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ТРАНСФОРМАЦІЯ КРАЇН ЄВРОПИ ДО МОДЕЛІ ЦИРКУЛЯРНОЇ ЕКОНОМІКИ
TRANSFORMATION OF THE EU COUNTRIES TO THE CIRCULAR ECONOMY MODEL

***Анотація.** Стаття присвячена дослідженню трансформації країн Європи до моделі циркулярної економіки.*

Для оцінки прогресу країн Європейського Союзу щодо впровадження циркулярної економіки проаналізовано 13 показників, згрупованих у 4 категорії, які стали основою розроблення індикатора досягнення циклічної економіки: виробництво та споживання, поводження з відходами, вторинна сировина, конкурентоспроможність та інновації.

Доведено, що інтегральні показники, які використовуються в процесі прийняття рішень на всіх рівнях, можуть стати важливим інструментом удосконалення управління соціально-економічним розвитком України, у тому числі в регіональному розрізі. Їх використання сприятиме підвищенню рейтингів, престижу та авторитету країни на світовій арені.

***Abstract.** The article is devoted to the research of the transformation of the EU countries to the circular economy model.*

The concept of the circular economy is based on the approach of closing the production cycle, the extended duration of the exploitation phase of the product life cycle, and the processing of waste as resources subject to secondary use. The circular economy is based on a completely new paradigm, according to which it is necessary to analyze in detail existing economic systems and reorganize them in order to increase the level of efficiency in the use of natural resources, transform waste into resources and introduce a new approach to production and consumption.

National circular economy monitoring indicators are adapted to strategies, policies and actions specific to a particular country. This is an obstacle to make comparison between countries. There is no single specific, universally accepted set

of indicators or indicators that would measure progress in implementing a circular economy for countries.

In order to assess the progress of the countries of the European Union, Great Britain, Norway and Ukraine regarding the implementation of the circular economy, an analysis of 13 indicators, grouped into 4 categories, was carried out, which formed the basis of the creation of the circular economy achievement indicator.

A correlation analysis was conducted between the calculated circular economy indicator and the global competitiveness index and a positive correlation (0.665) was obtained. Germany, the United Kingdom, the Netherlands, and Austria were found to be leaders, while Ukraine, Bulgaria, Cyprus, Greece, and Malta were outsiders in the circular economy index and global competitiveness index. Germany, Great Britain, the Netherlands and Austria belong to the group of leaders regarding the implementation of the circular economy and the level of competitiveness.

It was proved that integral indices, used in the decision-making process at all levels, can become an important tool for improving the management of the socio-economic development of Ukraine, including the regional context. Their use will help to increase the ratings, prestige and authority of the country on the world stage.

Key words: circular economy index, indicators, circular economy model, implementation, integral indexes, competitiveness, EU countries, transformation

Ключові слова: індекс циркулярної економіки, показники, модель циркулярної економіки, впровадження, інтегральні індекси, конкурентоспроможність, країни ЄС, трансформація

Statement of the problem.

Despite the growing degradation of the environment, most world economies function on the basis of a traditional linear economy [1; 2]. This model mistakenly assumes unlimited natural resources and the capacity of waste storage facilities. The linear model of business activity does not take into account the environmental burden arising from the process of production and consumption, or the natural limits to economic growth arising from the depletion of non-renewable resources (such as fossil fuels or minerals).

The concept of the circular economy is based on the approach of closing the production cycle, the extended duration of the exploitation phase of the product life cycle, and the processing of waste as resources subject to secondary use. The circular

economy is based on a completely new paradigm, according to which it is necessary to analyze in detail existing economic systems and reorganize them in order to increase the level of efficiency in the use of natural resources, transform waste into resources and introduce a new approach to production and consumption.

National circular economy monitoring indicators are adapted to strategies, policies and actions specific to a particular country. This is an obstacle to make comparison between countries. There is no single specific, universally accepted set of indicators or indicators that would measure progress in implementing a circular economy for countries.

Analysis of the latest research and publication. The topic of circular

economy implementation and its indicators are considered in the works of such domestic and foreign scientists: K.E. Boulding [3], V.I. Vernadskyi [1], V.V.Evdokimov [4], T.K. Kvasha and L.A. Musina [5], R. Stahel [2].

Purpose of the article is to form the circular economy index for the comparative analysis of the transformation of the EU countries to the circular economy model.

Results. In order to assess the progress of the countries of the European Union, Great Britain, Norway and Ukraine regarding the implementation of the circular economy, an analysis of 13 indicators, grouped into 4 categories, was carried out, which formed the basis of the creation of the circular economy achievement indicator:

- production and consumption. To understand progress towards a circular economy, one must focus on the production and consumption phases. Companies, government agencies and households must reduce the amount of waste they generate. By reducing the amount of generated waste, production has the opportunity to reuse raw materials.

