

THE ROLE OF RENEWABLE ENERGIES IN THE NEW EU MEMBER STATES

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ABSTRACT

This article provides an overview of the structure and utilization of the new EU member states' (EU-13) energy consumption. During the analysis, it was determined which non-renewable energy carriers were replaced by renewables ones. The replacement of energy sources with each other was analyzed by means of a correlation matrix. Results indicated that coal was replaced by renewable energies in Poland, Czech Republic, Slovakia, Bulgaria and Cyprus. Furthermore, renewables replaced oil in Malta and gas was replaced by renewables in Lithuania. In other countries, the relation between renewables and non-renewables could not be detected. The structure of energy production in the EU countries was different due to the differences of natural endowments. The main goal of the European Union energy policy is to reduce CO₂ emission by decreasing fossil fuel consumption and finding new ways to replace traditional energy sources is of utmost importance.

Keywords: correlation matrix, energy consumption, new EU member states, Sankey diagram

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INTRODUCTION

In recent decades, global economic growth was significant due to the low cost of natural resources used for production and transportation. Today, only a few regions in the world are producing fossil fuels. The political situation in most of these regions is unstable.

Therefore, these regions are fairly uncertain sources of energy (Harangi-Rakos et al., 2017). With the growth of the world's population, energy consumption is significantly increasing, mainly in the fast-growing Asian and African regions, especially China, which has become the world's largest energy consumer (Li et al., 2017). In addition to growing production and the

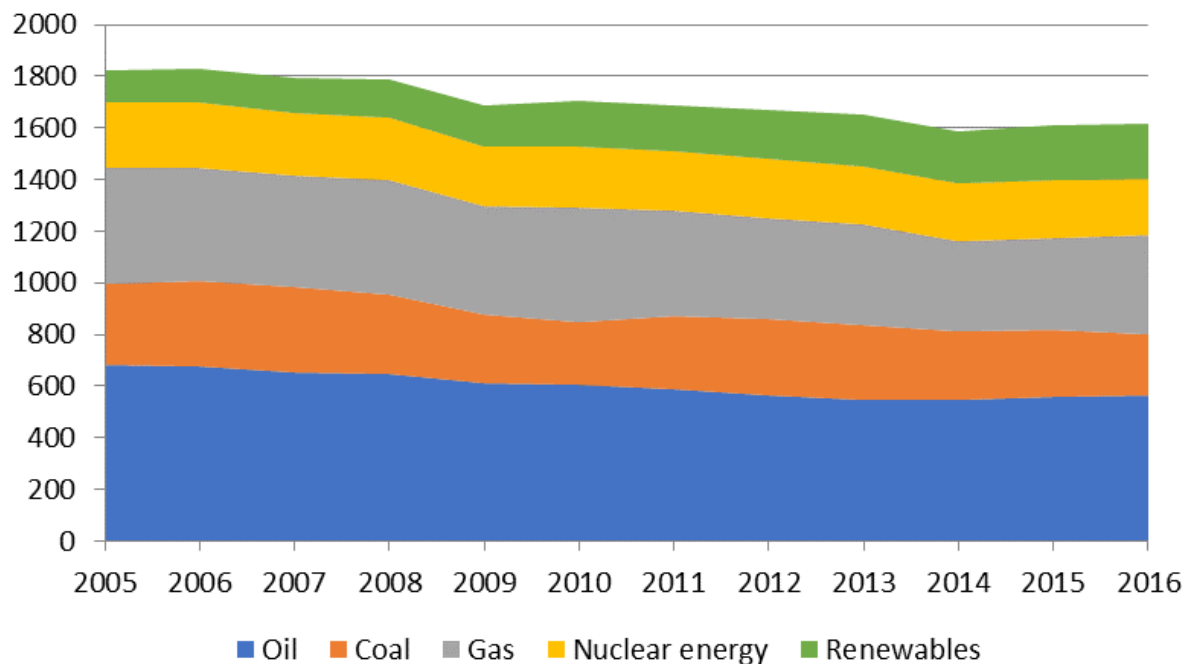
change in lifestyles - especially in developed countries - energy demand has also increased (Fodor, 2012). The improvement of energy efficiency reduces the growing demand for energy; however, renewable energy has become a key issue to partially replace the fossil energy. The European Union has contributed greatly to the growth of the sector of renewable energy in Europe with the Europe 20/20/20 targets setting the midterm policy framework and by means of a variety of programs and tools providing funding and support for regional development (Pawliczek & Zimmermannova, 2018). The role of renewable energy is significant; even if renewables are often available in smaller quantities, production cannot be regulated and some of them depend on weather conditions.

