POSITION OF HUNGARY ON EU'S MAP OF RENEWABLE ENERGY SOURCES

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Abstract:
The complex and decentralised use of renewable energy sources is one of the key issues in the European Union. The main objective is to develop a safe, diversified and environment-friendly energy structure in all member states, in which process agricultural production may play an important role. Although it seems that the energy demand of agricultural production is not intended to be self-supporting in the close future, the cooperation of the different agricultural sectors and activities is essential to meet these targets.

In our research, we examined the evolution of different macroeconomic factors in context of renewable energy sources; namely, how they are in accordance with the proposed objectives that must be fulfilled by 2010. The main goal of the research was to determine the key areas of the use of renewable energy sources and to explore their driving forces in the EU member states. By the evaluation of statistical data, we analyzed how the macroeconomic factors could influence the targeted objectives.

According to our assumptions, the use of biomass energy is connected to not only agricultural production, but also other macroeconomic factors and production outputs. At the first step of the research, the selected macroeconomic factors were grouped by factor analysis. Based on the result of a cluster analysis by different factors, we could determine Hungary's position compared to the other member states. We differentiated the groups and the group characters of Hungary and our competitors, by which the real competitors could be defined. The practical methods we collected can be adapted in the further development process of the Hungarian renewable energy sector.

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Keywords: European Union, sustainability, innovative technology, renewable energy sources, factor analysis

1. INTRODUCTION

Energy resources are classified primarily by the time of their renewal, thus we can differentiate fossil fuels or non-renewable energy sources and renewable energy sources. Renewable energy became one of the most important objectives in the past decade, even at national, international and global level. Biomass energy means a special group of renewable energy sources, which includes matter of plant origin or of animal origin (both with organic and inorganic compounds) as well as communal waste. Energy plants represent a closer category, which – according to different authors – includes field energy crops and energy trees. (Barótfi et al., 1993; Bai, 2008)

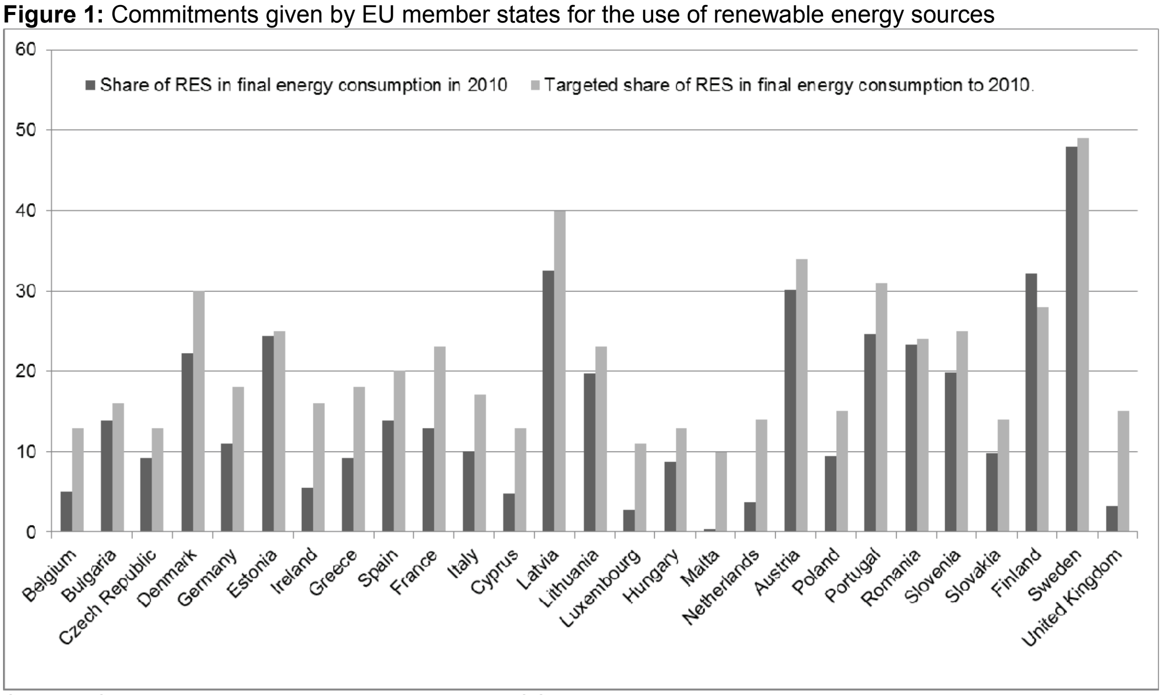
The advantages of energy crop production were described by several authors. According to Lukács, 2009) the most important advantages of energy crop production are the following:

