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Energy Demand Forecasting Methodology for Romania

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Abstract

The paper presents a methodology for energy demand forecasting which manifests at the Romanian society level. The accurate knowledge of the energy demand of a society allows it to plan its energy provision, formulation of strategies and recommendation of energetic policies. The proposed methodology is a heuristic one, which takes into account the evolution of the population, which is correlated to the possible evolution of the GDP/capita and to the evolution of the energetic intensity of the economy.

Keywords: *energy demand; GDP/capita; energy intensity of economy*

JEL Classification: *Q40; Q43; Q47*

Introduction

Assuring the required energy represents a fundamental problem for any country and for the administration of that country. The lack of energy resources may lead to the paralysis of the social and economic life of a country, which results in the occurrence of serious effects on the population and on the economy. Due to this cause, all the countries need predictions concerning the energy request that is to be manifested in the following period of time.

The energy requests can be resolved from their own internal resources, or by importing the necessary quantities. The countries that cannot ensure the energy requests from their own resources are dependent on the providers that exist on the international market and on the market fluctuations. The energetic dependence can be expressed either at a global or distinct level, on each energy resource that is being used in that state. As such, Romania has a low energetic dependence compared to other countries from the EU (Figure 1).

If we analyse Romania's energetic dependence for each energy resource (Figure 2), it can be observed that the liquid petroleum products dependence has the greatest value, and the lowest value is owned by the electric energy dependence. For natural gases, the energetic dependence has lower values due to the existent resources. The dependence for electric energy cannot be found in Figure 2 due to its extremely low level, as in certain years, its value had been negative, resulting in a sign of an excess of electric energy, which had to be exported in order to avoid its waste, caused by the lack of stocking solutions.

In order to ensure Romania's necessity of energy, the future request of energy for different periods of time must be known at least approximately. The prevision of a country's request of energy is a problem which has been treated enthusiastically in the past few decades, starting with the moment of the first oil crisis, which showed the vulnerability of the economy of all the states of the world, at the reduction or the disappearance of the known energy resources.