Energy situation in the European Union

The primary energy production of the European Union amounted to 755 Mtoe in 2016, which was a 15% drop compared to a decade before in 2006. The composition of primary energy production varies widely among the countries. In the EU, coal accounted for 19%, oil for 10%, natural gas for 14%, renewables for 28% and nuclear energy for 29% of the primary energy

production in 2016. The oil and gas production, as well as the refining capacity of the EU, have decreased more rapidly than energy demand in the last few years, which has resulted in negative consequences for energy security (Honvari, 2015). As a result of the decline in domestic production, the EU had to rely increasingly on primary energy imports to meet this demand. The EU consumed 1483 Mtoe import energy in 2016; meanwhile, it exported 579 Mtoe of energy. The EU is the world's largest energy importer; 53% of all energy was imported, amounting to 350 billion euros, in 2016. There are several EU members states which depend to a great extent on some suppliers, which makes them vulnerable. Russia has been the largest importer of crude oil and natural gas for the EU as well as the main supplier of solid fuel. Import dependency is also demonstrated by the fact that the total gas imports of six member states depend on one external supplier. The transport sector relies on 94% of petroleum products and 90% of them come from import. The most significant energy consumers are Germany (19.3%), France (15.1%), United Kingdom (11.5%), Italy (9.4%) and Spain (7.5%).

Figure-1: The Development of European Union's gross inland consumption (Mtoe)



Source: own edit based on British Petroleum (2018) statistical review of world energy

The gross inland consumption of the European Union decreased by 10% from 1822 Mtoe to 1618 Mtoe between 2006 and 2016. Meanwhile, the final energy consumption decreased from 1193 Mtoe to 1107 Mtoe, which is a 7.2% decrease. Fossil fuels are dominant in the European Union's gross energy consumption and account for 73.2% of energy consumption. Oil represented 34.7% (561 Mtoe), natural gas 23.7% (383 Mtoe), and coal products 14.9% (241 Mtoe) in consumption during 2016. The importance of non-fossil fuels is much smaller in the European Union. Nuclear energy accounted for 13.4% (217 Mtoe) in total energy consumption (Figure 1).

The EU's renewable energy consumption reached 217 Mtoe in 2016. The biomass had the largest share with 45%, followed by hydropower (14%), wind power (12%), biogas (8%), biodiesel (5%), municipal waste (5%), solar PV (4%), geothermal energy (3%) and solar energy (2%). In the EU, renewables represent 29.6% of electricity, 7.1% of transport and 19.1% of heating and cooling. Between 2006 and 2016, an opposite tendency could be observed in energy consumption within the EU. The consumption of fossils decreased by 17.8% and nuclear energy by 15.8%, however the consumption of renewable energies increased by 78%. Renewable energy is the only type of energy which volume and share have been steadily increasing in total energy consumption.

REVIEW OF LITERATURE

Hydropower, wind, solar, and biomass energy are even more expensive than fossil-based power generation. However, due to steadily declining reserves of fossils and rising energy prices, it is increasingly worthwhile to switch to renewable energy sources (Popp, 2013, Popp et al., 2018a, Popp et al., 2018b). The renewable energy growth around the world continues to be driven by a combination of targeted public policy and advances in energy technologies. The policy support for renewable energy focuses primarily on power generation, with support for renewable technologies lagging in the heating and cooling as well as transport sectors (REN21, 2018; Magda et al., 2019).

