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ECONOMIC DEVELOPMENT OF EUROPEAN UNION COUNTRIES AND IMPLEMENTATION OF THE CLIMATE AND ENERGY PACKAGE

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ABSTRACT: Economic development, being the primary objective of most nations, undoubtedly favours industrial production over environmental concerns. In an effort to balance the gains and losses resulting from industrial growth across the EU, regulations were imposed with regard to renewable energy sources, greenhouse gas emissions (GHG) and energy efficiency. The paper seeks to determine whether, and to what extent, economic growth is accompanied by commitment towards environment and climate protection on the part of the EU countries. To answer this question basic indicators were analyzed with the use of statistical measures and trend analysis. Diagnostic variables were standardized by the zero unitarization method. Finally, a classification of EU member states was constructed. It revealed that in both study years Austria, Denmark, Luxemburg and Sweden were the most economically and ecologically sustainable countries, joined by Ireland in 2016. Bulgaria, Estonia and Slovakia fell at the other end of the spectrum.

KEY WORDS: economic growth, climate and energy package

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Introduction

European Union sets stringent targets for its member states with regard to reduction of carbon dioxide emissions. The goals set for 2020 and later, for 2050, are a chance for advancing new technologies, but at the same time they constitute a threat in the form of barriers to economic growth. These objectives firmly encourage the use of renewable energy and lie at the core of the energy policy of the EU (Directive 2003/87/EC).

Energy policy is closely tied to economic growth. Today's economies consume increasingly larger amounts of energy coming from both renewable and non-renewable sources. Since energy consumption hugely affects the climate, European Union pursues mitigation targets pertaining to climate protection, energy efficiency and use of renewable energy sources. The EU's fundamental document in this respect is the Climate and Energy Package adopted in 2008. It identified three main targets: reduction of GHG emissions, promotion of the use of energy from renewable sources and improvement in energy efficiency of the EU countries (so called 20-20-20 targets). This means that member states are obliged to:

- reduce CO_2 emissions (by 20% in 2020 in comparison to 1990),
- increase the use of renewable energy (by 20% in 2020 in the EU, by 15% in Poland),
- improve energy efficiency (in 2020 by 20% in comparison to 2005) (Directive 2009/28).

The paper aims to analyze cross-country differences in environmental concern across the EU and changes taking place in this respect. Therefore answers were sought to the following questions:

- Are the targets realized to a sufficient degree?
- Do integration processes promote lessening of differences with regard to better environment protection and increased use of renewable energy across the EU?
- Does economic growth spur environmental quality and activities?

To address these questions, the ongoing changes were analyzed by trend analysis, and the forecast for the key indicators was made. Finally, a ranking of EU countries for the study years was made, based on adopted diagnostic features and with the use of zero unitarization method.

Overview of literature

Analysis of a country's economic development based on GDP only is not very reliable as it overlooks the human factor and other factors affecting the kind and scale of changes. Many authors and researchers explore the controversial issue of measuring development. Some researchers rely only on synthetic measures based on GDP (Piotrowski, 2015; Makrosińska, 2011), whereas others, seeking more reliable proxy measures, apply diagnostic variables to describe socio-economic changes (Tendera-Właszczuk, 2016; Bąba, 2016; Majewski, 2017).

Development of indices based on taxonomic methods initiated Beckerman and Bacon. They proposed the Net Economic Prosperity Index and they accepted the United States as a model (Beckerman, Bacon, 1966).

An important synthetic development indicator is the Social Development Index (HDI). It combines the economic sphere with the qualitative aspects of development.

Governments of all countries try to ensure that economic growth acts as a driving force for further economic development, the imperative of which prioritizes production over environment protection. Efforts to balance losses and gains resulting from economic activities and create ecologically sustainable societies took shape in the form of green politics and such theories as *Green Political Theory* or *environmentalism* (Piotrowska, 2008).

The Environment Endangerment Index (EEI) was proposed, which was based on the degree of afforestation of the country, the percentage of plants and animals threatened with extinction and the emission of greenhouse gases. Ramanathan, by adjusting the standard HDI by the EEI value, received Environment Sensitive HDI (Neumayer, 2004).

A country's economic development should translate into welfare of its citizens. To achieve this goal it is necessary that the country uses its natural resources. In today's world the natural environment is exploited, sometimes excessively, and therefore another key target is set by each country – to minimize resource consumption in order to preserve resources for future generations. The theory of sustainable development is one of such attempts seeking to harmonize these two goals (Dobrzański, 2011).