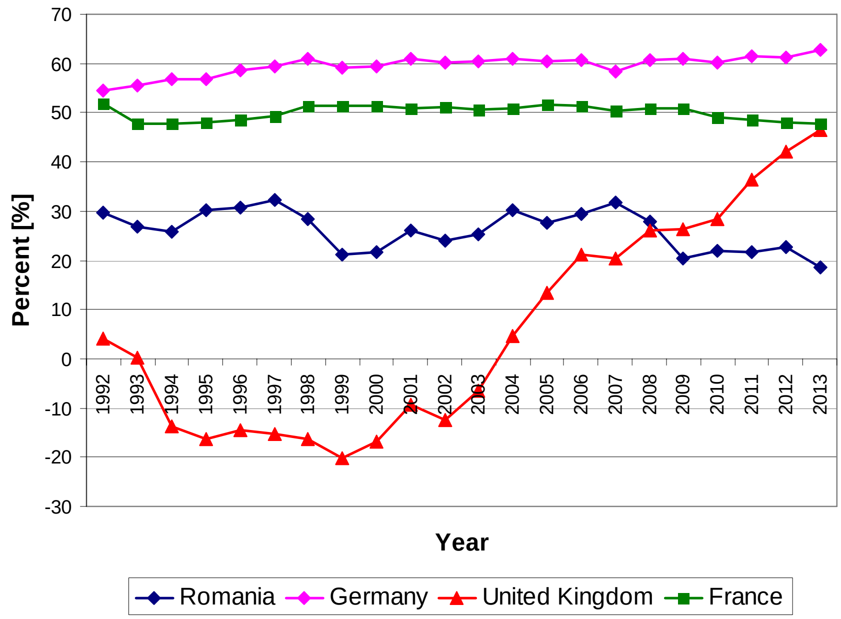

Fig. 1. Romania's energetic dependence compared to other EU countries

Source: author's calculations made with data from NSI and Eurostat

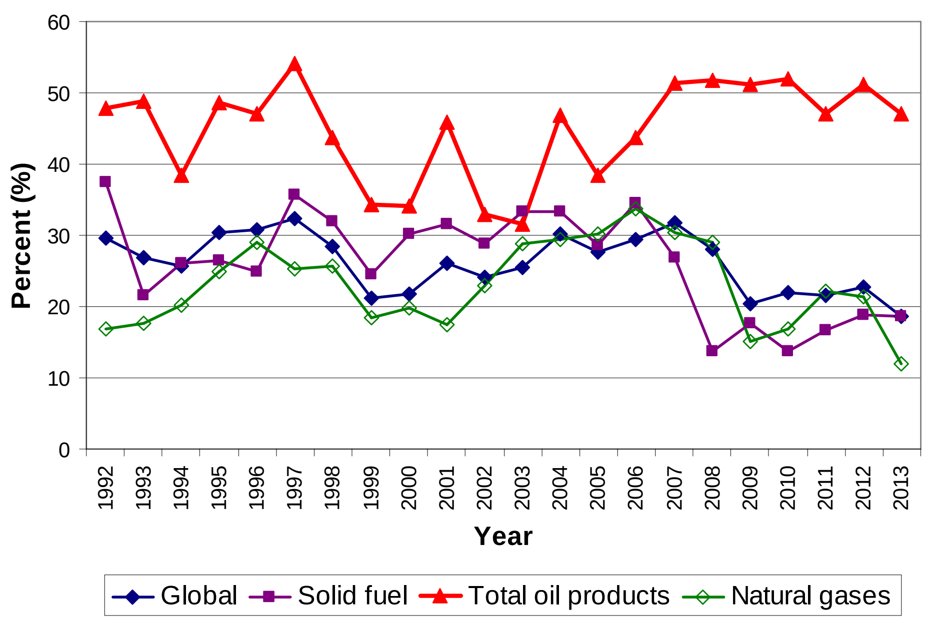

Fig. 2. Romania's energetic dependence, grouped by fuel resources

Source: author's calculations made with data from Eurostat

Therefore, different methodologies were elaborated in order to predict the volume of the energy request for different situations (Donnelly, W. A., 1987), (Eltony, M. N, 2004), (Hunt, L. C. and Y. Ninomiya, 2005) and many others.

In order to estimate the energetic necessity of Romania for an extended interval of time, the following hypotheses were taken into account:

- even though there were attempts to develop technologies that allows the transportation of great quantities of electric energy for long distances (ex: the transportation of electric energy from Africa to Europe on direct current lines, at a high tension), it is more realistic to consider that along with the reduction of the fossil fuels production, the countries that have those resources will want to keep them for their own country or will sell them at higher prices. Even the countries whose economy currently works on the base of the export of energetic products, especially oil, will negotiate increasing prices and will reduce the production in order to ensure the economic survival for a prolonged period of time. Given these conditions, it is obviously that a country such as Romania will have to manage as well as possible their own energy resources, and to make efforts in order to reach its energetic independence, ensuring its energy demand from alternative resources.
- the internal production of fossil fuels will have a decreasing trend, even if for short periods of time it will have increases that are based on the putting into operation of new deposits. The new deposits are limited and they are found at increasing depths, so that, in time, the efficiency of the extraction of oil from these deposits will be reduced until their complete cancelling.
- in the lack of a corresponding volume of the production data that allows Hubbert curve-like estimations, curve which might approximately indicate a moment of total exhaustion of the deposits, the estimation of Romania's necessity of energy will be done on the base of three scenarios referencing the three variant of population growth.

The Methodology for Estimating Romania's Required Energy

The energy consumption of each country depends on a multitude of factors, whose influence on the result is either difficult or impossible to quantify. Therefore, the consumption depends on the technologic level of the machines and devices that are used in every sectors of the economic and social life, on the consumption habits of the population, on the energy price on both the external and internal markets, on the level of the population's wealth, on the employment rate of the population etc.

Because of the fact that, in the specialized literature, certain connections have been established between the energy consumption of a country and its internal gross consumption, in this study this connection has been used in order to determine Romania's energy demand for a time period between year 2020 and year 2070.