The utilization of renewable energy sources has an increasing role in the EU's climate and energy policy. By using more renewables to meet

its energy needs, the European Union lowers its dependency on imported fossil fuels and ensures that energy production is more sustainable. Influenced by economic and environmental interests, the European Union committed itself to increase the utilization of renewable energy sources by the end of the 1990s. The Energy Policy White Paper issued by the European Commission initiated a common Renewable Energy Strategy and set up an Action Plan during 1997. The indicative objective was 12% share for the contribution by renewable sources of energy to the European Union's gross inland energy consumption by 2010 (European Commission, 1997). Recognizing the growing dependence on imports, the European Commission defined the objectives of energy policy in the Green Paper in 2006. Three key energy policy objectives were identified: improved competitiveness, security of supply, and protection of the environment (Commission of the European Communities, 2006). The Directive 2009/28/EC established an overall policy for the production and promotion of energy from renewable sources in the EU. The directive set a binding target of 20% final energy consumption from renewable sources by 2020 – to be achieved through the attainment of individual national targets. Each EU country must have shown what actions they would intend to take to meet their renewables targets (including sectorial targets for electricity, heating and cooling, and transport). The countries must also ensure that at least 10% of their transport fuel comes from renewable sources by 2020.

The European Council set even more ambitious goals by increasing commitments by 2030. The aim was to promote the EU to achieve a more competitive, secure, and sustainable energy system. The EU countries agreed on a new renewable energy target of at least 27% of EU's final energy consumption, a 40% cut in greenhouse gas emissions compared to 1990 levels. A target for improved energy efficiency at EU level of at least 27% by 2030 was set. The European Commission aimed to increase the proportion of renewables in gross final energy consumption by 2050 to between 55% and 75%. This, along with energy efficiency, is considered critical in any model that could be adopted (Hernández et al., 2017).

In comparison with traditional energy production, renewable energy production is not yet competitive under current market conditions, due to the high technology investment costs and to environmental effects of externalities not being adequately reflected in market prices. Therefore, support is needed for renewable energy production (Fodor, 2012). The development of renewable energy is important from the viewpoint of lowering the cost of imported energy, borne by Central European countries. In addition, it would help to achieve the aims of reducing CO₂ emissions (Piwowar et al., 2017). Many illusions are related to the widespread use of renewable energy resources. However, the low emission of harmful byproducts is making them attractive. It is true for the application of biomass which is neutral to CO₂ emission regarding the whole production cycle (Szabo & Kiss, 2014).

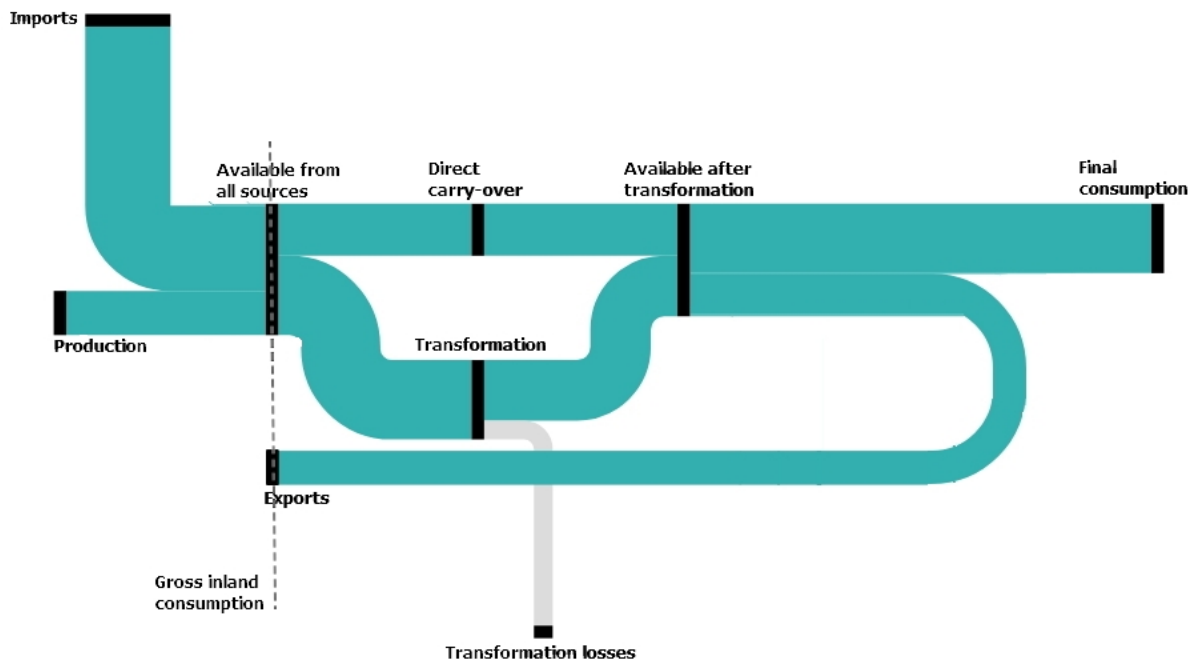
The EU policy on energy aims to ensure security of energy supply in the member states, to promote energy efficiency and energy saving, as well as to increase the share of renewable energy. Solidarity among the member states is fundamental. However, each country is