- additional income for the participants of the agricultural sector,
- less favoured areas/ areas of natural constraints can be cultivated,
- establishing new working possibilities for less qualified employees,
- decentralising of energy supply, local use of energy sources,
- technical/technological development of rural areas.

Nevertheless, some doubts were also formulated, mainly in connection with the energy balance of different energy sources of biomass origin, particularly in relation with their environment friendliness. Thus, some authors emphasized the sustainability of crop production as one of the most important aspects of biomass energy production (see Gyulai, 2006; Directive 2009/28/EC; Greenpeace, 2011)
The use of renewable energy sources was accelerated by the introduction of the Energy Policy of the European Union in 2007. According to the policy, the hydrocarbon import of the EU can be increased from 50% to 65% by 2030, under the same conditions. The dependence on natural gas import may be increased from 57% to 84% by 2030.

In order to the renewable energy sources could be inserted into the traditional energy system, several community commitments were formulated, which introduction was compulsory for all member states. One of these commitments was connected to the use of RES in national energy consumption, which is illustrated by Fig. 1. As it can be observed, only few member states could fulfil the targeted share of the use of RES.

Figure 1: Commitments given by EU member states for the use of renewable energy sources

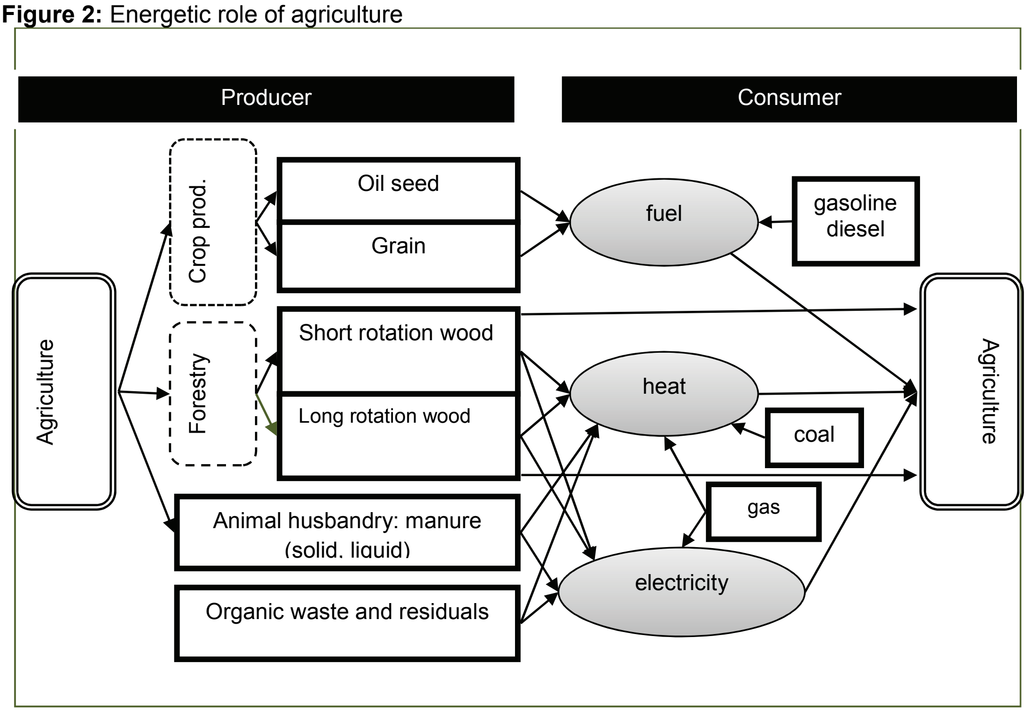


Source: Own construction, 2013 (based on EUROSTAT data 2013)

