EUROPE 2020 CLIMATE CHANGE AND ENERGY OBJECTIVES IN EU-15

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Abstract

The main purpose of the article is to compare the “old” European Union economies (EU-15) in regard to reaching climate change and energy objectives declared in the Europe 2020 plan. Based on the principals given by the European Commission result of countries should be verified with application of five criteria. This means that the comparison of the economies should be considered as a multiple-criteria analysis task. Thus, in current research multiple-criteria decision analysis method (TOPSIS) was used. The standard TOPSIS method is based on the Euclidean distance of objects from positive and negative ideal solutions. However, in the case of current research TOPSIS method with generalized distance measure GDM was used. The measure was applied due to its universality, as it can be used in the case of variables measured on the ratio scale, interval scale, the ordinal scale or the nominal scale. The analysis was conducted for the years 2005, 2010 and 2015. It was based on the Eurostat data. The method allowed to propose ranking and to group the countries into homogenous classes. In order to group the economies a natural breaks method was used. The conducted research enabled to verify the disparities between „old“ European Union countries.

Key words: climate change and energy, Europe 2020, EU-15, TOPSIS, generalized distance measure GDM

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Introduction

Climate change and possible human influence in this regard are currently considered as one of the main topics in ecological-political marketing in the European Union. The discussion in this regard has significant influence on policy making objectives, which can be seen in such long term strategies as Europe 2020 plan and political lobbying for implementing restrictions on national energy systems. As a result, climate change and energy objectives have significant influence in regard to national energy security strategies in the European Union countries.

Therefore, the main aim of the article is to compare the "old" European Union economies (EU-15) in regard to reaching the climate change and energy objectives declared in the Europe 2020 plan. The empirical analysis was limited to the EU-15 countries deliberately as they are characterised with significantly higher level of socioeconomic development than the new member states that joined the European Union after the year 2004. In the same time most of the "old" EU economies has significantly higher technological level than Central and Eastern European countries, which influences ecological effectiveness of their economies.

The current scientific problem was considered as a multiple-criteria phenomenon as the European Commission suggested five benchmark criteria that should be used for comparing the EU countries in this regard. Thus, in current research TOPSIS method with generalized distance measure GDM was used to conduct analysis for the years 2005, 2010 and 2015. The applied methodology enabled to order the EU-15 countries, which in the end were also grouped into homogenous classes with application of a natural breaks method.

1 TOPSIS method with GDM measure

In the case of decision making processes at organizational-microeconomic level and form policy-making perspective relating to regional and national strategies most of economic problems is difficult to measure and quantify (see Meluzi *et al.*, 2017; 2018a; 2018b; Mačerinskienė & Aleknavičiūtė, 2017) or is influenced by many determinants, which is the main justification for application of multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis (MCDA) methods in economic sciences (Balcerzak *et al.*, 2017; Zemlickienė *et al.*, 2018). This situation also relates to the objective of measuring abilities and achievements of the countries in reaching the climate change and energy objectives at national level. As a result, in the Europe 2020 plan European Commission provided five measurable criteria for climate change and energy objectives that should be applied in the process of comparing and benchmarking European Union members. The diagnostic variables for these criteria are provided by Eurostat. Four of these criteria should be considered as dis-stimulants, which means that the countries should aim at systematic reduction of the values of these variables. One of them is a stimulant, which means that high values of that variable are desired. The set of diagnostic variables declared by the European Commission is presented in Table 1.

Tab. 1: Diagnostic variables suggested by the European Commission for measuring the climate change and energy objectives in the EU countries

Variable	Description	Unit	Character
x1	Greenhouse gas emissions, base year 1990	Index (1990 = 100)	Dis-stimulant
x2	Share of renewable energy in gross final energy consumption	Percentage	Stimulant
x3	Primary energy consumption per capita	Million tonnes of oil equivalent (TOE) per capita	Dis-stimulant
x4	Final energy consumption per capita	Million tonnes of oil equivalent (TOE) per capita	Dis-stimulant
x5	Greenhouse gas emissions in ESD sectors per capita	million tonnes CO2 equivalent per capita	Dis-stimulant

Source: own work based on Eurostat data.