The main goal of sustainable development is to improve the quality of life through increasing welfare for the sake of present and future generations. This goal can be achieved by creating sustainable societies that know how to use natural resources efficiently and wisely, and how to benefit from social-ecological innovation. A sustainable society can ensure welfare of the people, environment protection and social cohesion. Environmental wellness is a prerequisite for people's general welfare and wellbeing. And again, to fulfill the mission of societal and environmental welfare, economic wellbeing is necessary, which, however, is not a goal in itself (Gechey, 2005; Kerk, 2016; Karmowska, 2017).

The system approach to sustainable development is illustrated by the Venn diagram, which presents sustainable development as the point of intersection of the goals assigned to the three connected systems: environmental (or ecological), economic and social. It shows that an attempt to maximize the goals of only one system does not ensure balance because it does not take into account the impact of other systems. Sustainable development can only be achieved by balancing the tradeoffs among the various goals of the three systems (Barbier, Burgess, 2017).

Sustainable economic development of the EU countries is a subject of many academic studies. For the purposes of such analyses various indicators are constructed that take into account, inter alia, Environmental Wellbeing (Sustainable Society Index, SSI), environmental performance (Environmental Performance Index, EPI) or eco-innovation performance (Eco-Innovation Scoreboard) (Karmowska, Czaja, Jach-Chrzaszcz, 2018). Overview of Indices of Sustainability or Societal Progress shown in technical report by Saisana and Philippas. This report addresses the need to go beyond GDP to assess social progress. Key results on the world landscape of societies' achievements confirmed the inverted shaped relationship between Economic and Environmental Wellbeing. The Environmental Wellbeing had a strong and negative correlation to the Human Wellbeing and to the Economic Wellbeing. Only in a few countries, Human and Economic well-being go hand in hand, but often at the expense of environmental well-being (Saisana, Philippas, 2012).

Rational use of renewable energy harvested from wind, sunlight, geothermal sources, river gradients, biomass and landfill biogas is one of the crucial elements of sustainable development which bring about quantifiable ecological and energy effects. Increased share of renewable energy in the overall global fuel-energy balance contributes to improved efficiency in the use and management of natural resources, and plays an important role in improving the condition of the environment through reduced air and water pollution and reduced waste production.

To determine energy intensity of individual countries and regions the GDP indicator is used (energy intensity of GDP as index of energy conservation). Yet, one should bear in mind that energy intensity of GDP is not an ideal measure even when the Purchasing Power Parity (PPP) is taken into account. However, energy intensity of GDP is not the only available measure of energy intensity in inter-country comparisons (Efektywność..., 2017). Energy intensity of GDP can be to contain the two concepts of Energy efficiency on the production system and efficiency on lifestyle. However, their directional characters are not necessarily the same. Manufacturing productivity in economically developing counties is generally inefficient while their living standard is lower and energy consumption is smaller. It is impossible to accurately evaluate how advanced a country's energy conservation is and measure it against that of other countries, which are different not only in terms of their economies and welfare level but also in natural social conditions. However, numerical evaluation or energy conservation levels or potential energy conservation levels for any country is of interest for international politics surrounding environmental problems and energy conservation policies (Suehiro, 2007).

Research methods

The paper seeks to determine whether, and to what extent, economic growth is accompanied by commitment towards environment and climate protection on the part of the EU countries. To answer this question basic indicators were analyzed with the use of statistical measures and trend analysis. Diagnostic variables were standardized by the zero unitarization method. Finally, a classification of EU member states was constructed.

The paper made use of statistical data from the World Bank, Eurostat and the Sustainable Society Foundation. The research covered 28 EU member states (as of 2017) over the 2008-2017 period. Research questions were analyzed from the static and dynamic perspective.

To find answers to the research questions posed, the following indicators were used:

- Gross Domestic Product (GDP),
- Human Development Index (HDI),
- Environmental Wellbeing (EnvW),
- Renewable Energy (RES) in overall gross energy consumption,
- Energy Intensity of GDP (MJ/GDP) Greenhouse Gas Emission (GHG).

The indicators served as basis for analysis, evaluation of trends, development of forecasts and ranking of countries.

GDP was adopted as a basic measure of economic development. Although GDP is not a perfect measure of economic changes, it still remains the primary measure of development, in particular when GDP per capita is applied.

The HDI index contains more information about socio-economic development as along with GDP, as it also measures other dimensions of human development, such as life expectancy and education.

Another indicator, that is Environmental Wellbeing, is concerned with two dimensions: Natural resources and Climate and energy. The latter takes into account energy consumption, energy conservation, greenhouse gases and renewable energy. Each wellbeing dimension is evaluated separately on a 10 point numeric scale (from 0 to 10), where 10 stands for highest level of sustainability. To each variable the same weights were attributed. Geometric mean of all variables within one category and one wellbeing dimension allows for an overall evaluation of wellbeing sustainability and ranking of countries.