The EU accession has brought several changes for the Hungarian energy sector. In accordance with the Community rules, renewable energy sources should be utilized at an increased level. According to

some Hungarian studies, heat and electric power as well as fuels originated from biomass (i.e. produced by the agricultural sector) may play an important role in this process.
Pylon Ltd., a Hungarian consulting company determined three scenarios for the utilization of biomass energy in Hungary. According to each scenario, the most significant energy amounts may be produced by biomass energy, primarily heat energy and electricity production (Pylon, 2010). Lukács (2009) made a comparison between different fossil and renewable energy sources based upon social, economic and environmental aspects. Regarding the social and economic aspects, biomass energy was considered as most important and mostly accepted, while in environmental aspects biomass energy was equivalent with solar and geothermal energy. The energetic role of agriculture may be examined both from the producers' and users' dimension (Fig. 2)

Figure 2: Energetic role of agriculture



Source: Own construction, 2013

Every matters of origin of biomass energy may be connected to the agricultural sector, of course, assuming sustainable production for energy purposes, either crop production and animal husbandry, or even forest management. The use of organic matters for energy production is constrained by different limiting factors. The most significant and complex issue is that farmers prefer to produce crops for food consumption, therefore its by-products and the manure produced in the livestock sector are primarily used for preserving and improving the fertility of the soil. The left column of Table 1 summarizes factors which are important from the investment's or the investor's aspects. In the right column, the factors that determine the farmers' attitudes and willingness towards energy crop production are collected. In the course of energy policymaking process, the policy makers should take into consideration the opinion of both sides; this is the key to successful operation.

Table 1: Two aspects of the determining factors of the profitability of biomass energy production

Determining factors of	
profitability of biomass production (investor's aspects) (Bai, 2008; p. 73.)	**farmers' willingness to biomass energy production (Villamil et al. 2008, 2012)**
– price of the raw materials and the agricultural products competing for the agricultural land, – processing technologies in use, – utilization of possible by-products, – energy prices at the world market, – institutional and regulation system influencing the raw material production and processing industry	– legal form of production (contractual or non-contractual), – period of land use for energy production, – usability of present infrastructure, – effects of the new crops on the landscape, – possibilities for support, – predictable net income values, – safe marketability,

	– innovative attitudes

Source: own construction (based on Bai, 2008 és Villamil et al. 2008, 2012)

According to Ángyán et al. (2006) agiculture can be defined as self-supporting in energetic aspects when it is operating not only as an energy consumer, but it uses self-produced energy sources as well.

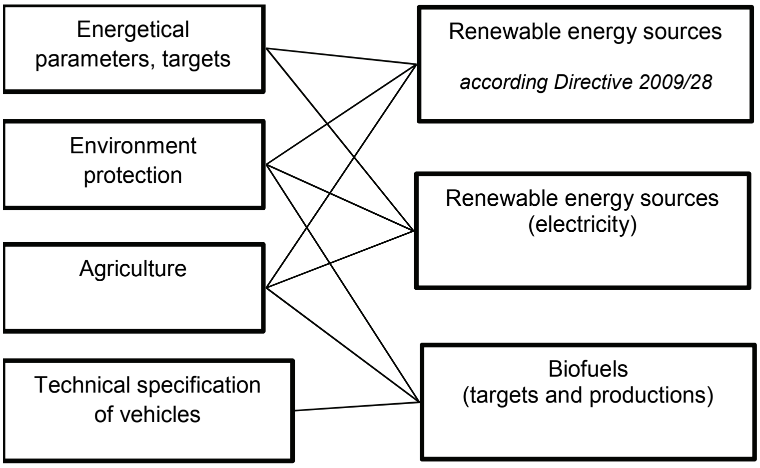
2. MATERIAL AND METHOD

For the evaluation of the theoretical aspects we introduced formerly, we started our research on the base of the EUROSTAT database. The year of the examination was 2009, for two reasons; firstly, a complete database was available for this year, secondly, the commitments announced by the Member States were connected to 2010, thus, in our opinion, it is worth to explore the connections between the data in this year, when the targets may be near to be fulfilled.

