Analysis of the electricity prices in the Slovak Republic and their impact on the individuals' energy security

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Abstract

This paper describes the position of the electricity prices in ensuring individuals` energy security. First chapter deals with analysis of electricity prices for households and the calculation of the short-term prognosis of their development. Subsequently, the position of the Slovak Republic within the framework of EU-27 and V4 is determined on the basis of the electricity prices comparison for the year 2011. The share of expenditures on electricity in gross cash expenditures is also the important indicator influencing the individuals` energy security. Therefore, the second section of this paper deals with the analysis and forecasting of this indicator.

Keywords: individuals` energy security, electricity prices, method of least squares, method of terminal sliding increments of the first order, the Slovak Republic, the European Union

1. Introduction

The electricity market unlike the natural gas market has a regional character. The price of electricity is quoted on the European commodity exchanges, among the most important of which are the European Energy Exchange (EEX) in Germany and the Power Exchange Central Europe (PXE) in Prague. The Slovak electricity market belongs to the region of CENTREL, which in addition to the Slovak Republic includes also Poland, Hungary and the Czech Republic. (*Energy in the Slovak Republic*, n.d.) The advantage of the Slovak electricity market lies in the adequate connection of the electricity system to the surrounding markets. (*Report on compliance*, 2012) Mutual globalization of European electricity markets negatively influences the safety of the Slovak Republic transmission system operation. Since the August 2011 it is reflected by the increased transit of electricity through the transmission systems of the Czech and Slovak Republic related with the raise of electricity production from the renewable energy sources located in the north of the Germany. (*Report on the results*, July 2012).

In the year 2011 the electricity production in the Slovak Republic accounted for 28,135 GWh of the electricity. Compared to 2010, it means an increase of 1.50 %. (*Report on the results*, July 2012) The nuclear power plants (54.8 %) and the thermal power plants (20.4 %) participated in the greatest extent on the electricity production in 2011.

In the same year the hydro-electric power plants produced 14.2 % and other power plants (industrial power plants and the renewable energy sources power plants) generated 10.6 % of electricity (see Fig. 1).
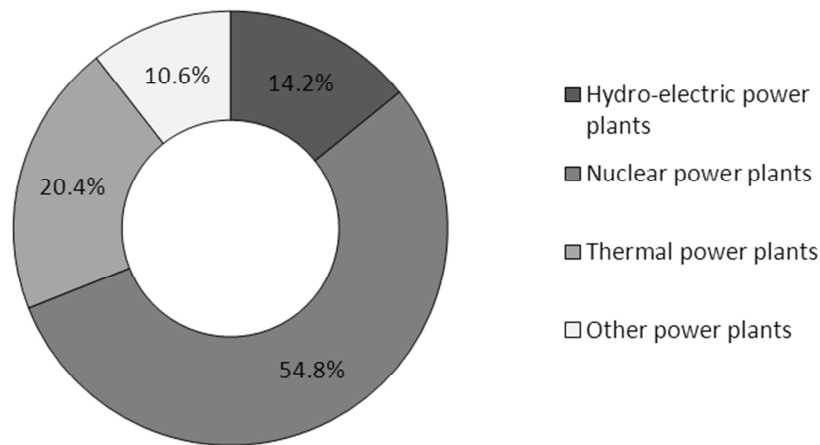

Fig. 1 The share of electricity production in the Slovak power plants in the year 2011 (in %), Data source: (*Report on the results*, July 2012), Own processing

The overall installed capacity of the Slovak power plants in the year 2011 achieved 8,152 MW (*Report on the results*, July 2012). Out of this volume, the thermal power plants came first with a 33.2% share, followed by the hydro-electric power plants with 30.4%, nuclear power plants with 23.8% and finally other power plants with a 12.6% share (see Fig. 2). The significant increase in the production of electricity in the year 2011 noticed the photovoltaic power plants ranked between other power plants (*Report on the results*, July 2012).
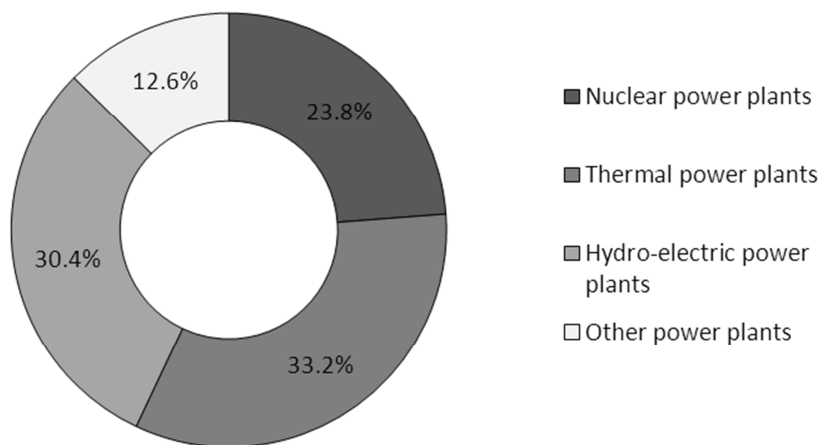