The share of renewable energy in final gross energy consumption is yet another variable, and one that is important in the light of the targets set in the Climate and Energy Package.

To determine energy efficiency the indicator of energy intensity of GDP was applied. Energy intensity level of primary energy is the ratio between energy supply and gross domestic product measured at purchasing power parity (PPP). It is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is consumed to produce one unit of output.

Waste generation, including non-renewable waste, continues to increase in line with economic growth. This means that the better we manage waste, the better it is for the environment. Unfortunately, due to incomplete data, the variable measuring non-renewable waste use could not be included in the analysis.

Finally, the last variable considered was the Greenhouse Gases Emission (GHG). Although they are present in small concentrations, they are potent gases that trap heat effectively, making them high "global warming potential" gases. Varied inventory of greenhouse gases worldwide and their increasing concentration can lead to rapid temperature rise. Therefore firm action was taken to commit state parties to reduce greenhouse gas emissions (United Nations Framework Convention on Climate Change – Rio de Janeiro, 1992; Kyoto Protocol, 1997; Wysokińska, 2016).

Basic statistical values were calculated for the aforementioned variables, as well as trend function for extreme (minimum and maximum) and average value parameters. Evaluated functions were pursued only if the value of determination coefficient was high and the structural parameters were significant. In case a linear trend was observed, *a* regression coefficient was interpreted as a measure of dynamics of medium-term increases/declines. Moreover, forecasts were made for individual EU countries to check to what extent the Climate and Exchange Package targets will be achieved in 2020 (Nowak, 2002; Kukuła, 2003).

Artificial variables were computed for selected indicators, which helped in the grouping of countries and making a ranking. Variables were standardized using the method of zero unitarization (Nowak, 1990; Kukuła, 2000). The method is a transformation of diagnostic variables of different weights that brings their values to the state of comparability since after the method is applied, variables have no weights. Hence, the method allows for multicriteria evaluation of objects and their comparison with regard to a selected complex phenomenon.

Standardized variables z_{ij} were computed according to the formula for stimulants (formula 1):

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij}, \tag{1}$$

and for destimulants (formula 2):

$$z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}; \quad \max_i x_{ij} \neq \min_i x_{ij}' . \tag{2}$$

Subsequently, synthetic variables $q_{i,}$, their mean values and deviations were calculated (formulas 3):

$$q_i = \frac{1}{s}\sum_{j=1}^{s} z_{ij}; \quad \overline{q} = \frac{1}{r}\sum_{i=1}^{r} q_i; \quad S(q) = \left[\frac{1}{r}\sum (q_i - \overline{q})^2\right]^{0,5}. \tag{3}$$

Countries were clustered with the use of synthetic aggregate measure (q_i):

Group	Class interval	Development level
I	$q_i \geq \overline{q} + S(q)$	high
II	$q_i \in \langle \overline{q}, \overline{q} + S(q))$	above average
III	$q_i \in \langle \overline{q} - S(q), \overline{q})$	below average
IV	$q_i < \overline{q} - S(q)$	low

The higher the group, the higher is the level of development of a given country in comparison to EU mean.

Application of synthetic measures that capture many developmental aspects is an alternative source of information for partial measures. The use of partial measures only can limit the overall evaluation of development, albeit synthetic measures are problematic in terms of results interpretation though they allow to group and evaluate changes in the classification of objects.

Research findings

The most commonly used indicator to measure economic development is GDP per capita. In the analysis of changes in GDP per capita in the EU minimum, maximum and average value trends were considered (figure 1).

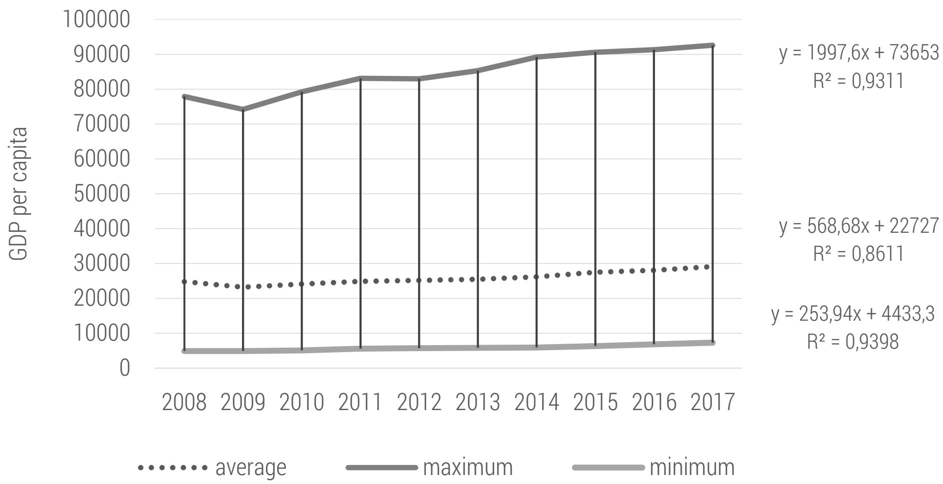

Figure 1. GDP *per capita* in EU countries [current prices, euro]

Source: author's own work based on https://ec.europa.eu/eurostat/data/database.