responsible for its own energy security. The spread of renewables may be impeded by the availability of fossil resources within a country (e.g. UK, Poland). The factors that provide the framework for countries are as follow: different international obligations, differences in planning/licensing cultures, public awareness concerning renewables, and/or technical differences (Reiche & Bechberger, 2004).

RESEARCH METHODOLOGY

In this article, we analyze the gross inland energy consumption of the new EU member states. The gross inland energy consumption represents the quantity of energy necessary to satisfy inland consumption of the geographical entity. Thus, it represents the sum of primary energy production and net import (import-export). In a broad sense, it is supplemented with recovered products, variations of stocks, bunkers and direct use. The energy flow can be illustrated by the Sankey diagram (Figure 2), where the direction of flow is shown by the arrows and the width of the arrows is shown proportionally to the flow quantity.

Figure-2: Simplified Sankey Diagram for energy flow



Source: Designed by the authors based on Eurostat (2019)

Figure 2 is "simplified" because it does not indicate the network loss or the energy

consumption of the system (transformation, transport, etc.), but only the transformation loss. However, the results are not affected by these factors. The data used in the analysis were obtained from the database of the European Commission Eurostat and the International Renewable Energy Agency (IRENA) for the period between 2010 and 2016.

In the study, we used comparative time series analysis. The purpose of the article was to analyze the gross inland energy consumption of the new EU member states and to examine the relationship between renewable energy and non-renewable energy sources. During the analysis, we tried to determine which non-renewable energy carrier was replaced by the renewables in the new EU member states. The replacement of energy sources with each other was analyzed by using a correlation matrix and it was evaluated at 5% significance level. Then, we applied partial correlation analysis under control variables to decide whether the relationship calculated in the correlation matrix exists or not. The evaluation was conducted using IBM SPSS Statistics 20, GRETL 2018a, and MS-Office Excel 2016.

RESULTS AND DISCUSSION

For the **European Union** as a whole, the analysis of the relationship between renewables and non-renewable energy sources showed the following results. The values of the correlation matrix (Table 1) showed that the growth of renewable energy was due to the decrease of nuclear energy (-0.9635), coal (-0.7692) and oil (-0.7733). Natural gas proved to be out of the 95% confidence interval. The partial correlation calculation based on control variables showed that the relation between renewables and coal, as well as renewables and oil could not be detected. However, the relation between renewables and nuclear energy could be detected. It can be stated that in the European Union the renewables have mainly replaced nuclear energy.

In the case of **Bulgaria**, renewables showed significant linear correlation with coal (-0,8089). It was confirmed by the partial correlation test for the three control variables (oil, natural gas and nuclear energy). In Bulgaria, renewables

basically replaced coal. In the case of the **Czech Republic**, the situation is clear regarding the relation between renewables and non-renewable energy sources. Only the renewables-coal relation was relevant. The other three non-renewable energy types proved to be out of the 95% confidence interval. It was confirmed by the partial correlation test, in case, when oil, natural gas and nuclear energy were the control variables. In the Czech Republic renewables replaced coal. In the case of **Estonia**, the renewables showed weak significant linear correlation with gas (-0,6586) at 10% significance level. It must be noted that the renewables showed positive correlation with oil (+0,8552).