Fig. 2 The installed capacity of the Slovak power plants in the year 2011 (in %), Data source: (*Report on the results*, July 2012), Own processing

In the year 2011 the electricity consumption in the Slovak Republic accounted for 28,862 GWh. Compared to 2010, it means an increase of 0.35%. (*Report on compliance*, 2012) It can be stated that the Slovak Republic was in the year 2011 self-sufficient in the field of electricity generation, because the statistical difference between consumption and generation have been also covered by electricity sources in the Slovak Republic, however the import of electricity was more market efficient than its production based on the Slovak sources. (*Report on the results*, July 2012)

Nuclear power plant Mochovce, since 2008 under construction, is a key source from the perspective of achievement the surplus electricity balance in the Slovak Republic. After putting this source into operation during the year 2014 (*Report on compliance*, 2012), the share of carbon-free technologies in the production of electricity in the Slovak Republic will be more than 80% (*Report on the results*, 2011). This source is going to become another stabilizing factor of the Slovak power system and will ensure stable and secure electricity supplies.

It will also contribute to lower fluctuation of electricity prices for households and industry in the Slovak Republic. (*Nuclear energy*, 2012) The construction of renewable energy sources under the National action plan for energy from renewable energy sources will also contribute to the surplus balance achievement. Electricity market in the Slovak Republic is fully liberalized and opened to the new participants. Every end customer can choose the electricity supplier. In this context the number of household consumers switching the electricity supplier (see Table 1) is gradually increasing.

Table 1 Number of household consumers switching supplier, Data source: (*Report on compliance*, 2012), Own processing

Year	Number of household consumers
2009	7,697
2010	17,171
2011	40,574

2. State of the problems

The concept of individuals` energy security was defined by Felix Ciuta in the article published in Security Dialogue. According to him "*for many individuals, energy security may simply mean being able to afford heating in the depths of a cold winter or having access to a means of cooking – a "logic of subsistence*" (Ciuta, 2010, p. 123). Based on this definition an individuals' energy security is closely related to the prices of electricity and natural gas for households in each individual country. Since the annual costs of electricity in the average household occupying the residential house in the Slovak Republic are approximately 4 times higher than the costs of gas, this contribution analysis the impact of electricity prices on the energy security of households.

3. Methods

In this paper are used the standard methods of the statistical analysis. To eliminate the random component of the analyzed time series the machinery of moving averages is used. Short-term prognosis of the development of electricity prices for households, respectively the development of share of expenditures on electricity in gross cash expenditures of household consumers is made on the basis of method of least squares, respectively the method of terminal sliding increments of the first order. The data required for the analysis were obtained from the Eurostat and the Statistical Office of the Slovak Republic statistics.

4. Electricity prices for households

In the Slovak Republic the electricity market is regulated by Act No. 276/2001 Coll. on Regulation in Network Industries and on amendment and supplement of some acts as amended. Abovementioned Act introduced establishment of two Energy Regulators: Board for Regulation – an authority which forms the regulatory policy – and the Regulatory Office for Network Industries - a body which issues appropriate decrees supplementing the regulatory policy, covers the price proceedings in regulated industries and conducts other implementation activities (*Regulatory policy*, 2011). Current regulatory period (2012-2016) was determined by the Board for regulation for 5 years.