The calculation formula that is used connects the gross domestic product to the energetic intensity of the economy, according to the following formula:

$$E^{i}_{demanded} = GDP^{i}_{estimated} * EI^{i}_{estimated} \tag{1}$$

where:

$E^{i}_{demanded}$ represents the requested energy quantity for Romania's final internal consumption, in the year ***i***;

$GDP^{i}_{estimated}$ - estimated gross domestic product, in the year i;

$EI^{i}_{estimated}$ - estimated energetic intensity in the year ***i***.

Estimating the internal gross product is made on the base of the estimated GDP/ capita indicator and of the estimated population for every year, according to the following formula:

$$GDP^{i}_{estimated} = \left(\frac{GDP}{capita}\right)^{i}_{estimated} * POPULATION^{i}_{estimataed} \qquad (2)$$

The value of the internal gross product is determined by considering a straight increase from the current level of 7500 euros/ capita, to the value of 45000 euros/ capita, a value which will be achieved in year 2080, and which corresponds to the highest values of the indicator, at the current moment, for the EU countries.

The level of Romania's population is estimated according to the following scenarios:

- the population is decreasing according to the predictions of the Global Bank and of Eurostat;
- the population is slowly increasing, according to a positive natural increase of the population, an increase which has a reduced, subunitary value;
- the population is evolving according to a continue increase of the natural growth rate with about 0,15 people/1000 residents/year; growth rate which starts from the current value of -3 and reaches a value of +7,05 in year 2080.

The energetic intensity indicator has known a continuous decrease at the EU countries level, decrease which has important values in the case of the former communist countries.

This decrease does reflect, in Romania's case, both the increase of the efficiency with which the energy is consumed, but a strong decrease of the consumption, which is due to the shutdown of the industrial consumers of great capacity and to the modification of the structure of the internal gross product, to the detriment of another activity sectors, with lower energetic consumptions.

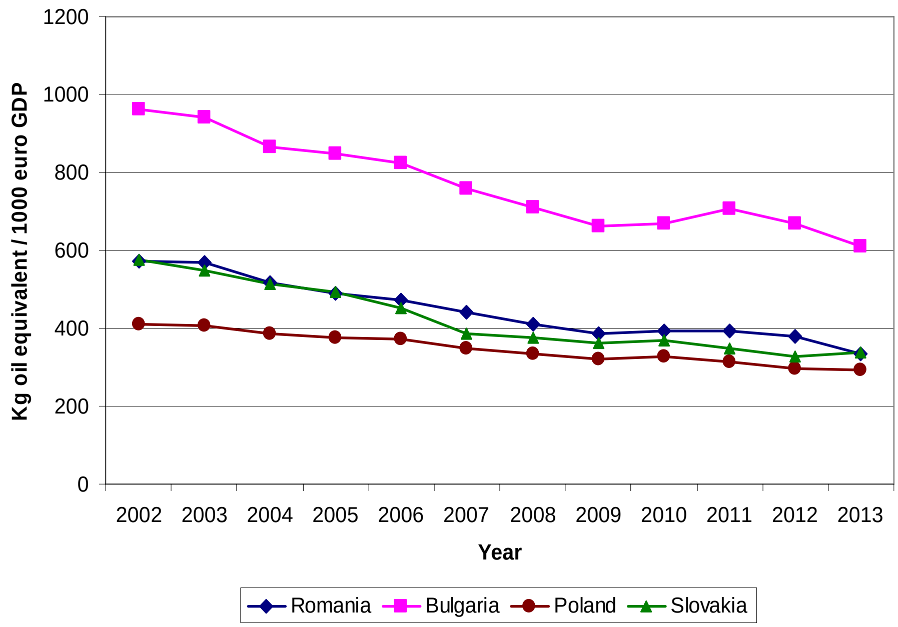

Fig. 3. The evolution of energy intensity of economies

Source: author's calculations made with data from Eurostat

At the level of the EU developed countries, it can be noticed that the energetic intensity of the economy presents a far less abrupt decrease, corresponding to the economic stability of those countries and of the increased technological level, existent for more years in those countries.

