The environmental and resource productivity as the key element of green economy in EU

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Abstract. The purpose of this study was to analyze the indicators of environmental and resource productivity of European countries to identify leaders and outsiders and study their trends over recent decades. The results of the analysis showed that the indicators are characterized by uneven development, due to the characteristics of countries and their green policies. The key indicators of the Europe 2020 policy have been used for the analysis, namely resource productivity, greenhouse gas emissions per capita, recycling rate of municipal waste, eco-innovation index, final energy consumption in households. Linear trends for the period 1995-2019 with indication of trend equations were constructed for each indicator. The slope of the functions has been analyzed in order to identify the dynamics of trends. According to the results of the analysis, all indicators except greenhouse gas emissions per capita were characterized by positive dynamics, i.e., increased. It has been determined that the problematic indicator for EU countries is final energy consumption in households, which requires further detailed research.

1. Introduction
The modern world dictates new conditions for the competitiveness of economic systems, which consist in environmentally oriented activities aimed at green growth and the achievement of global sustainable development goals. In the context of green economy, the indicators of green growth: environmental and resource productivity, environmental quality of life, natural asset base, economic opportunities and policy responses, which were formulated by the OECD, shape the competitiveness of countries [1]. In a market economy, the core of the economic system is the element of production, which should acquire green characteristics especially in the form of environmental and resource productivity. The development of green sectors and industries results in conscious consumption and green investments aimed at supporting green business. All this should function in the conditions of state support, which should be formed with the help of administrative and fiscal instruments of green policy.

The key factors in the development of green production are such inputs as labor, capital and resources. In a green economy, inputs are transformed and take on new forms. Thus, the workforce should primarily be characterized by a high degree of human capital development, which becomes possible in an intellectual economy and is characterized by the process of intellectualization. Capital must be environmentally friendly, and therefore in the conditions of green growth and intellectualization it is transformed into green intellectual capital, the components of which are green
human capital, green organizational capital and green relational capital [2]. Production resources are also undergoing transformations and the global economic system is shifting to the use of alternative energy sources, biomaterials and renewable resources.

EU countries are considered leaders in the pace of implementation of the foundations of the green economy and are characterized by a high level of environmental and resource productivity [3]. In these circumstances, an important task is to analyze the successful strategies of green development of European countries in order to identify key success factors that can be adapted to the green course of different countries.

2. Related works

Achieving environmental productivity of economic systems is one of the EU's priority goals. With the establishment of humanity's course for sustainable development and the change of a linear type of economy to a circular one, the role of green innovations and technologies has increased, which would be characterized by productivity with simultaneous environmental orientation and aimed at overcoming global problems, primarily within the green economy to reduce carbon emissions and waste management [4].

The transition to a green economy is characterized by certain difficulties, especially for developing countries. This is due to the fact that not all countries have sufficient technical potential to implement green innovations, and the investment climate of some countries is not attractive for green investment. All this causes uneven development of green sectors in the world and is explained by the difference in environmental production capacity. A study by Mealy P and Teytelboym A [5] showed that the earlier countries receive environmental production opportunities, the greater will be its further achievements in the development of green economic sectors.

Since the transition to environmental development strategies, more attention in growth policies is paid to the concepts of green, circular and bioeconomy and implementation of their goals in the development strategies of countries. According to D'Amato D [6], most research on the green economy has been conducted in the EU and this is one of the reasons why European countries are considered leaders in achieving the goals of the green economy and sustainable development and are being studied by scientists to identify successful elements of green growth strategies.

Some scientists highlight environmental and resource productivity as the key factor in the success of countries, which is the basis of green growth [7, 8, 9, 10, 11, 12, 13, 14]. At the same time, within the framework of the European cohesion policy, the main emphasis was placed on supporting the old industrial regions and certain depressed areas, ensuring the outflow of capital and technology from the center to the periphery. Such support ensured the equalization of development at the European level while minimizing the negative effects in the areas that had the greatest environmental problems and at the same time a low level of economic development [15, 16, 17, 18, 19].

In these conditions, an important task is to assess the level of environmental and resource productivity of EU countries and the selection of leaders and outsiders. Therefore, the purpose of this research is to assess the productivity of EU countries and to identify groups of leaders and outsiders while determining their development trends.