- waste management. This category is important for the circular

economy because it allows us to determine how much recycled waste is returned to the economic cycle to continue creating added value. The category shows the current status of each country's recycling programs.

- secondary raw materials. The circular economy is seen as a circle. In this case, in order to close the cycle, materials and products must re-enter the economy, taking the form of new materials or products. Thus, it is not necessary to use new resources to produce a specific object, this action has a positive effect on the ecological footprint of production.

- competitiveness and innovation. The circular economy contributes to the creation of new jobs and economic growth, as innovation is the key to success in the transition period. Thanks to innovation, new technologies are characterized by a smaller number of used resources, and therefore the consumption pattern changes, as well as industrial processes. In this regard, the circular economy is closely related to other concepts, such as the innovation-oriented economy and the knowledge-based economy [4]. Additional explanations of the categories are shown in the table. 1.

Table 1

Indicators for creating a circular economy indicator

Category	Indicator	Unit of measurement
Production and consumption	Municipal waste generation per capita	Kilograms per capita
	Generation of waste, except for basic mineral waste per unit of GDP	Kilograms per EUR thousand
	Generation of waste, with the exception of basic mineral waste for household consumption of materials	Percentage

Continued Table 1

Waste management	Household waste recycling rate	One thousand tons
	The rate of processing of all wastes, except for basic mineral wastes	Percentage
	Packaging waste recycling ratio by types of containers	Percentage
	E-waste recycling rate	Percentage
	Bio-waste processing	Kilograms per capita
	Construction and demolition waste recovery rate	Percentage
Secondary raw materials	Circular material usage rate	Percentage
	Trade in secondary raw materials	Ton
Competitiveness and innovation	Private investment, jobs and gross value added related to circular economy sectors	Value added by factor cost – EUR million
	Patents related to the processing and secondary raw materials	Number

Source: compiled by the author

The study began with the collection of statistical data on the above-mentioned indicators. Next, the data were normalized for each of the

selected indicators. Normalization was performed according to the following formulas:

for stimulants:

$$x_{ij} = \frac{X_{ij} - \min_i \{X_{ij}\}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}} \quad (2.1)$$

for destimulants:

$$x_{ij} = \frac{\max_i \{X_{ij}\} - X_{ij}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}} \quad (2.2)$$

where the index i denotes the number of the object, and the index j is the number of the attribute.

At the next stage of the analysis, the obtained normalized data were combined into a single indicator of the circular economy. The closer the indicator is to 1, the higher the country is in the rating. The results of the analysis are shown in the table. 2.3.

Based on the values of the circular economy indicator, a ranking

of countries was compiled in terms of their progress towards the circular economy in 2013–2021.

The data included in the table. 2 and 3 show that the best results in the implementation of the circular economy were achieved in Germany, Great Britain, the Netherlands and France. Such countries as Malta, Greece, Cyprus, Croatia and Ukraine received rather lower values.

Table 2

The value of the circular economy indicator for the countries of the European Union, Great Britain, Norway and Ukraine for 2013–2021

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021
Austria	5	5	4	6	5	6	6	6	3
Belgium	12	8	12	8	12	8	7	7	6
Bulgaria	26	20	28	18	24	13	22	17	29
Great Britain	2	2	2	2	2	2	2	2	2
Greece	28	26	30	28	29	27	26	27	24
Denmark	13	17	13	13	13	15	13	16	9
Estonia	24	12	24	16	26	18	28	20	26
Ireland	14	16	15	15	14	20	16	19	16
Spain	10	10	11	5	9	7	10	8	11
Italy	7	7	6	7	7	5	4	5	5
Cyprus	30	30	27	29	28	29	29	29	27
Latvia	17	28	19	24	21	26	23	25	22
Lithuania	20	24	18	22	18	21	12	14	10
Luxembourg	3	11	5	11	6	12	8	10	13
Malta	29	29	25	30	27	30	27	30	28
Netherlands	4	3	3	4	3	3	3	3	4
Germany	1	1	1	1	1	1	1	1	1
Norway	9	9	10	10	8	10	18	15	18
Poland	15	19	16	19	15	11	15	11	15
Portugal	18	21	17	17	17	19	17	21	17
Romania	25	25	23	25	25	25	25	26	25
Slovakia	22	22	20	21	22	23	24	22	23
Slovenia	16	18	14	20	16	16	11	13	8
Hungary	19	23	21	23	20	22	20	23	19
Ukraine	23	15	29	27	30	28	30	28	30
Finland	21	14	22	14	19	17	19	18	20
France	6	4	7	3	4	4	5	4	7
Croatia	27	27	26	26	23	24	21	24	21
Czech Republic	11	13	9	12	10	14	9	12	14
Sweden	8	6	8	9	11	9	14	9	12