Unfortunately, the above reveals that although trends indicate overall growth, differences between countries are also growing: economic welfare in the richest countries (maximum values – regression coefficient equal to 1998) increases eightfold faster than in the poorest countries (minimum values – regression coefficient equal to 254). In 2008 the variation between the richest and poorest countries (maximum and minimum values) was ca. 73K euro, whereas 10 years later it increased by 12,3K euro (ca. 17%).

As mentioned before, GDP per capita is not the best measure of a country's economic welfare and economic health. Therefore, to get a wider socio-economic development, values of HDI – which considers also life expectancy and education – were analyzed. Similarly, maximum, minimum and mean value trends were analyzed for the EU countries (figure 2).

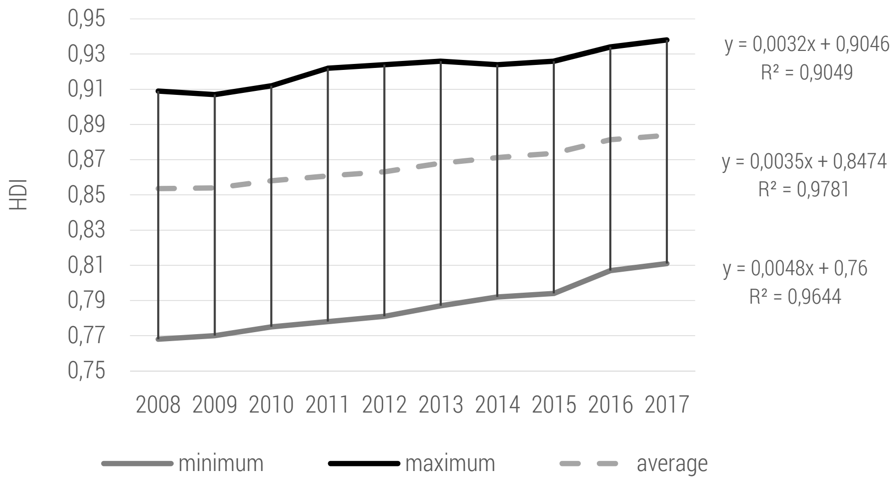

Figure 2. HDI index in years 2008-2017 in EU countries

Source: author's own work based on Human Development Indices and Indicators 2018 Statistical Update UNDP, 2018.

HDI trends indicate divergence between the EU countries. Countries with the lowest HDI scores show a 1.5 faster increase in its value (by annual average of 0.0048) in comparison to the richest countries. These increases are relatively small, since all EU member states are highly developed and their HDI score is above 0.77. In the study period, despite the variation coefficient remaining at the level of ca. 4%, convergence was observed (the gap between EU countries decreased by ca. 11%). It results from increased availability of education and improved standard of living which affects life expectancy.

Economic development is tied to increased demand for energy, which has its consequences for the natural environment. A composite indicator that takes into account energy consumption is the Sustainable Society Index (SSI). It captures a country's stability with regard to three wellbeing dimensions: people, environment and economy. The three dimensions are evaluated separately and they are not aggregated into a single value for the overall composite. Since this paper focuses on renewable energy, only one dimension of SSI – Environmental Wellbeing was used in the analysis (figure 3).

The Environmental Wellbeing (EnvW) subindex indicates divergence of EU countries in this regard. Mean value trend reveals an increase in environmental wellbeing, however, in countries with the lowest EnvW score this dimension shows no significant changes (therefore trend function could not be calculated). In 2008 the lowest value was scored by Belgium – 2.18, and in 2016 by Estonia – 2.21. The subindex maximum value increased significantly, from, respectively, 4.65 to 5.93 (for Croatia in both study years). These are not satisfactory values when juxtaposed against the maximum score of 10. It means that European countries still face many challenges in the field of environmental protection.