Final electricity price for households is in principle made up from a commodity price, respectively a price of active power and grid charges. The price of active power, which constitutes about 43% of final electricity price, is quoted on the stock exchanges. The remaining 57% of final electricity price consists of grid charges (for example transmission and distribution charges, losses and others) which are regulated in the Slovak Republic. ("Opportunities and regulation", 2012)

Through Decree No. 1/2010 on the scope of price regulation in network industries and the method of its execution the Regulatory Office for Network Industries enforced „*the 2011 price regulation in the electricity industry on the production of electricity from renewable energy sources, combined heat and power production technologies and from domestic coal, grid connection, access to the transmission network and electricity transmission, access to the distribution network and electricity distribution, electricity supply to households and small businesses and provision of balancing and ancillary services in the electricity industry*" (*Annual report*, 2012, p. 70).

According to Regulatory Office for Network Industries the final electricity price for the compound electricity supply to domestic consumers increased by an average of 5.7% in 2011 (*Annual report*, 2012).

4.1. Development of the electricity prices for households in the Slovak Republic

Electricity prices for households in the Slovak Republic are influenced by these factors:

➢ electricity consumption of the whole customers portfolio,
➢ estimated consumption of the electricity in the Slovak Republic,
➢ electricity generation capacity,
➢ development of the electricity prices on the European Energy Exchange in Germany,
➢ government decisions (price regulation),
➢ historical data of the development of electricity prices for households and others.

For the purposes of this paper the future development of the electricity prices for households was predicted on the basis of historical data. We supposed that the abovementioned factors affecting the electricity prices for households are reflected in the analyzed historical data.

Fig. 3 shows initial statistical data on electricity prices for households in the Slovak Republic in the period 2004S1-2012S1. The data express a semi-annual frequency and reflect different amount of VAT (Value added tax) in the abovementioned period. The aim was to analyze the development of the trend component of the time series on the basis of the abovementioned historical data from the period 2004S1-2012S2 and to make forecast of the development of electricity prices for households in the Slovak Republic until 2014S1. To eliminate the random component of the analyzed time series the machinery of moving averages was used (see Fig. 3 and Table 2 in Appendix 1).

Time series adjusted by moving averages was subsequently analyzed from the perspective of the trend component development. To express the trend the rational function of the second degree was used. Also an artificial variable S1 was utilized to emphasize half-yearly seasonality. Estimation of the parameters of a polynomial equation was carried out on the basis of the values of the time series using the method of least squares. For estimation of the parameters the sequence of orders Data / Data analysis / Regression / OK in Microsoft Excel was used. (Chajdiak, 2009)
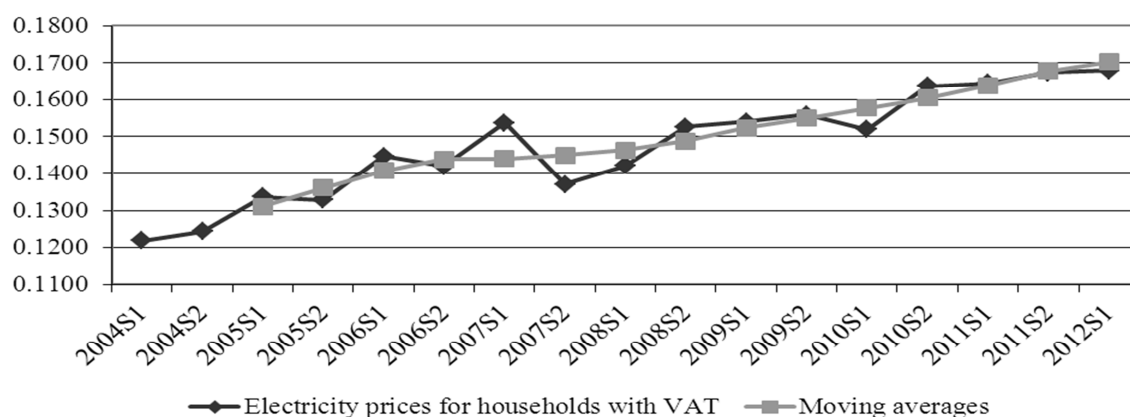

Fig. 3 Electricity prices for households in the Slovak Republic with VAT in the period 2004S1-2012S1 in kWh and moving averages, Data source: Eurostat, Own processing

In the next step quadratic equation in the form $y = 0.0002x^2 - 0.6318x + 629.4259 - 0.0029S1$ was obtained. Also the value of R-squared at the level of 0.983 was acquired. It is thus possible to assess this model as high-quality in terms of use it for making forecasts, because 98.3% of its total variability can be explained by the regression model.