3. Method

The research includes data collection of indicators of environmental and resource productivity of EU, analysis of their trends in order to understand which European countries are leaders and outsiders and which indicators are considered the major factors of green growth.

The information base of the study consisted of key indicators of Europe 2020 policy (resource efficiency indicators) – resource productivity, greenhouse gas emissions per capita, recycling rate of municipal waste, eco-innovation index, final energy consumption in households. The object of the study was EU member states as of 2021 (27 countries). To analyze the results, all indicators were presented graphically and analyzed for leaders and outsiders by indicators. For each of the indicators linear trends were formed over the period 1995-2019 and the equation of trend lines were reflected.
The obtained equations were analyzed by the slope of the function and conclusions were drawn about the development trend.

4. Results and discussions
According to the results of the analysis of the eco-innovation index as of 2019, the top five were Luxembourg with 165, Denmark – 146, Finland – 145, Austria – 130, Germany – 123 (with an accepted European average of 100). Outsider countries – Bulgaria – 34, Hungary – 54, Cyprus – 56, Romania – 57, Poland – 59 (Fig. 1). According to the results of final energy consumption in households as of 2019, the lowest amount (thousand tons of oil equivalent) was consumed by Cyprus, Luxembourg, Estonia, Slovenia and Latvia. In turn, Germany, France, Italy, Poland and Estonia were characterized by the highest rates (Fig. 2).

According to the greenhouse gas emissions per capita indicator as of 2019, the lowest indicators were shown by Sweden, Malta, Romania, Hungary and Latvia. Lithuania, Ireland, the Czech Republic, Cyprus and Estonia showed the highest level of emissions (Fig. 3). According to the indicator Recycling rate of municipal waste as of 2019, the highest level was demonstrated by Germany, Slovenia, Austria, the Netherlands and Belgium. The lowest levels of recycling were observed in Malta, Romania, Cyprus, Greece and Portugal (Fig. 4). According to the results of Resource productivity as of 2020, the leaders are Germany, Slovenia, Austria, the Netherlands and Belgium. The outsider countries were Malta, Romania, Cyprus, Greece and Portugal (Fig. 5).
For each of the analyzed indicators, linear trends were constructed based on the results of the average European level for the period 1995-2019. The equations of trends and dynamics are given in Table 1. It is possible to see that all indicators except greenhouse gas emissions per capita have a positive trend, i.e. are growing. This indicates an increase in the overall level of environmental and resource productivity of European countries.

However, the positive dynamics of the indicator final energy consumption in households reflects the presence of a problem in energy consumption by households, as the amount of energy consumed increases. This means that green programs need to pay special attention to increasing the energy productivity of households through green technologies, green building and alternative energy.
### Table 1 Trends for indicators of the environmental and resource productivity of EU, 1995-2019

| Indicator                              | Equation                  | Trend of the indicator |
|----------------------------------------|---------------------------|------------------------|
| Eco-innovation index                   | \( y = 1.1735x + 81.694 \) | Positive               |
| Final energy consumption in households | \( y = 172.08x + 251987 \)   | Positive               |
| Greenhouse gas emissions per capita    | \( y = -0.1398x + 11.218 \)  | Negative               |
| Recycling rate of municipal waste      | \( y = 1.1835x + 19.499 \)    | Positive               |
| Resource productivity                 | \( y = 0.0346x + 1.4161 \)     | Positive               |

At the same time, the Greenhouse gas emissions per capita indicator is characterized by negative dynamics, which indicates its reduction and means approaching the goals of the green economy, namely to reduce greenhouse gas emissions into the atmosphere.

### 5. Conclusion

The results of the study showed that the key indicators of environmental and resource productivity of European countries show positive dynamics. At the same time, the indicator Final energy consumption in households shows an upward trend, which indicates inefficient energy consumption by households and requires detailed research. In general, the indicators are characterized by uneven development of EU countries, due to their characteristics and green policies. The general trend of indicators reflects the increase in environmental and resource productivity of European countries in recent decades, as a result of successful green growth strategies.

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