

## Analysis of the Diversity European Union Countries in the Level of Bioeconomy

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The analysis of sustainable development in 28 countries of the European Union is carried out. Using taxonomic methods, clusters of countries that are similar in their potential and level of development of bioeconomics are identified. The main purpose of the report is to identify and cluster the EU countries in connection with the current state of sustainable development in order to search for growth potentials of the bioeconomy.

For the poster, we present a classification of EU countries by indicators of sustainable development related to the development of bioeconomics. The initial set of potential variables included 18 indicators [1]. The analysis of variability and correlation allowed us to identify 12 indicators that are characterized by completeness, high variability, and weak correlation. The final set of indicators included two types of indicators that characterize, on the one hand, environmental pollution (X1 – X6), and, on the other, bioeconomics development activities (Y1 – Y6) in 2017: X1 – Harmonised risk indicator for pesticides (HRI1), by groups of active substances; X2 – Ammonia emissions from agriculture; X3 – Greenhouse gas emissions intensity of energy consumption; X4 – Exposure to air pollution by particulate matter; X5 – Recycling rate of municipal waste; X6 – Greenhouse gas emissions; Y1 – Government support to agricultural research and development; Y2 – Area under organic farming; Y3 – Energy productivity; Y4 – Share of renewable energy in gross final energy consumption by sector; Y5 – Resource productivity and domestic material consumption; Y6 – Energy productivity.

Taxonomic methods are used to study objects with multiple features. They guarantee uniformity within the formed clusters and differentiation between them. Before starting the basic taxonomic analysis, the input data were normalized. One of the agglomerative clustering methods – Ward’s method – was used in the analysis [2]. It aims to minimize the sum of squares of deviations of any two clusters that can be formed at any stage of the study. This is one of the most effective clustering methods. The order of conduct in Ward’s method is similar to that in other agglomeration methods. Two countries (Malta and Iceland) were not considered in the analysis. The analyses used computer packages and programs such as Excel spreadsheet, Statistica.

The results of the clustering indicators X1-X6 are presented in Figure 1.

Table 1. As a result of the classification, 6 clusters were formed.

Cluster	Countries
A	Poland, Italy, France, Spain, Germany
B	Romania, Croatia, Greece, Hungary, Slovakia, Czechia, Bulgaria
C	Finland, Latvia, Lithuania, Estonia
D	Sweden, Denmark
E	Cyprus, Portugal, Ireland
F	Slovenia, Austria, Netherlands, Luxembourg, Belgium

Source: own elaboration based on the analyzed data.

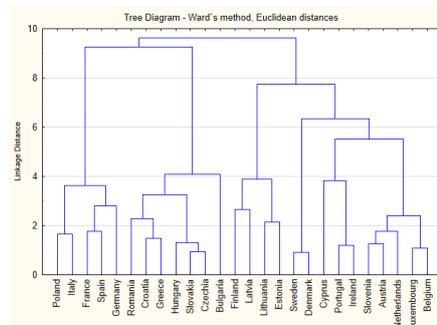


Fig. 1. Tree diagram – division of the EU countries into clusters characteristics of environmental pollution (X1-X6)

Lithuania is part of a common cluster with Estonia, Latvia and Finland.

The results of the clustering indicators Y1-Y6 are presented in Figure 2.

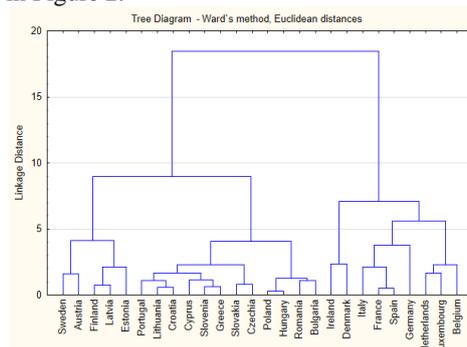


Fig. 2. Tree diagram – division of the EU countries into clusters characterizing the development of bioeconomics (Y1-Y6)

Table 2. As a result of the classification, 5 clusters were formed.

Cluster	Countries
A	Sweden, Austria, Finland, Latvia, Estonia
B	Portugal, Lithuania, Croatia, Cyprus, Greece, Slovenia, Slovakia, Czechia, Poland, Hungary, Romania, Bulgaria
C	Ireland, Denmark
D	Italy, France, Spain, Germany
E	Netherlands, Luxemburg, Belgium

Source: own elaboration based on the analyzed data.

Each resulting cluster has its own specifics. Lithuania is part of a common cluster with Portugal and Croatia.

The study may include further analysis of the selected indicators of the EU countries and may be expanded to include other countries and other factors.

- <https://ec.europa.eu>
- Montgomery D.C. Design and Analysis of Experiments. – John Wiley&Sons, 2008. – 680 p.