Subsequently based on data obtained using the Regression tool, forecast of the development of electricity prices for households in the Slovak Republic until the first half of 2014 was carried out. (see Fig. 4 and Table 2 in Appendix 1). From the conducted analysis arose that the price of electricity for households for the period from the second half of 2012 to the end of the forecasted period should demonstrate half-yearly average growth rate on the level of 2.19%.
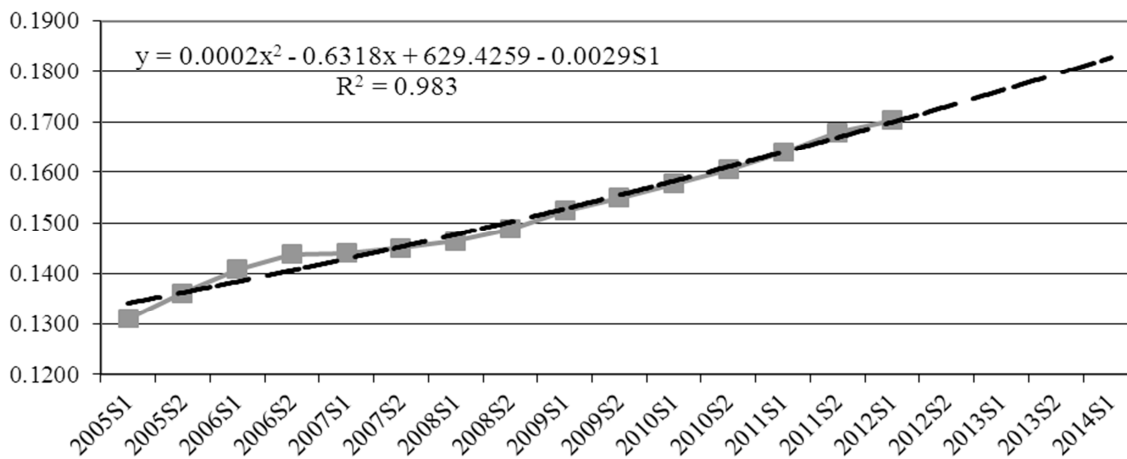

Fig. 4 Forecast of the development of electricity prices for households in the Slovak Republic until the first half of 2014, Own processing

4.2. Comparison of electricity prices for households in the EU-27

a. In absolute terms

For the purposes of the analysis were the prices of electricity in the different countries of the EU-27 ranked in ascending order. Performed analysis showed that the price of electricity in the Slovak Republic in absolute terms is 14th highest in the EU-27 and is located just over the average price in this cluster (see Fig. 5). In terms of comparison of electricity prices in the V4 it can be stated that the Slovak Republic is in the fourth place, it follows that Slovak citizens pay the highest price for electricity among the V4 member countries.
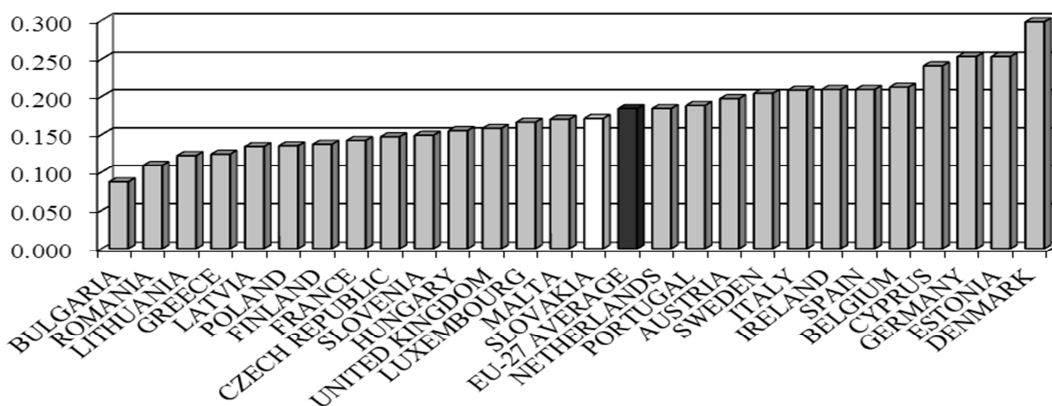