In the beginning of the examination process, we chose the variables relevant to the purposes of the research that were grouped in the following system (see also Fig. 4.):

- environmental protection (the amount of air pollution and organic waste)
- agriculture (amount and price of harvested cereal and oilseed crops)
- technical specification of vehicles (age and composition of vehicles)
- energetical parameters (energy intensity, prices, energy consumption per capita)
- renewable energy sources (amount and composition of produced renewable energy).

Figure 3: Possible links between variables



Source: Own construction, 2013

The methods we used for our calculations were factor and cluster analyses.

Factor analysis describes the variability among observed, correlated variables in terms of a number of hypothetic variables called factors, which explain the original information at the utmost, thus the main objective is to minimize the losses of information. Factors cannot be observed directly only through the correlations between the different variables. Additional characteristics of the factors given by Falus and Ollé (2008, p. 234.) are the following:

- factors are independent from each other, thus the correlation coefficient of any two factors is zero,
- factors show strong correlations with the original variables, either positive or negative correlations,
- their number is definitely lower than the number of the original variables.

The basic equation of factor analysis is the following (Szűcs, 2004):

$$r_{jk} = \frac{1}{N}\sum_{j=1}^{N} a_{ij} * a_{kj}$$

which means that “the correlation coefficient *(r)* of the i-th and k-th variables equals with sum of the multiplied factor weights connected to i-th and k-th variables.” (Szűcs, 2004)

"Cluster analysis is a collective name for the methods and algorithms which allow classifying different objects into different groups" (Szűcs, 2004. p. 496.). It means grouping a set of objects in such a way that objects in the same group (called cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). In order to make the grouping we used hierarchic methods, which aggregate the two closest groups after each stage of the process.

According to our presumptions:

a) The EU Member States announced their commitments according to their macroeconomic attributes. These macroeconomic attributes can be traced back to the indicators expected with positive impacts (for example the indicator of favourable environmental impacts: the CO_2 emission of the energy sector)
b) It is possible that the basic indicators used for the determination of the targeted RES shares were not correlated, but before the first milestone, the year 2010, they should be in closer correlation with the target share values.
c) These macroeconomic indicators are correlated indicators, from which independent, but heterogeneous groups could be formed by factor analysis methods.
d) According to these factors, the EU member states can be classified into different groups, in which Hungary may be inserted.