Providing five diagnostic variables for the description of the climate change and energy objectives means that the comparison of the European economies should be considered as a multiple-criteria analysis task. In the case of economics sciences, especially for spatial research (Pietrzak & Ziemkiwicz, 2017), linear ordering methods (Żelazny & Pietrucha, 2017; Kruk & Waśniewska, 2017) or cluster analysis (Rollnik-Sadowska & Dąbrowska, 2018) are commonly used. The objective of the article was ordering of the analysed countries form the “best” to the “worst”. Therefore, in the case of current research taxonomic measure of development (TMD) obtained with application TOPSIS method is used (Pietrzak, 2016; Kuc, 2017). In the case of TOPSIS procedure applied in the study instead of Euclidean distance the general distance measure GDM was used. The GDM measure was proposed by Walesiak (1999) and its biggest advantage is its universality in application. The GDM can be applied for variables measured on the ratio scale, interval scale, the ordinal scale or the nominal scale.

In the first step of the procedure for designation of TMD based on TOPSIS with GDM measure, the researcher should choose a multiple-criteria phenomenon under research, objects O_i and set of diagnostic variables X_j. The current analysis is devoted to the Europe 2020 climate change and energy objectives as the multiple-criteria phenomenon, where EU-15 countries make the set of objects O_i, and the set of diagnostic variables X_j was provided by the European Commission and described in Table 1. Then, the diagnostic variables should be standardised, for example, with application of formula 1:

$$Z_j = \frac{X_j - M(X)}{S(X)} \tag{1}$$

where $M(X)$ is an arithmetic mean, and $S(X)$ is a standard deviation of diagnostic variables.

Then, the pattern of development P_j, commonly called as a positive ideal solution, and anti-pattern of development AP_j, called as a negative ideal solution, should be determined for all standardised diagnostic variable Z_j. The values of P_j are determined as maximum valued of a diagnostic variable in the case of stimulants, and minimum values for dis-stimulants. The values of anti-pattern AP_j are set in the opposite way. In the case of the research for few years constant values of patterns P_j and AP_j must be taken, which is a condition for obtaining comparability of the results in time (Wierzbicka, 2018).

In the next step, for every object O_i, the GDM distance to pattern P_j d_i^+ and GDM distance to anti-pattern AP_j d_i^- are determined. The detailed description of the procedure for assessing the GDM measure is available in the article by Walesiak (1999). In the case of current research the estimation of GDM distance was conducted in the R-Cran software – Package.

Finally, the value of TMD for every object O_i can be determined with application of formula 2:

$$TMD_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{2}$$

Based on the obtained TMD measure a natural breaks method can be used for grouping the analysed objects into relatively homogenous subsets (see Bartkowiak-Bakun, 2017; Pietrzak *et al*, 2017).

2 Research results

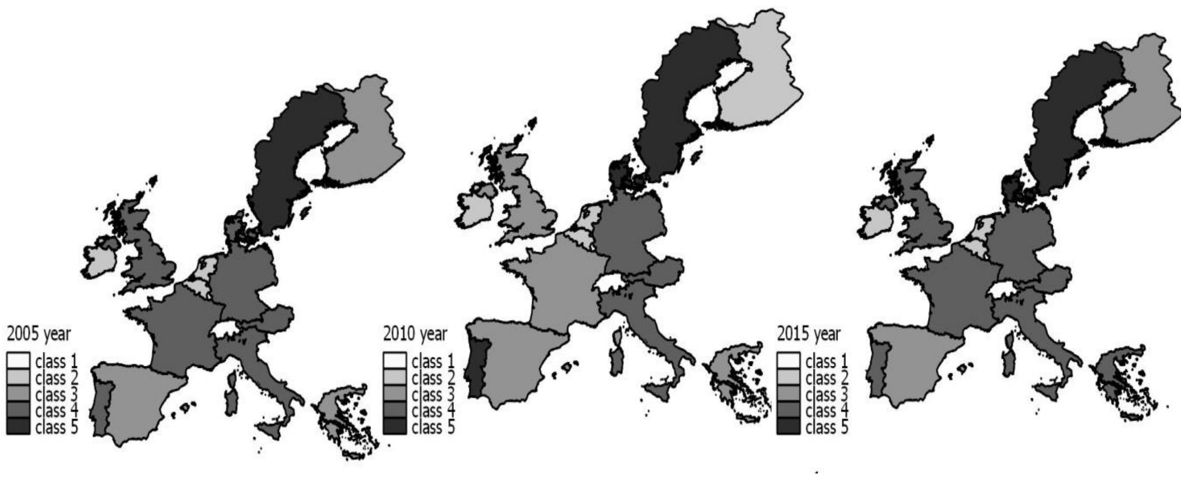
In the article EU-15 countries were analysed in regard to their achievements in reaching the climate change and energy objectives declared by the European Commission in the Europe 2020 plan. The research covered three separate years 2005, 2010 and 2015. The time span of the research is the result of data availability in the Eurostat data base. From the perspective of the nature of the analysed phenomenon the five year sub-periods may be considered as long enough to provide information on the structural changes in the analysed group of countries. For the subsequent years, the values of the TMD were determined with application of the procedure described in previous section and based on the diagnostic variables presented in Table 1. After obtaining the TMD values a natural breaks method was used to group the countries into 5 homogenous classes. The result are given in table 2 and figure 1.