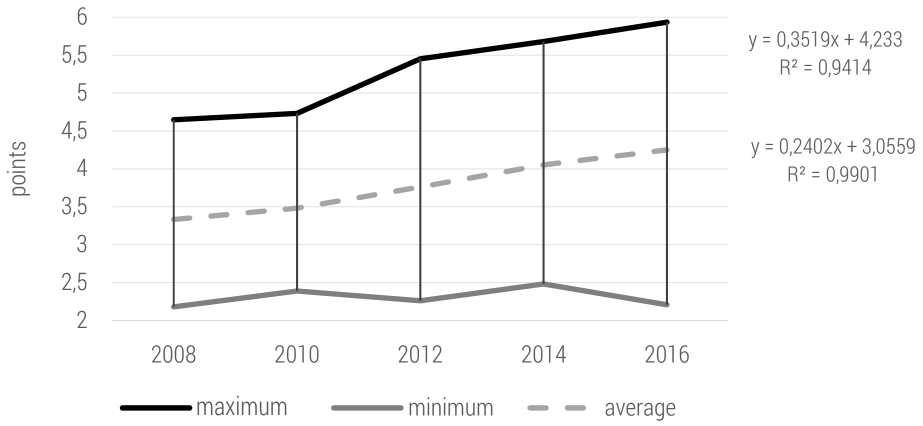

Figure 3. Environmental Wellbeing in EU countries

Source: author's own work based on Sustainable Society Foundation SSI, 2017.

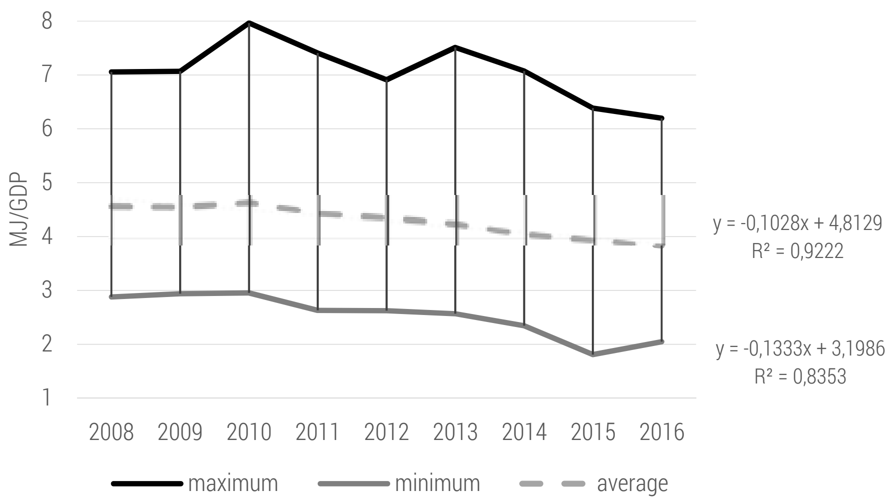

Figure 4. Energy Intensity of GDP (MJ/PKB) across the EU

Source: author's own work based on Data World Bank.

A positive phenomenon observed in the study period was the persistent decreasing trend in energy intensity of GDP across the EU. The mean and lowest values of this tendency are described by linear trends, whereas for the highest values – by a quadratic trend (figure 4).

The annual average energy intensity showed a decline of ca. 0,1 MJ/PKB and decreased by ca.16% compared to 2008. The biggest decline, of ca. 30%, occurred in the most energy efficient countries (annual average of 0.13 MJ/GDP). Ireland turned out to be most energy efficient, as in 2008 its energy intensity indicator was 2.88 MJ/GDP and the 2016 indicator showed a decline by ca.30%. Bulgaria scored at the other extreme with energy efficiency of ca. 7 MJ/GDP in 2008 and 6 MJ/GDP in 2016 (decline by 12%). Despite changes taking place over the study period, variation between the EU countries in terms of energy intensity remained at roughly the same level, that is ca. 28%.

In 2016, compared to 2008, 10 countries increased their energy efficiency by over 20%, which means that they have achieved the target set forth in the climate and energy package. The trend analysis shows that not all countries will be able to reach this threshold by 2020. Assuming a ca.1,8% annual average increase in energy efficiency, 7 countries will not be capable of reaching the 20% target within just 4 years. This means that there will be 10 countries that will fail to meet the 20% reduction target.

Renewable Energy Sources (RES) have an increasingly more important role for fulfilling energy demand. RES harvests energy from wind, sunlight, geothermal sources, river gradients, marine waves and currents, biomass and landfill biogas, as well as biogas generated from sewage sludge disposal and treatment, or decomposition of organic matter.

Application and development of RES is one of the key focuses of EU Energy Policy 2030. Such current energy policy agenda is driven by the carbon dioxide reduction targets adopted by the European Union. The targets set until the year 2020, and in fact until 2050, are also an opportunity to foster new technologies.

Across the EU a systematic increase in the share of renewable energy in final energy consumption was observed (figure 5).