Fig. 5 Comparison of electricity prices for households in the absolute terms in EU-27 in the second semester of 2011 (in EUR/kWh) Data source: (*Electricity and natural gas prices*, 2011), Own processing

b. *In purchasing power parities*

Fig. *6* shows a comparison of electricity prices for households in purchasing power parities between the EU-27 member states, Norway, Croatia and Turkey for the second half of 2011.
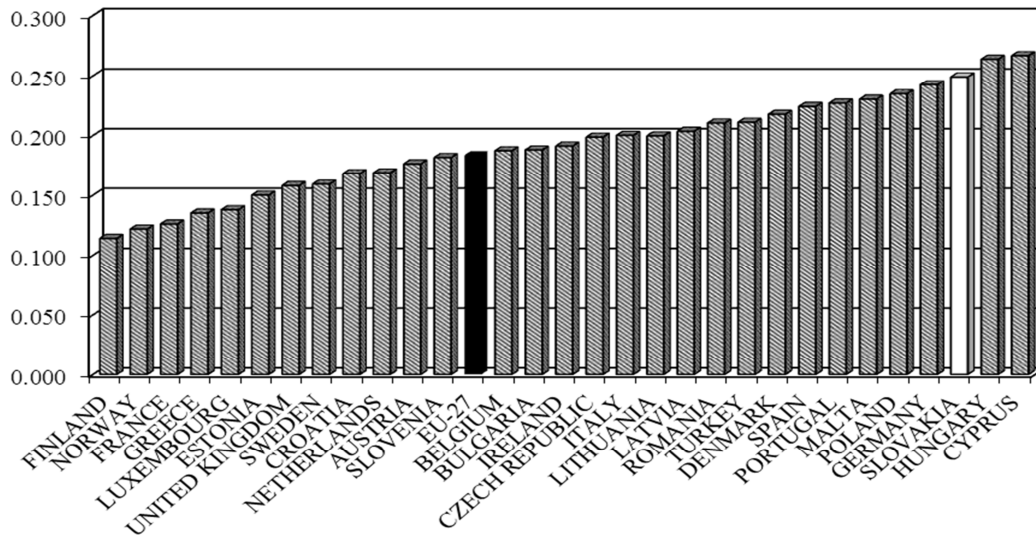

Fig. 6 Comparison of electricity prices for households in purchasing power parities in the EU-27 member countries, Norway, Croatia and Turkey in the second semester of 2011 (in PPS/kWh), Data source: (*Electricity and natural gas prices*, 2011), Own processing

The Slovak Republic is located at 29th position. It follows that in comparison with other analyzed countries the Slovak inhabitants pay in relation to their income the third highest sum of money for electricity.

5. *Share of expenditures on electricity in gross cash expenditures of household consumers*

In addition to the development of the electricity prices the households are also interested in the current and future development of the share of expenditures on electricity in their gross cash expenditures.

5.1. *Development of the gross cash expenditures of household consumers in the Slovak Republic*

In the first step the development of the aggregated indicator gross cash expenditures of household consumers in the period 2004Q1-2012Q3 (quarterly data) (see Fig. 7) was reviewed. Since the values of the considered time series exhibit high variability, to make short-term prognosis of their development was utilized the method of terminal sliding increments of the first order. To eliminate random component of the analyzed time series the machinery of central moving averages of size 4 and moving averages of size 5 were used. Subsequently the method of terminal sliding increments of the first order was used and the forecast for the analyzed time series until the end of 2013 (see Fig. 7) was calculated.

Fig. 7 Development of the gross cash expenditures of household consumers in the period 2004Q1-2012Q3
(in % - quarterly data) and forecast of the development until the end of 2013, Data source: (*Cash expenditures*, 2012), Own processing

On the basis of analysis conducted, it is anticipated that gross cash expenditures of household consumers should report during the forecasted period quarterly average growth rate on the level of 0.17%.

5.2. Development of the share of expenditures on electricity in gross cash expenditures of household consumers in the Slovak Republic