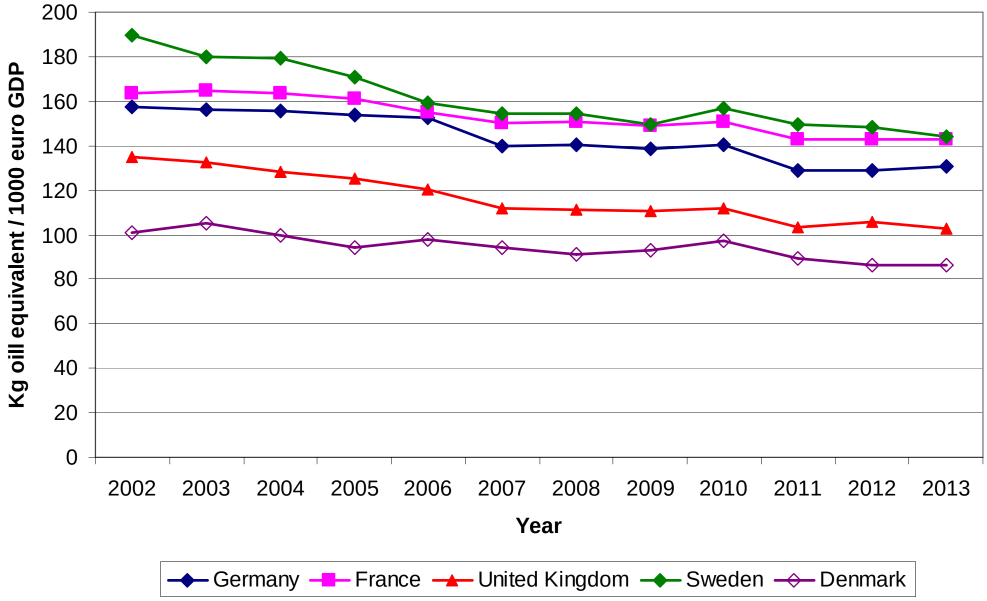

Fig. 4. The energetic intensity of the economy for countries with a strong economy in EU

Source: author's calculations made with data from Eurostat

Because the necessity of energy is estimated to the final energy consumption, the energetic intensity is determined for this value of the consumed energy. As a conclusion, the energetic intensity of the Romanian economy in the analysed period of time will be estimated as varying from the current value of 155 kg of equivalent oil/1000 euros GDP to a value of 57,5 kg of equivalent oil/1000 euros GDP, a value which will be obtained in year 2080.

That value is a reasonable value, which can be achieved during the analysed time interval, due to the fact that other EU states, which have more developed economies than Romania's, currently have values that are closer to this indicator (Denmark, Great Britain etc.)

Results

After applying the methodology of calculation that is specified in the previous chapter, a series of values have been obtained for Romania's necessity of energy, which corresponds to the three calculation variants that were used:

- Variant I - Romania's population evolves according to a negative natural growth which has a value of -3,23 people/ year;
- Variant II - the population evolves according to a positive natural growth but with a reduced value, of only 0,25 people/ year;
- Variant III - the population evolves according to straight increase of the natural growth with a value of 0,15 people/ year. The natural growth starts from a value that is considered current, of -3 people/year, and reaches to +7,05, in year 2080.

The variation of the estimated GDP and of the energetic intensity remains the same for all three variation scenarios of the population.

In the Table 1 are presented the estimated GDP values and the estimated energetic intensity value for the period of time for which the simulation is made, and in Table 2, Romania's population is specified for the analysed period of time.

Table 1. Estimated GDP and estimated energy intensity of economy

Year	Estimated GDP [euro / capita]	Estimated energy intensity [kg oil equivalent / 1000 euro GDP]
2030	16500	132,5
2050	28500	102,5
2080	46500	57,5

Source: author's calculations made with data from NSI and Eurostat

Table 2. Estimated population of Romania

Year	Estimated population		
	Variant I	Variant II	Variant III
2030	18.948.724	20.105.330	19.465.773
2050	17.761.480	20.206.095	19.908.317
2080	16.118.621	20.358.192	23.034.825

Source: author's calculations made with data from NSI and Eurostat

On the base of the premises that were mentioned, the following values for Romania's energy request were obtained, according to the three scenarios that have been analysed.