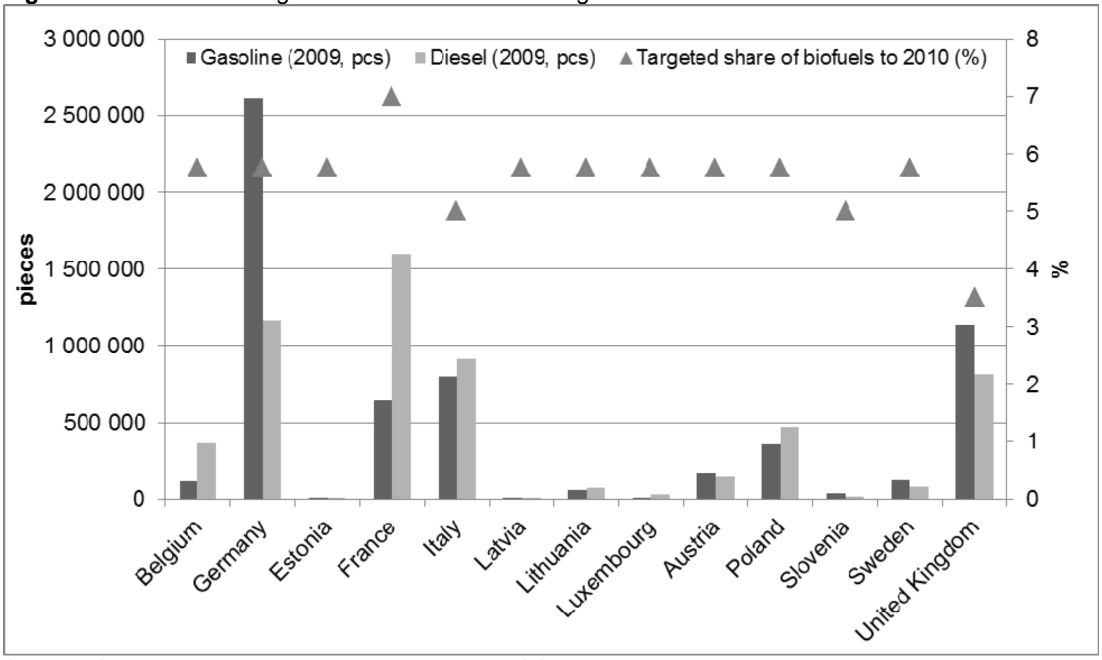
3. RESULTS

In the course of the examination process, we had to decrease the number of variables in order to complete the factor analysis.

In our opinion, the composition of the number of vehicles of a country may be in relation with the share of the targeted biofuel consumption. Because of the lack of the relevant data, these variables should be excluded from our researches.

As it is shown by Fig. 4, only 13 Member States could supply relevant data for the new, registered vehicles and the targeted share of biofuels for 2010.

Figure 4: Stock of new registered vehicles and the targeted share of biofuels



Source: Own construction, 2013 (based on EUROSTAT database, 2013)

We should remark that the statement, which can be heard in many forums, that the use of diesel vehicles is dominant in Europe, is not confirmed by any EUROSTAT data either for new vehicles or for used ones.

We conducted factor analysis for the reduction of the number of remaining variables; the applicability of the factor analysis was verified by Kaiser-Meyer-Olkin and Bartlett's Test, which results justified the applicability of the factor analysis.

Table 2: Result of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,707
Bartlett's Test of Sphericity	Approx. Chi-Square	341,062
	df	78
	Sig.	,000

Source: Own calculation, 2013

As a result of the analysis (Principal Component method and Varimax rotation) three factors were determined. In the factor analysis, it is very important to know at which extent is the total variance covered by the three factors. That means, how much information is allowed to be lost by decreasing the number of the variables.

The column "Cumulative (%)" of Table 3 shows that more than 88% of the original information remained by using the three factors, which may be regarded as a very good result.

Table 3: Total variance explained

Component	Total	% of Variance	Cumulative %
1	7,001	53,853	53,853
2	2,725	20,959	74,812
3	1,754	13,492	**88,304**

Source: Own calculation, 2013

Table 4 details the resulted composition of the factors and their factor weight. It can be seen that factor weight is outstandingly high in case of all variables, which made the denomination of the factors more difficult.

Those variables were introduced into the first factor, which serves the internal biomass energy supply of the different countries. The largest factor weight is connected to energy consumption (en_cons = primary energy consumption in 1000 oil equivalent) in this factor. Other variables such as biodiesel and bioethanol production amounts (bioD_prod and bioE_prod), and the amount of harvested wheat and corn (buza_harv and kuk_harv) refer to providing the biomass demand.

Table 4: Rotated component matrix

Component	Variables	Factor weight	Name
1	en_cons	0,978	Energy safety (by biomass)
	co2_agri	0,971	
	bioD_prod	0,966	
	buza_harv	0,955	
	bioE_prod	0,937	
	waste_comp	0,906	
	co2_energy	0,887	
	kuk_harv	0,743	
2	electr_pr	0,91	Economics of energy
	energia_int	-0,86	
	gas_pr	0,826	
3	RES_target_dir2009	0,974	RES targets

	electr_RES	0,901	

Source: Own calculation, 2013

Two indicators connected to the decrease of CO_2 emission (CO2_agri and CO2_energy) is also included by the first factor, which name is "Energy safety".

Variables that characterize energy prices (elektr_pr and gas_pr) were classified into the second factor, as well as energy intensity (unit: Kilogram of oil equivalent per 1000 euro). In our opinion, these factors are representing the economic features of the energy sector, thus the name of the second factor is "Economics of energy".