In the second step development of the share of expenditures on electricity in gross cash expenditures of household consumers in the period 2004Q1-2012Q3 was analyzed in the same way (quarterly data) (see Fig. 8). To eliminate random component of analyzed time series the machinery of central moving averages of size 4 and moving averages of size 5 were used. Subsequently the method of terminal sliding increments of the first order was applied and forecast for the analyzed time series until the end of 2013 was calculated (see Fig. 8 and Table 3 in Appendix 1).
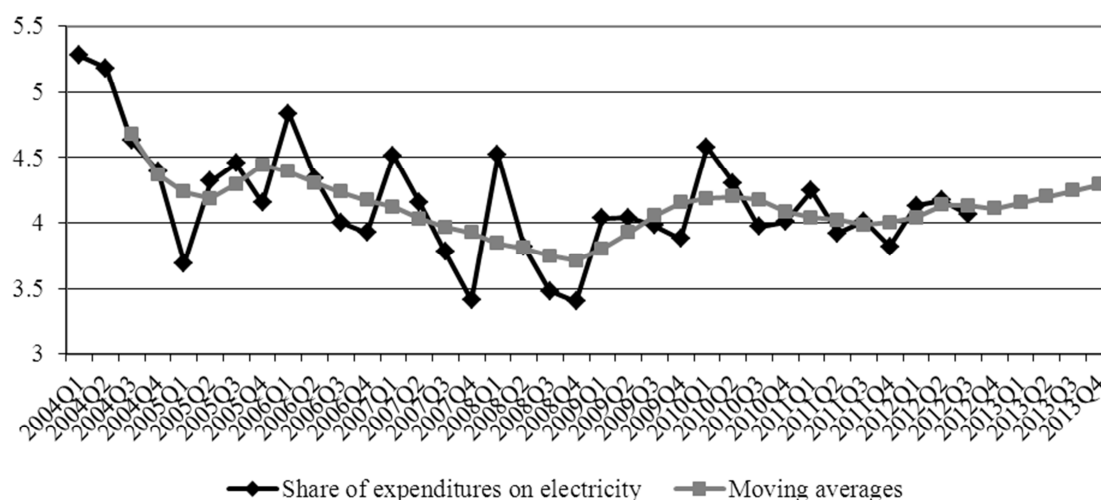

—◆—Share of expenditures on electricity   —■—Moving averages

Fig. 8 Share of expenditures on electricity in gross cash expenditures of household consumers in the period 2004Q1-2012Q3 (in % - quarterly data) and forecast of the development until the end of 2013, Data source: (*Cash expenditures*, 2012), Own processing

From the conducted analysis arose that the share of expenditures on electricity in gross cash expenditures of household consumers for the period 2012Q3-2013Q4 should demonstrate average quarterly growth rate on the level of 1.10%.

6. Conclusions and recommendations

In this contribution the electricity prices were analyzed from the various points of view and the position of electricity prices in ensuring individuals` energy security was evaluated. From the analysis carried out in Chapter 4.1 arose that electricity prices for households with VAT should in the period 2012S2 – 2014S1 achieve half-yearly average growth rate on the level of 2.19%. In the previous two-year period (2010S2 – 2012S1) half-yearly average growth rate achieved the level of 2.36%. The forecast performed in this article assumes approximately the same increase in energy prices than in the previous two-year period. From the comparison of electricity prices for households in the purchasing power parities (see Chapter 4.2) results that compared to the other analyzed countries the Slovak inhabitants pay in relation to their income the third highest sum of money for electricity. This has a negative impact on their personal energy security. This situation negatively affects the Slovak economy as a whole, because it has a significant impact on the competitiveness of the Slovak Republic and increases the costs of the Slovak economy.

As regards the analysis of gross cash expenditures of households conducted in Chapter 4.1, this indicator should during the forecasted period show average quarterly growth rate on the level of 0.17%. The share of expenditures on electricity in gross cash expenditures of household consumers analyzed in Chapter 5.2 should in the same period report the average quarterly growth rate at the level of 1.10%.

If the total gross cash expenditures over the forecasted period increased by 0.17 EUR to 100 EUR of cash expenditures, then at a given share of the electricity prices on gross cash expenditures the expenses of households on electricity would increase by 0.045 EUR on the same basis, which represents 27% of the increase in gross cash expenditures. This share should rise by the end of the forecasted period up to 28%. Therefore, the partial indicator, which participates in the aggregate one only about 4%, should participate in the growth of this indicator 27%-28%. The abovementioned also means that gross cash expenditures except from expenditures on electricity should during the forecasted period increase by 0.125 EUR to 100 EUR, representing 73% of the increase in gross cash expenditures. This proportion should until the end of forecasted period drop to 72%. Therefore, the partial indicator that contributes to aggregate one to approximately 96% would be involved in the growth of this indicator only 72%. It can be stated that in the course of the forecasted period, the expenditures on electricity should increase faster than other items of gross cash expenditures (for example expenditures on food, housing, clothing, etc.) which represents the negative impact on the individuals` energy security. How is thus possible to reduce household expenditures on electricity? Consumers cannot influence the price of electricity, because it is crucially influenced by the development in the market and regulation of the Regulatory Office for Network Industries. Consumers may reduce spending on electricity only by energy savings.