Table 3. The energy demand of Romania

Year	Variant I [thousand toe]	Variant II [thousand toe]	Variant III [thousand toe]
2030	41.427	43.955	42.557
2050	51.886	59.027	58.157
2080	43.097	54.433	61.589

Source: author's calculations made with data from NSI and Eurostat

As it can be observed, even though the population is constantly growing, the energy consumption has an increase and the a decrease, due to the decrease of the energetic intensity of the economy, as an effect of the increase of the efficiency of using energy in the Romanian society. The complete evolution of the Romania's energy necessity, in the period of time that was analysed, can be observed in Figure 5.

The maximum values of the necessity of energy in the analysed period of time are the following: for variant I - 52.298 thousands toe, in year 2055, for variant II - 61.162 thousands toe, in year 2061, and for variant III - 63.473 thousands toe, in the year 2069. In the following tables are presented the energy demands for the year with maximum consumption into the analysed period.

Table 4. Estimated energy demand, by energy sources

Energy source	Year 2055 [thousand toe]	Year 2061 [thousand toe]	Year 2069 [thousand toe]
Electric energy	8.891	10.398	10.790
Solid fuel	1.569	1.835	1.904
Petrol fuels	16.212	18.960	19.677
Natural gases	14.644	17.125	17.772
Thermal energy from fossil fuels	3.661	4.281	4.443
Nuclear thermal energy	7.322	8.563	8.886
TOTAL DEMAND	**52.298**	**61.162**	**63.473**

Source: author's calculations made with data from NSI and Eurostat

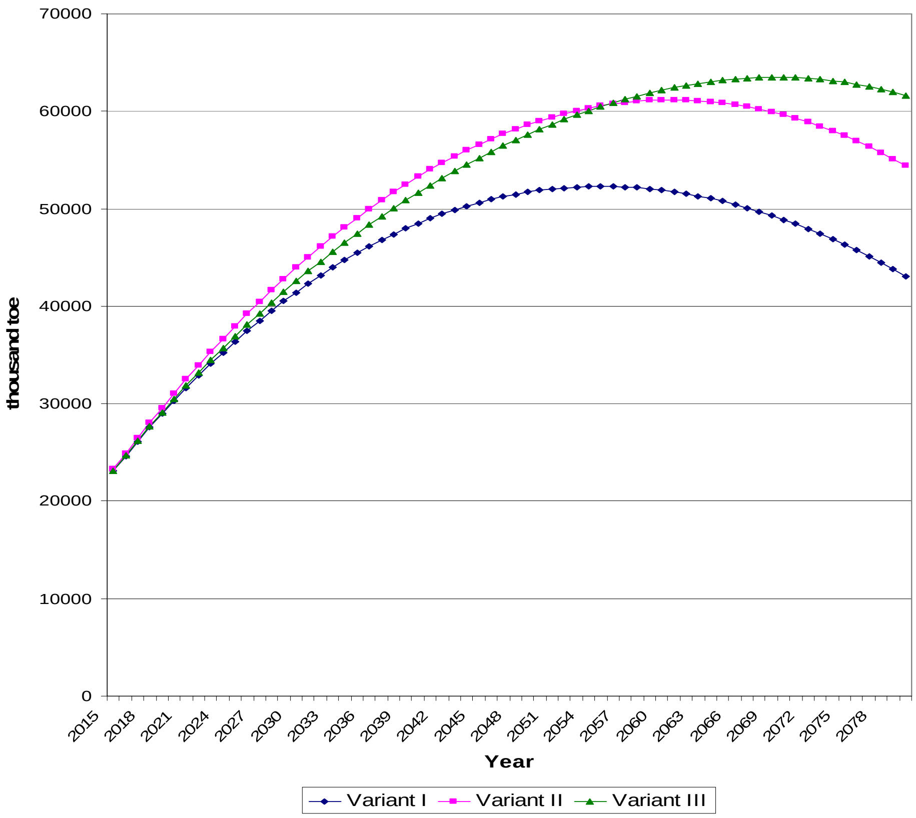

Fig. 5. Evolution of the Romania's energy demand into the analysed period

Source: author's calculations made with data from NSI and Eurostat

Conclusions

The methodology presented in this paper is a heuristic methodology. This means that is not precisely but can offer qualitative information about the evolution of an economic phenomenon, information useful, in this case, for adopting measures and policies for cover the energy demand, especially in the years with maximum demand.