Contrary to the expectations, the targeted share of the use of RES could not fit into any of the former groups, that mean they are not correlated to the given macroeconomic indicators. Based upon the research results, it may be assumed that the targeted electricity use values were determined before the determination of the targeted RES share, but we cannot show the variables and data underlying this assumption.

The second step of our examinations was to perform a cluster analysis. We used the results of our factor analysis, thus the three factors were used as a starting point in the cluster analysis. In order to perform the cluster analysis, we should exclude those countries, which could not present appropriate data; therefore, only 20 countries were drawn into the examination.

This method was the most applicable and relevant to our basic goal, i.e. to identify those member states, which have similarities with the Hungarian situation.

The SPSS programme offers many opportunities to illustrate the results of the cluster analysis by graphical methods. In our research, the use of the Agglomeration schedule was chosen, because of the additional information given by this method.

The first steps of aggregations concerning Hungary were indicated by light grey colour. In Stage 12, the programme aggregated Hungary's group with the group of the 1st country (Belgium) because of the less distance, therefore these steps were also remarked (by dark grey colour).

The additional information we referred above is given by the changes of the coefficients' values. It is clearly shown that the inclusion of Spain into the cluster, and the aggregation of Germany with France, and finally the fusion of these three countries represented significant increase of the coefficients.

Table 5: Agglomeration schedule of cluster analysis

Stage	Cluster Combined		Coefficients	Stage	Cluster Combined		Coefficients
	Cluster 1	Cluster 2			Cluster 1	Cluster 2	
1	3	12	0,012	10	1	7	0,581
2	1	13	0,045	11	2	17	0,756
3	3	19	0,139	12	1	3	0,881
4	4	18	0,144	13	14	20	0,96
5	4	16	0,217	14	4	14	0,969
6	2	6	0,233	15	1	2	0,976
7	2	10	0,267	16	**1**	**8**	**1,736**
8	1	11	0,363	17	1	4	1,829
9	3	15	0,376	18	**5**	**9**	**3,16**
				19	**1**	**5**	**3,927**

1: Belgium, 2:Bulgaria, 3: Czech Republic, 4: Denmark, 5: Germany, 6: Estonia, 7: Ireland, 8: Spain, 9: France, 10: Lithuania, 11: Luxembourg, 12: Hungary, 13: Netherlands, 14: Austria 15: Poland, 16: Portugal, 17: Romania, 18: Slovenia, 19: Slovakia, 20: Sweden

Source: Own calculation, 2013

In case of Hungary (Stage 1) the shortest distance was with the Czech Republic, then with Slovakia and Poland. It means that Hungary – in macroeconomic aspects – is less different from these countries. This result is obvious in the light of our common historical and economic background, and the common date of the EU accession. It is important to highlight the results of Stage 12, where it was aggregated by the group of the following countries: (by order) Belgium, Netherlands, Luxemburg and Ireland. Slovenia (18), which also accessed to the EU in 2004, was aggregated firstly by Denmark, then Portugal, and in Stage 14, it merged with the group of Austria and Sweden. Due to the fact that even Stage 14 did not caused significant increase of the coefficients value, it may be concluded that Slovenia is more developed than CEE countries, it is suited closer to the former EU-15 member states in the examined aspects.

4. SUMMARY AND CONCLUSION

Our assumptions prior to the research were just partly verified. The macroeconomic indicators used for fulfilling the EU objectives are not in compliance with the national target shares of the use of renewable energy sources. By performing a factor analysis, we could determine two independent factors. These factors are connected to the importance of material producing processes and the economic aspects of energy use.

As a result of the cluster analysis we could specify those member states similar to Hungary, they are Czech Republic, Poland and Slovakia. This similarity is very important for us, because these countries may be our competitors in the market of biomass production. It is suggested to make further examinations to explore the practical results of Slovenia. Although Slovenia accessed to the EU also in 2004, as Hungary and the other CEE countries, the country is clearly separated from the countries of the CEE region according to the examined indicators.

The results of our researches made suggestions for additional researches for the introduction and assessment of the social aspects of the sustainable use of renewable energy sources.
However, it should be noted, that the examinations might be constrained by the missing data of the EUROSTAT database.

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