In the 2008-2017 period, the share of RES showed an average annual increase of ca. 0.8%. The lowest values demonstrated a similar increase. The most dynamic increase of ca.1,01% was shown by the highest values. This confirms that the range in the share of RES is becoming even wider, that is from 45 pp. to 48 pp. Pursuant to the EU Directives, each member state should reach the 20% renewable energy target in 2020. In 2008 only 7 states met that threshold, and in 2012 it was 11 states, and that number did not change in 2017. As the forecast based on linear trends for individual countries reveals, still 11 EU states will meet this target in 2020 (figure 6).

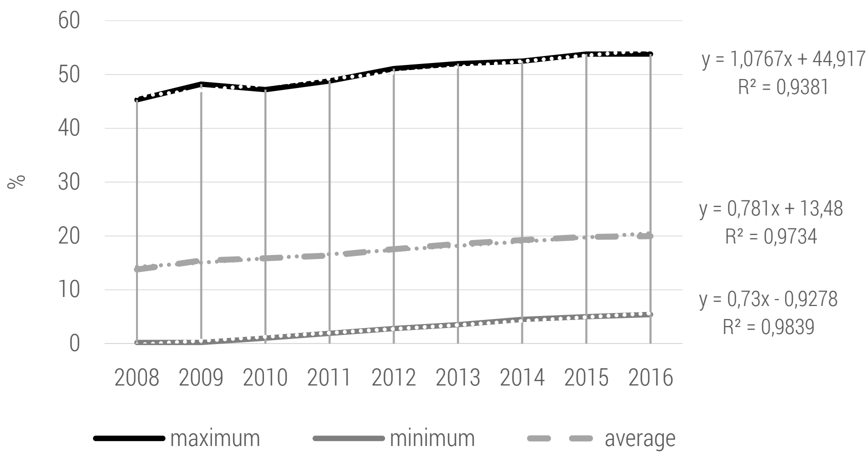

Figure 5. Share of renewable energy in gross final energy consumption in the EU
Source: author's own work.

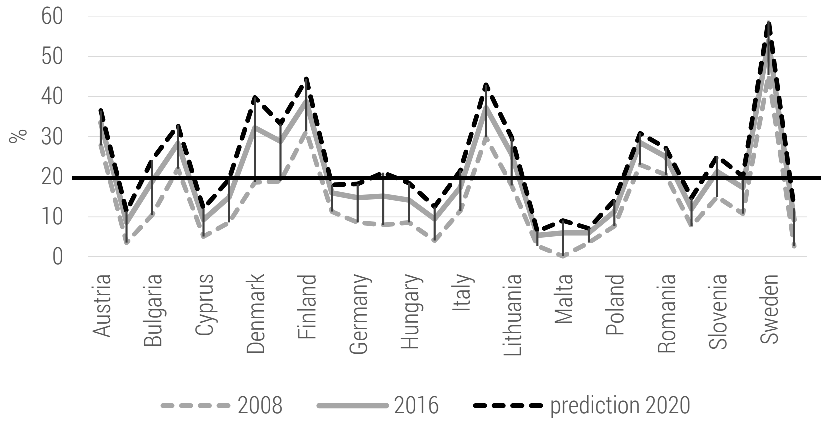

Figure 6. Share of renewable energy in gross final energy consumption in EU countries
Source: author's own work based on Eurostat.

Malta registered the lowest levels of energy generation from green sources both in 2008 (0,2%) and 2017, despite the increase to 7%. Conversely, in Sweden the share of clean energy sources in 2008 was 45.2% and had increased by 9,3 pp by 2017. In 2008 only 7 countries exceeded the 20% renewable energy target (Austria, Croatia, Finland, Latvia, Portugal, Romania, Sweden). They were joined by Croatia, Denmark, Estonia, Lithuania i Slovenia in 2017.

On average, the share of RES in final energy consumption increased by 6.7 pp in 2017. The Netherlands and Poland demonstrated the smallest increase, ca. 3 pp respectively, whereas the biggest increase (of 17.2 pp) occurred in Denmark.