Tab. 2: Ranking of the EU-15 countries

Country	2005			2010			2015		
	TMD	Rank	Class	TMD	Rank	Class	TMD	Rank	Class
Denmark	0,640	2	4	0,753	2	5	0,926	1	5
Sweden	0,782	1	5	0,820	1	5	0,909	2	5
Italy	0,542	5	4	0,697	4	4	0,817	3	4
Austria	0,540	6	4	0,695	5	4	0,797	4	4
Portugal	0,558	4	4	0,746	3	4	0,783	5	4
Greece	0,475	9	4	0,602	9	4	0,780	6	4
Germany	0,599	3	4	0,663	6	4	0,739	7	4
France	0,535	8	4	0,629	7	4	0,733	8	4
United Kingdom	0,538	7	4	0,628	8	4	0,730	9	4
Finland	0,431	10	3	0,387	13	2	0,662	10	3
Spain	0,425	11	3	0,582	10	3	0,659	11	3
Belgium	0,356	13	2	0,403	12	2	0,546	12	2
Netherlands	0,382	12	2	0,373	14	2	0,528	13	2
Ireland	0,322	14	2	0,405	11	2	0,473	14	2
Luxembourg	0,041	15	1	0,055	15	1	0,104	15	1

Source: own estimations based on Eurostat data.

Fig. 1: Grouping of the EU-15 countries



Source: own estimations based on Eurostat data.

The study made it possible to assess the situation regarding the process of implementation of the climate change and energy objectives in 2005, 2010 and 2015. It should be emphasized that for the selected years the classification of countries into classes has slightly changed. However, the value of the TMD systematically increased over time. It means that the EU-15 countries were pursuing a positive policy in order to adapt their economies to the principals given by the European Commission.

In the class 5, which was grouping the "best" countries in regard to the climate change and energy objectives, in 2005 only Sweden was assigned. However, in 2010 and 2015 the class was enlarged with Denmark, which was promoted from class 4. It is necessary to distinguish Sweden and Denmark, which are the leading Scandinavian countries in meeting the principals given by the European Commission. Therefore, these economies can be considered as the positive benchmark countries in this regard.

The following countries were assigned to class 4 with an "average" results in implementing climate change and energy objectives in the analysed years: Italy, Austria, Portugal, Greece, Germany, France and United Kingdom. As it was already mentioned in 2005, Denmark also belonged to class 4. In class 3 – also with an average level of the analysed phenomenon – one could find Spain in the entire period, and in 2005 and 2015 also Finland. It could be seen that in 2010 Finland was degraded to class 2 from class 3.

Countries with a relatively "low" results in reaching the objectives were grouped in class 2. In this group Belgium, the Netherlands and Ireland could be found for all the years. As it was mentioned, in addition, to this class in 2010 Finland was also assigned. These countries are distinguished negatively in terms of reaching the climate change and energy objectives, compared with the countries from classes 5,4 and 3.

The lowest TMD value for all the years was recorded for Luxemburg. This result to some extent can be a consequence of the specifics of the country in regard to its population and the limitations of the Eurostat data – discrepancy between the official population of the country and non-residents who are not included in the official statistics but who contribute to the level of economic activity. However, it can be also noted that in the subsequent periods, also in this country an increase in the TMD level is visible.

Conclusion

The objective of the article was to compare the EU-15 economies in regard to reaching the climate change and energy objectives declared in the Europe 2020 plan. The proposed research problem was considered as a multiple-criteria analysis task. In order to order the analysed countries TOPSIS method based on generalized distance measure GDM was used, which enabled to obtain a taxonomic measure of development for the analysed phenomenon. After obtaining the TMD measure it was possible to group the countries into homogenous five subsets.

The conducted research enabled to verify the disparities between „old" European Union countries, which to a high extent are analogous to socio-economic level of development of the analysed economies. As the second empirical contribution the current article confirms positive tendencies in the process of reaching the climate change and energy objectives. The third empirical contribution of the article can be related to the confirmation of relatively high stability of the obtained results in time. This factor indicates that improving ecological sustainability of the economies, even in the case of developed countries, is a long term process, which should be especially taken into consideration in the case of European objectives that must be implemented at national level by lower developed economies of the European Union.

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