In the area of reducing energy consumption, however, it can be stated that the energy intensity of the Slovak economy in the long term significantly decreases. However the total consumption of the electricity in the Slovak Republic during the year 2011 increased by 0.35% (*Report on the results*, July 2012) and over the years 2012-2014 it is expected a slight increase in its consumption - according to the *Report on the results* (July 2012), it is expected that the total consumption of the electricity in the Slovak Republic would increase during the year 2012 by 0.5%, in the course of 2013 by 1.4% and during the year 2014 by 2.4%. This growth, however, should be primarily caused by the economic recovery after the economic crisis and the gradual return to the values from the pre-crisis period. Another possibility to enhance energy security of every individual citizen is wage increase and its movement towards the EU average. What may stimulate employers to increase wage levels of employees? It can be growth in the market in which they operate, increasing the share in a given market, the growth of exports but also the levies and tax policy of the state with a positive approach to the increase in wages. Unfortunately, just in this area measures have been taken which rather negates the increase in wages and represent a threat not only to the energy security of the population.

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Appendix 1

Table 2 Electricity prices for households in the Slovak Republic with VAT – development in the period 2004S1-2012S2 and prognosis based on moving averages m=5 until 2014S1 (in EUR/kWh), Source: Eurostat, Own processing

Period of time	Electricity prices for households (EUR/kWh)	Moving averages (EUR/kWh)	Period of time	Electricity prices for households (EUR/kWh)	Moving averages (EUR/kWh)
2004S1	0.1219		2009S2	0.1560	0.1550
2004S2	0.1244		2010S1	0.1520	0.1578
2005S1	0.1336	0.1310	2010S2	0.1637	0.1605
2005S2	0.1328	0.1361	2011S1	0.1646	0.1639
2006S1	0.1447	0.1408	2011S2	0.1674	*0.1678*
2006S2	0.1420	0.1438	2012S1	0.1680	*0.1703*
2007S1	0.1537	0.1441	2012S2		**0.1730**
2007S2	0.1371	0.1451	2013S1		**0.1765**
2008S1	0.1421	0.1464	2013S2		**0.1794**
2008S2	0.1527	0.1488	2014S1		**0.1832**
2009S1	0.1540	0.1524			

Table 3 Development of the share of expenditures on electricity in gross cash expenditures of household consumers in the period 2004Q1-2012Q3 (in% - quarterly data and forecast of the development until the end of 2013, Data source: (*Cash expenditures*, 2012), Own processing

Period of time	Share of expenditures on electricity in gross cash expenditures (in %)	Moving averages m=5 (in %)	Period of time	Share of expenditures on electricity in gross cash expenditures (in %)	Moving averages m=5 (in %)
2004Q1	5.2811		2009Q1	4.0361	3.8022
2004Q2	5.1825		2009Q2	4.0390	3.9246
2004Q3	4.6282	4.6734	2009Q3	3.9817	4.0518
2004Q4	4.3964	4.3665	2009Q4	3.8798	4.1529
2005Q1	3.6920	4.2367	2010Q1	4.5774	4.1851
2005Q2	4.3166	4.1848	2010Q2	4.3061	4.1998
2005Q3	4.4554	4.2976	2010Q3	3.9726	4.1742
2005Q4	4.1537	4.4439	2010Q4	4.0060	4.0848
2006Q1	4.8373	4.3902	2011Q1	4.2469	4.0412
2006Q2	4.3416	4.3046	2011Q2	3.9209	4.0225
2006Q3	4.0008	4.2356	2011Q3	4.0096	3.9845
2006Q4	3.9237	4.1716	2011Q4	3.8192	4.0009
2007Q1	4.5152	4.1203	2012Q1	4.1295	4.0387
2007Q2	4.1521	4.0286	2012Q2	4.1700	*4.1334*
2007Q3	3.7798	3.9649	2012Q3	4.0631	*4.1298*
2007Q4	3.4107	3.9234	2012Q4		**4.1088**
2008Q1	4.5189	3.8439	2013Q1		**4.1546**
2008Q2	3.8164	3.8053	2013Q2		**4.2004**
2008Q3	3.4790	3.7440	2013Q3		**4.2462**
2008Q4	3.4032	3.7115	2013Q4		**4.2920**