Naturally, all endeavors aimed at improving energy efficiency and increasing renewable energy production should imply reduced greenhouse gas emission. In the study period average CO_2 emission across the EU declined by ca. 3 mln tons, that is an annual average of ca.2%. If this trend continues until 2020, most of the EU states will be likely to meet the targets of the Climate and Energy Package. However, such a conclusion based o average values does not translate into trends in individual countries. Geometrical mean for respective countries shows a decline of 1 to 3 pp., which means that 15 countries have not met the 20% reduction target, and 5 of them have not met even the 10% target (Bulgaria, Estonia, Germany, Netherlands, Poland). Germany is the biggest emitter of greenhouse gases in Europe. In 2008 Germany emitted ca. 780 mln tons of CO_2 (CO_2 equivalent is a metric measure used to compare emissions), and the emission was reduced by merely 7% by 2016. Malta emitted the least CO_2 and reduced the emission by 37% (down to 1,8 mln tons) in 2015 as compared to 2008. Besides Germany, only Poland, Netherlands and Bulgaria succeeded in bringing CO_2 emission down to less than 10%. On the other hand, compared to 2008, 11 EU states reduced CO_2 emission, though they still exceeded the 20% target. Although the volume of CO_2 emission is related to, *inter alia*, the size of a country and its level of industrialization, the reduction level is definitely the result of preventive measures undertaken by governments.

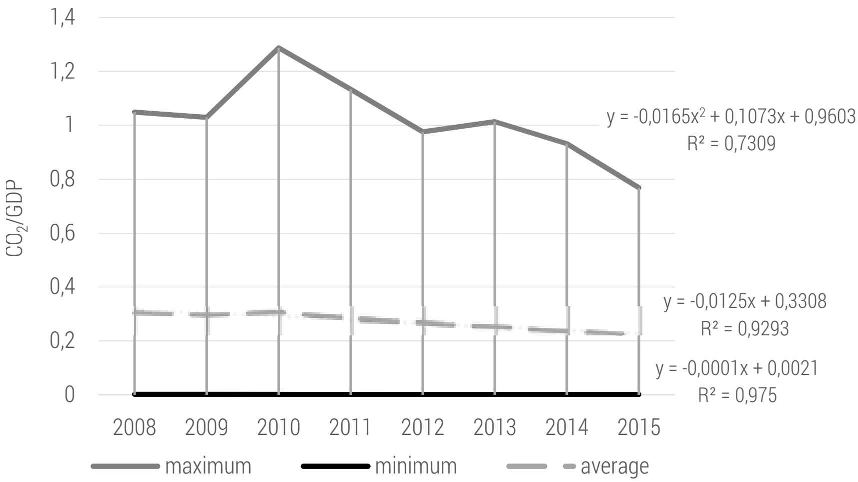

Figure 7. Greenhouse Gas Emission per GDP in the EU [thousand tons CO_2/GDP]

Source: author's own work based on Eurostat.

Therefore, to provide a more reliable comparison of countries with different GDP levels, an indicator of GHG emissions per GDP expressed in CO_2 equivalent was proposed (figure 7).

These trends reveal a declining trend in GHG emissions, to be exact, by average annual of 12.5 tons CO_2 in the study period. It is reassuring that the countries with high GHG emission reduce it more and more effectively, as captured by the quadratic trend. As it comes to countries with the lowest GHG emissions per GDP, a decreasing trend was also found (regression coefficient of -0,0001).

Hungary, Sweden, Denmark and the Czechia had the lowest GHG emission per GDP levels (below 0.03 CO_2/GDP) in the 2008-2016 period. Comparison of 2008 and 2016 gas emissions per GDP reveals a 30% decline on average. It was Malta that achieved the biggest reduction of ca. 70%, whereas Greece, with only 13% reduction, fell at the opposite end of the spectrum. Trend function was used to make a forecast for the year 2020 for EU countries (figure 8).

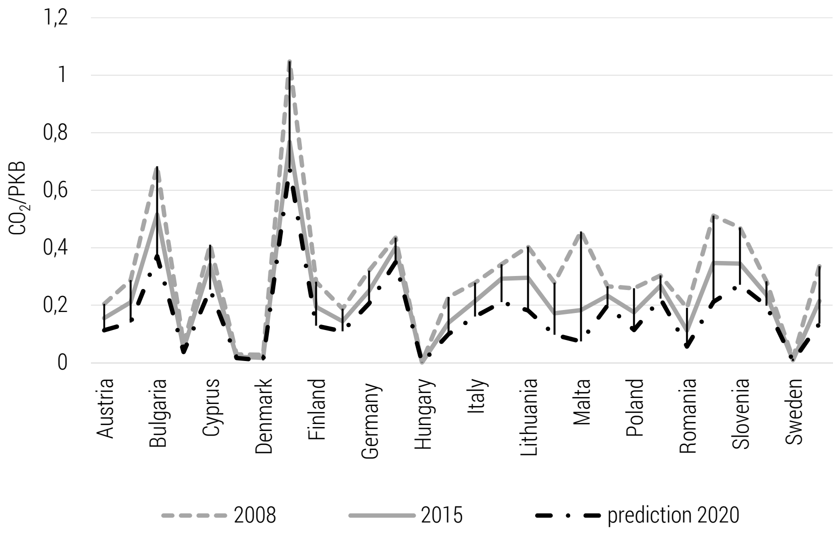

Figure 8. GHG emission per GDP across the EU countries

Source: author's own work based on Eurostat.

