etc.). The need for the scientific substantiation of such decisions creates a space for further research and development in this area.

5. REFERENCES

- Andersen, M. M., 2008, Eco-innovation – towards a taxonomy and a theory. *25th Celebration DRUID Conference ENTREPRENEURSHIP AND INNOVATION*. June 17-20.
- Andersen, M. M., Andersson, I. (Ed.), 2006, *Eco-innovation indicators*. European Environment Agency. Copenhagen.
- ASEM Eco-Innovation Index (ASEI): *Measuring sustainable future for Asia and Europe*, 2015, ASEM SME's Eco-innovation center. The Republic of Korea.
- Chen, J., Cheng J., Dai, Sh., 2017, Regional eco-innovation in China: an analysis of eco-innovation levels and influencing factors. *Journal of Cleaner Production* 153: 1-14, DOI: 10.1016/j.jclepro.2017.03.141.
- Classifier of types of economic activity 009:2010, 2010, State Statistics Service of Ukraine, http://kved.ukrstat.gov.ua/KVED2010/kv10_i.html (accessed October 5, 2018).
- de Jesusa, A., Mendonça, S., 2018, Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecological Economics* 145: 75–89, <http://dx.doi.org/10.1016/j.ecolecon.2017.08.001>,
- Díaz-García, C., González-Moreno, Á., Sáez-Martínez, F. J., 2015, Eco-innovation: insights from a literature review. *Innovation: Management, Policy & Practice* 17 (1): 6-23, <http://dx.doi.org/10.1080/14479338.2015.1011060>
- Doloreux, D., Parto, S., 2005, Regional innovation systems: current discourse and unresolved issues. *Technology in Society* 27: 133–153.
- Eco-Innovation Scoreboard: Thematic areas and indicators, 2018, European Commission. Brussels.

- Europe in transition: Paving the way to a green economy through eco-innovation*, 2013, Eco-Innovation Observatory. Brussels.
- Ghisetti, C., Quatraro F., 2017, Green Technologies and Environmental Productivity: A Cross-sectoral Analysis of Direct and Indirect Effects in Italian Regions. *Ecological Economics* 132: 1–13, <http://dx.doi.org/10.1016/j.ecolecon.2016.10.003>
- Hojnik, Jana, 2017, *In Pursuit of Eco-innovation: Drivers and Consequences of Eco-innovation at Firm Level*. Založba. Univerze na Primorskem. University of Primorska Press. Koper, DOI: <https://doi.org/10.26493/978-961-7023-53-4>
- Horbach, J., 2013, Do eco-innovations need specific regional characteristics? An econometric analysis for Germany. *Beiträge zur Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung - Session: Environment, Regions, and Innovation No. B04-V3, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften. Leibniz-Informationszentrum Wirtschaft. Kiel und Hamburg.*
- Horbach, J., 2017, Determinants of eco-innovation: Theoretical approaches and recent empirical analyses. *KID Summerschool. Nice.*
- Ilyashenko, S. M., 2012, Analysis of market opportunities and organization potential of innovative development on basis of ecological innovation. *Management and Marketing of Innovation* 3: 229–241.
- Irshad, Humaira, 2010, *Rural tourism – an overview*. Alberta: Government of Alberta.
- Kemp, R., Pearson, P., 2007, *Measuring eco-innovation : Final report MEI project about measuring eco-innovation*. DG Research of the European Commission (Call FP6-2005-SSP-5A), UM-MERIT, <https://search.oecd.org/env/consumption-innovation/43960830.pdf>
- Kirat, T., Lung, Y., 1999, Innovation and proximity: territories as loci of collective learning processes. *Eur Urban Reg Stud* 6(1):27–38.
- Koblianska, I.I., 2015, Innovation as the basis of regional development strategy in the context of sustainable development. *Mekhanizm rehulyuvannya ekonomiky* 4: 17-28.
- Kudla, N., 2013, Development of rural tourism in Karpaty region (survey of local council deputies). *Ahrarna ekonomika* 6 (1-2): 40-45.
- Liu, Shang-Yu, Yen, Chen-Ying, Tsai, Kuang-Nan, Lo, Wei-Shuo., 2017, A Conceptual Framework for Agri-Food Tourism as an Eco-Innovation Strategy in Small Farms. *Sustainability* 9(10), <https://doi.org/10.3390/su9101683>
- Lundin, N., Serger Schwaag, S., 2018, *Agenda 2030 and A Transformative Innovation Policy – Conceptualizing and experimenting with transformative changes towards sustainability*. Work in process WP 2018-01. Lund University.
- Machiba, T., 2009, *Sustainable manufacturing and eco-innovation: framework, practices and measurement – synthesis report*. OECD.
- Martiyenko, A. I., Bondarenko, S. A., 2015, Environmental innovations in the regional innovation system. *Efekty`vna ekonomika* 8, <http://www.economy.nayka.com.ua/?op=1&z=4232>. (accessed July 12, 2018).
- Mishenin, Ye., Koblianska, I., Medvid V., Maistrenko Yu., 2018, Sustainable regional development policy formation: role of industrial ecology and logistics, *Entrepreneurship and Sustainability Issues*, Vsl Entrepreneurship and Sustainability Center, vol. 6(1), p. 329-341
- Musina, L., Kvasha, T., 2017, *Eko-innovatsiyi v resursoefektyvniy ekonomitsi. Suchasni kontseptsii, rushiyi rozvytku ta baryery, rekomendatsiyi shchodo polityky poshyrennya v Ukraini. Tsentr resursoefektyvnoho ta chystoho vyrobnytstva v Ukraini. Orhanizatsiya obyednanykh natsiy z promyslovoho rozvytku. UNIDO.*
- On Approval of the Procedure for keeping the Register of producers of organic products (raw materials)*. Decree of the Cabinet of Ministers of Ukraine from 8 August 2016 # 505, <http://zakon.rada.gov.ua/laws/show/505-2016-%D0%BF>.