The research will be extended to identify the potential of renewable energy sources and the possibilities to cover the entire energy demand for final consumption in Romania from renewable sources.

Acknowledgement

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References

1. *** World Population to 2300, United Nations, Department of Economic and Social Affairs, 2004.
2. *** Model for Analysis of Energy Demand (MAED-2). User's Manual, Computer Manual Series, No. 18, International Atomic Energy Agency, Vienna, 2006.

3. Apergis, N., Danuletiu, D.C., Energy Consumption and Growth in Romania: Evidence from a Panel Error Correction Model, *International Journal of Energy Economics and Policy*, vol. 2, no.4, 2012, pp.348-356.
4. Capros, P., L. Mantzos, N. Tasios, A. De Vita, N. Kouvaritakis, *EU energy trends to 2030*, Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG, 2010.
5. Conti, J., Beamon, A., Eynon, R., E.O., *Analisys of Impact of a Clean Energy Standard*, U.S. Energy Information Administration, octomber 2011, www.eia.gov
6. Duşmănescu, D., *Aspecte tehnico-economice ale promovării energiilor din surse neconvenționale*, PhD thesis, INCE Bucureşti, Romanian Academy, 2013.
7. Duşmănescu, D., *Aspects Regarding Implementation of Renewable Energy Sources in Romania up to 2050*, International Journal of Sustainable Economies Management, vol. 2, no. 4, 2013, pp.1-21.
8. Duşmănescu , D., Andrei, J.V., Subic, J., *Scenario for Implementation of Renewable Energy Sources in Romania*, Procedia Economics and Finance, vol. 8/2014, pp.300-305.
9. Donnelly, W. A., *The econometric of energy demand: A survey of applications*, Praeger, New York, 1987.
10. Eltony, M. N, 2004, A model for forecasting and planning: The case for energy demand in Kuwait, *The Journal of Energy and Development*, 30(1), pp. 91-108.
11. Hondroyiannis, G., 2004, Estimating residential demand for electricity in Greece, *Energy Economics*, 26, pp. 319-334.
12. Hunt, L. C. and Y. Ninomiya, 2005, Primary energy demand in Japan: an empirical analysis of long-term trends and future CO2 emissions, *Energy Policy*, 1409-24.
13. Felea, I., Dan, F., Dzitac, S., Consumers Load Profile Classification Corelated to the Electric Energy Forecast, *Proceedings of the Romanian Academy*, Series A, Volume 13, Number 1/2012, pp. 80–88.
14. Lapillonne, B. and B. Chateau, 1981, The MEDEE models for long term energy demand forecasting, *Socio-Economic Planning Sciences*, 15(2), pp. 53-58.
15. Murphy, R., N. Rivers and M. Jaccard, 2007, Hybrid modelling of industrial energy consumption and greenhouse gas emissions with an application to Canada, *Energy Economics*, 29, pp. 826-46
16. Nakata, T., 2004, Energy-economic models and the environment, *Progress in Energy and Combustion Science*, 30, pp. 417-78.
17. Robert, M., P. Hulten and B. Frostell, 2007, Biofuels in the energy transition beyond peak oil: A macroscopic study of energy demand in the Stockholm transport system 2030, *Energy*, 32, pp. 2089-98.
18. Schenk, N. J. and H. C. Moll, 2007, The use of physical indicators for industrial energy demand scenarios, *Ecological Economics*, 63, pp. 521-535.
19. Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R., Thorsnes, P., Energy cultures: A framework for understanding energy behaviours, *Energy Policy*, Vol. 38/2010, no. 10, pp.6120-6129.
20. Suganthi, L., Anand, A.S., Energy models for demand forecasting – A review, *Renewable and Sustainable Energy Reviews*, Volume 16, Issue 2, 2012, pp. 1223 – 1240.
21. Urban, F., R. J. M. Benders and H. C. Moll, 2007, Modelling energy systems for developing countries, *Energy Policy*, 35, pp. 3473-82.
22. Ziramba, E., 2008, *The demand for residential electricity in South Africa*, Energy Policy, 36, pp. 3460-66.