Assuming that the declining trend in GHG emission per GDP continues, in 2020 we can expect a ca. 35% decrease in that indicator as compared to 2008.

After the variability of potential diagnostics features was analyzed and their correlation asserted for the sake of constructing an artificial variable that took into account both the economic and environmental welfare, 4 variables were adopted, including 2 stimulants: GDP per capita, share of RES in gross energy consumption and 2 destimulants: gas emission per GDP and energy intensity of GDP. The variables were used to create a ranking of EU states in the years 2008 and 2016 (table 1).

Table 1. Ranking of EU member states

Countries	Ranking	
	2008	2016
Austria	3	5
Belgium	21	21
Bulgaria	28	28
Croatia	7	7
Cyprus	19	20
Czechia	23	24
Denmark	2	1
Estonia	27	27
Finland	13	16
France	11	14
Germany	14	13
Greece	17	23
Hungary	18	18
Ireland	5	4
Italy	8	8
Latvia	9	6
Lithuania	24	17
Luxembourg	4	3
Malta	20	11
Netherlands	12	19
Poland	25	22
Portugal	6	9
Romania	15	10
Slovak Republic	26	26
Slovenia	22	25
Spain	10	15
Sweden	1	2
United Kingdom	16	12

Source: author's own work.

In both study years Denmark and Sweden came at the top of the ranking, followed by Austria, Ireland and Luxembourg. Conversely, Bulgaria, Estonia and Slovakia came at the bottom of the ranking persistently scoring the last positions (26-28). The biggest positive change was recorded for Malta which advanced from the 20th position in 2008 to 11th position in 2016, followed by Lithuania which jumped from the 24th place to 17th. Conversely, Greece fell from 17th to 23rd place and the Netherlands from 12th to 19th position in the ranking.

A classification made on the basis of research findings identifies 16 countries in 2008 and 17 countries in 2016 that most successfully reconciled economic development with environment protection most successfully (above average) (table 2).

Table 2. Grouping of EU countries according to artificial variable

Clases	Countries in 2008	Countries in 2016
1	Austria, Denmark, Luxemburg, Sweden	Austria, Denmark, Ireland, Luxemburg, Sweden
2	Croatia, Finland, France, Germany, Ireland, Italy, Latvia, Netherland, Portugal, Romania, Spain, United Kingdom	Croatia, Cyprus, Finland, France, Germany, Italy, Latvia, Malta, Portugal, Romania, Spain, United Kingdom
3	Belgium, Cyprus, Czechia, Greece, Hungary, Lithuania, Malta, Poland, Slovenia	Belgium, Greece, Hungary, Lithuania, Netherlands, Poland, Slovenia
4	Bulgaria, Estonia, Slovakia	Bulgaria, Czechia, Estonia, Slovakia

Source: author's own work.

Conclusions

Global challenges such as climate change, energy security and natural resource depletion require urgent actions aimed at improving Environmental Wellbeing, with focus on, in particular, renewable energy (RHS), GHG emissions and energy efficiency.

A systematic increase of clean energy in gross final energy production and consumption was observed in the EU. The RES share grew by an annual average of ca. 0,8% in the 2008-2016 period. The forecast made by the author projects that only 14 states will reach the 20% renewable energy target in 2020.

Yet another positive phenomenon observed is the decline in energy intensity of GDP. Energy intensity showed an average annual drop of ca. 0.1 MJ/GDP and decreased, as compared to 2008, by 16%. However, trend analysis revealed that not all of the EU states will be able to meet the 20%

reduction target by 2020. It is highly likely that this target will not be reached by 10 EU states.

Actions aimed at improved energy efficiency and increased green energy consumption should translate into reduced greenhouse gas emission. The average annual decline in CO_2 emission across the EU was ca. 3 mln tons which comes up to ca. 2%.

To measure GHG emission intensity an indicator of CO_2 emission per unit of GDP was introduced. In the author's opinion when comparing countries this indicator is more reliable, which is also true for energy intensity of GDP. Comparison of GHG emission to GDP in 2008 and 2015 shows that the indicator declined by 30%.

Ranking of EU states by economic development and implementation of the Climate and Energy Package targets allowed the author to identify leaders (class 1) and outsiders (class 4). Comparison of 2008 and 2016 demonstrates that in both years Austria, Denmark, Luxembourg and Sweden were the most efficient in reconciling economic development with environmental welfare, and the group was joined by Ireland in 2016. Conversely, Bulgaria, Estonia and Slovakia fell at the other end of the spectrum as least sustainable economically and ecologically.

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