- On Approval of the State Strategy for Regional Development for the period up to 2020*. Decree of the Cabinet of Ministers of Ukraine from 6 August 2014 # 385, <http://zakon.rada.gov.ua/laws/show/385-2014-%D0%BF>
- On Strategy of Sustainable Development "Ukraine - 2020"*. Decree of the President of Ukraine from 12 January 2015 # 5/2015
- Park, Mi Sun, Bleischwitz, R., Han Ki Joo, Jang Eun Kyung, Joo Ji Hyung, 2017, Eco-Innovation Indices as Tools for Measuring Eco-Innovation. *Sustainability* 9 (12): 1-28, DOI:10.3390/su9122206
- Pereira, Á., Vence, X., 2012, Key business factors for eco-innovation: an overview of recent firm-level empirical studies. *Cuadernos de Gestión* vol. 12: 73-103, DOI: 10.5295/cdg.110308ap
- Plikus, I., Sokolenko, L., Boronos, V., 2018, Formalization of The Approaches Regarding Assessing the Level of the Eco-Friendly Regional Innovation Systems. *International Journal of Ecology and Development* 33(4), 93-102.
- Prokopenko, O. V., 2010, Concepts of innovative activity ecologization: advancing development of their public motivation realization in comparison with enterprises motivation. *Energoberezhny'e. Enegrety'ka. Energoaudy't* 2: 37–53.
- Reid, A., Miedzinski M., 2008, *Eco-Innovation. Final Report for Sectoral Innovation Watch*. Technopolis group. Innova.
- Rennings, K., 2000, Redefining innovation – eco-innovation research and the contribution from ecological economics. *Ecological Economics* 32 (2): 319-332, [https://doi.org/10.1016/S0921-8009\(99\)00112-3](https://doi.org/10.1016/S0921-8009(99)00112-3)
- Sarkar, A.N., 2013, Promoting eco-innovations to leverage sustainable development of eco-industry and green growth. *European Journal of Sustainable Development* 2 (1): 171-224.
- Smol, M., Kulczycka, J., Avdiushchenko, A., 2017, Circular economy indicators in relation to eco-innovation in European regions. *Clean Techn. Environ. Policy* 19, <https://doi.org/10.1007/s10098-016-1323-8>
- Speirs, J., Pearson, P., Foxon, T., 2008, *Adapting innovation systems indicators to assess eco-innovation*. DIME working paper. Brussels, http://www.dime-eu.org/files/active/0/Foxon_Speirs_Pearson_final.pdf (accessed September 15, 2018).
- State Service for Food Safety and Consumer Protection of Ukraine*, official website: www.consumer.gov.ua/
- State Statistics Service of Ukraine*, official website: <http://www.ukrstat.gov.ua/>
- UNEP. Ten sectors for a greener planet., 2018, <http://www.greenup-unep.org/green-economy/ten-sectors.htm?lng=en#.W8-BHPZn1Pb> (accessed September 12, 2018).