Source: calculated by the author based on [6; 7; 8; 9]

The greatest progress in moving towards a circular economy was shown by Latvia, rising from 20th place in 2013 to 10th place in 2021; Slovenia – from 16th to 8th place and Belgium – from 12th to 6th place. At the same time, the biggest regression was shown by Luxembourg, losing 10 positions (from 3rd to 13th place) and Norway, losing 9 positions (from 9th to 18th place).

It is important to analyze

whether the development of the circular economy affects the competitiveness of the world economy in countries. Therefore, a comparison of the calculated values of the circular economy indicator and the global competitiveness index for 2021 was carried out. A Pearson correlation test shows that there is a positive correlation between two sets of index data. According to the results, the Pearson correlation coefficient is 0.665.

Table 3

Ranking of the countries of the European Union, Great Britain, Norway and Ukraine according to the indicator of the circular economy in 2013–2021

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021
Austria	5	5	4	6	5	6	6	6	3
Belgium	12	8	12	8	12	8	7	7	6
Bulgaria	26	20	28	18	24	13	22	17	29
Great Britain	2	2	2	2	2	2	2	2	2
Greece	28	26	30	28	29	27	26	27	24
Denmark	13	17	13	13	13	15	13	16	9
Estonia	24	12	24	16	26	18	28	20	26
Ireland	14	16	15	15	14	20	16	19	16
Spain	10	10	11	5	9	7	10	8	11
Italy	7	7	6	7	7	5	4	5	5
Cyprus	30	30	27	29	28	29	29	29	27
Latvia	17	28	19	24	21	26	23	25	22
Lithuania	20	24	18	22	18	21	12	14	10
Luxembourg	3	11	5	11	6	12	8	10	13
Malta	29	29	25	30	27	30	27	30	28
Netherlands	4	3	3	4	3	3	3	3	4
Germany	1	1	1	1	1	1	1	1	1
Norway	9	9	10	10	8	10	18	15	18
Poland	15	19	16	19	15	11	15	11	15
Portugal	18	21	17	17	17	19	17	21	17
Romania	25	25	23	25	25	25	25	26	25
Slovakia	22	22	20	21	22	23	24	22	23
Slovenia	16	18	14	20	16	16	11	13	8
Hungary	19	23	21	23	20	22	20	23	19
Ukraine	23	15	29	27	30	28	30	28	30
Finland	21	14	22	14	19	17	19	18	20
France	6	4	7	3	4	4	5	4	7
Croatia	27	27	26	26	23	24	21	24	21
Czech Republic	11	13	9	12	10	14	9	12	14
Sweden	8	6	8	9	11	9	14	9	12

Source: compiled by the author based on the table. 2

Germany, Great Britain, the Netherlands and Austria belong to the group of leaders regarding the implementation of the circular economy and the level of competitiveness. The "lagging" countries include Ukraine, Bulgaria, Cyprus, Malta, and Estonia - they have unfavorable conditions for the development of a circular economy as of 2021.

Conclusions. As a result of the conducted research, an indicator of the circular economy was developed based on 13 indicators, since there is no single approach to measuring the implementation of the circular economy. An analysis of the countries of the European Union, Great Britain, Norway and Ukraine was carried out according to the created indicator and their ranking based on the received

data. Additionally, a correlation analysis was conducted between the calculated circular economy indicator and the global competitiveness index and a positive correlation (0.665) was obtained. Germany, the United Kingdom, the Netherlands, and Austria were found to be leaders, while Ukraine, Bulgaria, Cyprus, Greece, and Malta were outsiders in the circular economy index and global competitiveness index.

Integral indices, used in the decision-making process at all levels, can become an important tool for improving the management of the socio-economic development of Ukraine, including in the regional context. Their use will help to increase the ratings, prestige and authority of the country on the world stage. An extremely important condition for

activating the intensification of the transition to the circular economy model is the creation of a comprehensive methodological tool for assessing its development, which is required for effective strategic and program planning at the state level.

In Ukraine, there are many obstacles to the formation of a circular economy, the great inertia of the outdated model of export-raw materials economy, which is obviously unstable and linear. Therefore, the continuation of the research, based on the conceptual theoretical and methodological provisions of the circular economy, should be aimed at improving the evaluation tools, which will contribute to the qualitative achievement of the goals of sustainable development of our society.

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