In the case of **Croatia**, there is no significant linear correlation between the renewables and non-renewables. **Cyprus** revealed that the renewables showed significant linear correlation with coal (-0,8044). The renewables replaced coal in Cyprus. In the case of **Latvia**, the renewables showed weak significant linear correlation with gas (-0,6996) at 10% significant level. **Lithuania** revealed that the renewables were in negative correlation with gas (-0,8910), which is confirmed by the results of the partial correlation matrix. It can be concluded that renewables replaced gas in Lithuania. **Hungary** was the only country among those included in the analysis where the renewables did not show significant correlation with any non-renewable resource. The highest correlation value (-0.5800) was for coal, however the replacement of renewables for coal was not proved. In the case of Hungary, none of the non-renewable energy types could be detected to have been replaced by the renewables. In the case of **Malta**, the renewable energy had a negative correlation with the only non-renewable (the oil) (-0.8762), so renewables replaced oil in Malta.

Poland indicated that renewable energy was in negative correlation with coal (-0.8547) and in positive correlation with natural gas (+0.7826). Oil proved to be out of the 95% confidence interval, which makes it not relevant. Poland did not consume nuclear energy. The partial correlation calculation showed that the negative correlation decreased between the renewables and coal when natural gas was the control variable. Therefore, the natural gas consumption affects the renewables-coal relation. However, to

what extent renewables replace coal could not be detected. Based on the analysis, it can be concluded that both natural gas and renewables replaced coal in Poland. In the case of **Romania**, the renewables were in negative correlation with coal (-0.8486) and with natural gas (-0.8128). However, it was not proved by partial correlation calculation. In the case of this country, it could not be detected which non-renewable energy types were replaced by the renewables, but

certainly not by crude oil. **Slovenia** showed no significant correlation between renewables and non-renewables. Furthermore, in the case of **Slovakia**, the renewables were in negative correlation with coal (-0.8659) and with natural gas (-0.7719), which was proved only for coal by partial correlation calculation (but only partially). In Slovakia, renewables replaced mainly coal during the examined period (Table 1).

Table-1: Correlation matrix of replacement of non-renewable energies for renewables

Countries	Coal	Oil	Natural gas	Nuclear energy
EU-28	-0,7692	-0,7733	-0,7442	-0,9635
Bulgaria	-0,8089	0,5292	0,2779	-0,3427
Czech Republic	-0,9467	-0,6256	-0,7115	-0,2352
Estonia	-0,5009	0,8552	-0,6586	-
Croatia	-0,706	-0,4538	-0,3581	-
Cyprus	-0,8044	-0,7078	-	-
Latvia	-0,6250	-0,3134	-0,6996	-
Lithuania	-0,5912	0,7814	-0,8910	-
Hungary	-0,5800	-0,2838	-0,5163	-0,2221
Malta	-	-0,8762	-	-
Poland	-0,8547	-0,3778	0,7823	-
Romania	-0,8486	0,0006	-0,8128	-0,3240
Slovenia	-0,3296	-0,3945	-0,2414	0,0617
Slovakia	-0,8659	-0,3999	-0,7719	-0,2670

Source: Authors own calculation.

Concerning the results, it should be noted that the non-renewable energy sources were clearly separated, but the renewables were examined holistically. Regarding the composition, the renewables can be very different by countries. The biomass is the dominant renewable energy in each country; however, some member states have other renewable sources with higher rates than the average of the EU (e.g., the wind in Poland, biogas in the Czech Republic, or hydropower in Slovakia).

CONCLUSION

The structure of energy production of the new EU member states was different due to the differences of natural endowments. However, the results showed that renewables replaced mainly coal. Most countries were highly dependent on oil and natural gas. The main goal is to reduce the consumption of fossil energy and to replace them by renewables in the future. Reduction of oil consumption could be achieved by increasing consumption of biofuels and by

using more electric or hybrid power devices. Natural gas used for heating can be replaced by biomass, solar and geothermal energy. Coal, which is mainly responsible for environmental damage can be replaced by biomass; in case of electric power generation, coal can be replaced by hydropower, wind or solar energy. In addition to increasing the share of renewable energy, the EU also emphasized improvement of energy efficiency (savings). During the examined period, the decrease of energy consumption was affected not only by the negative impact of the 2008 crisis, but also by the spread of efficient consumers (e.g. more energy-efficient motors, passive houses, modernization of light technics etc.). Although this study added some valuable insights on the topic of renewable energy, it is not without its limitations. One of the main limitations is the data set including data only till 2016. Future studies may include using longer timed data sets and included more counties to the analysis to determine if similar results in for example more western countries exist.

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