ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

RETAIL ELECTRICITY PRICE FORMATION FACTORS: LITHUANIAN CASE

Viktorija Bobinaite[1], Aldona Juozapaviciene[2]

[1]*Kaunas University of Technology, Lithuania, viktorija_bobinaite@yahoo.com*
[2]*Kaunas University of Technology, Lithuania, aldona.juozapaviciene@ktu.lt*
crossref http://dx.doi.org/10.5755/j01.em.17.1.2259

Abstract

The developed system of retail electricity price formation factors is presented in this paper. It allows understanding retail electricity price formation process. Factors having impact on electricity cost, profit and electricity volume consumed are analyzed. Factors allowing explaining the volume of electricity consumed are grouped under the economic, social, climatic, technical-technological, political and demographical criteria. Analysis of Lithuanian retail electricity price is performed. Retail electricity price structure, its development in Lithuania is presented. Overview of regulating environment is done. The results of correlation analysis disclosed the positive and negative relationships between electricity price for household and 55 indicators. Three multiple linear regression equations, enabling to link electricity price for household and its factors into a single set, are prepared. The equations are assigned to: describe electricity price for household by macroeconomic factors and factors that impact on electricity production costs; assess the impact of changes of electricity production structure on electricity price for household; assess the impact of quantities and prices of electricity production factors and macroeconomic indicators on electricity price for household, as well impact of changes of electricity production structure on electricity price for household.

Keywords: retail electricity price, electricity price factors, correlation, regression.
JEL Classification: C20; C30; C32; L90; L94.

Introduction

Topicality of the article. Electricity sector is an important part of national economy. It creates gross domestic product, contributes to formation of state budget, helps to solve social (unemployment) problems and has impact on countries competitiveness. The main product of this sector is electricity, which is a public good consumed in households and other sectors. When electricity price increases, changes in the structure of households expenditures is noticed, i.e. expenditure for electricity increases, therefore households post less money for acquisition of other goods and services. This will reduce growth of economy, since producers of other goods and services receive less money, therefore will employee less people. As a result social problems can arise. Certainly, electricity price increase has a negative effect on expectations of households, since they will have difficulties on understanding how the economy will develop in future. Pessimistic expectations can influence households to save today and to reduce expenditures for acquisition of fixed asset. Optimistic expectations can promote consumption today. If consumer goods and services are imported, country's balance of trade will worsen. Thus, retail electricity price is an essential parameter of the economy.

Novelty of the article. A significant effect of retail electricity market price on country's economic-social parameters has an influence on self-determination to put more efforts to investigate the retail electricity price. First of all, it is essential to understand the structure of it. Secondly, it is relevant to know the factors forming it and influencing on its development.

The object of the article is a retail electricity price, which is set for Lithuanian households that consume 1000-2500 kWh of electricity per annum.

The aim of the article. After the assessment of relationships between retail electricity price and its factors during 2002-2010, to prepare a system of indicators that can explain retail electricity price level and will enable to foresee electricity price development in medium term.

Seeking to implement the aim the following *tasks* are set:

- at theoretical level to formulate a system of indicators that enable to explain the process of retail electricity price formation and price changes;
- to discuss the structure of retail electricity price and its development in Lithuania;
- to analyze factors, forming retail electricity price in Lithuania and influencing their changes;
- to present the system of Lithuanian retail electricity price formation factors based on the results of calculations.

In order to exercise these tasks the following *methods* are applied: analysis of legal documents and scientific literature, quantitative analysis of selected statistical data, correlation and regression analysis.

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

System of electricity retail price factors

Currently, the issue of retail electricity price is open for the discussion. Various aspects of retail electricity pricing are analyzed in scientific literature. However, it has to be acknowledged that there are lacks of publications that deal with issue of factors of retail electricity price. Seeking to fulfil this gap, this article is prepared. Based on the results of literature analysis, the following system of retail electricity price factors is developed (Figure 1):

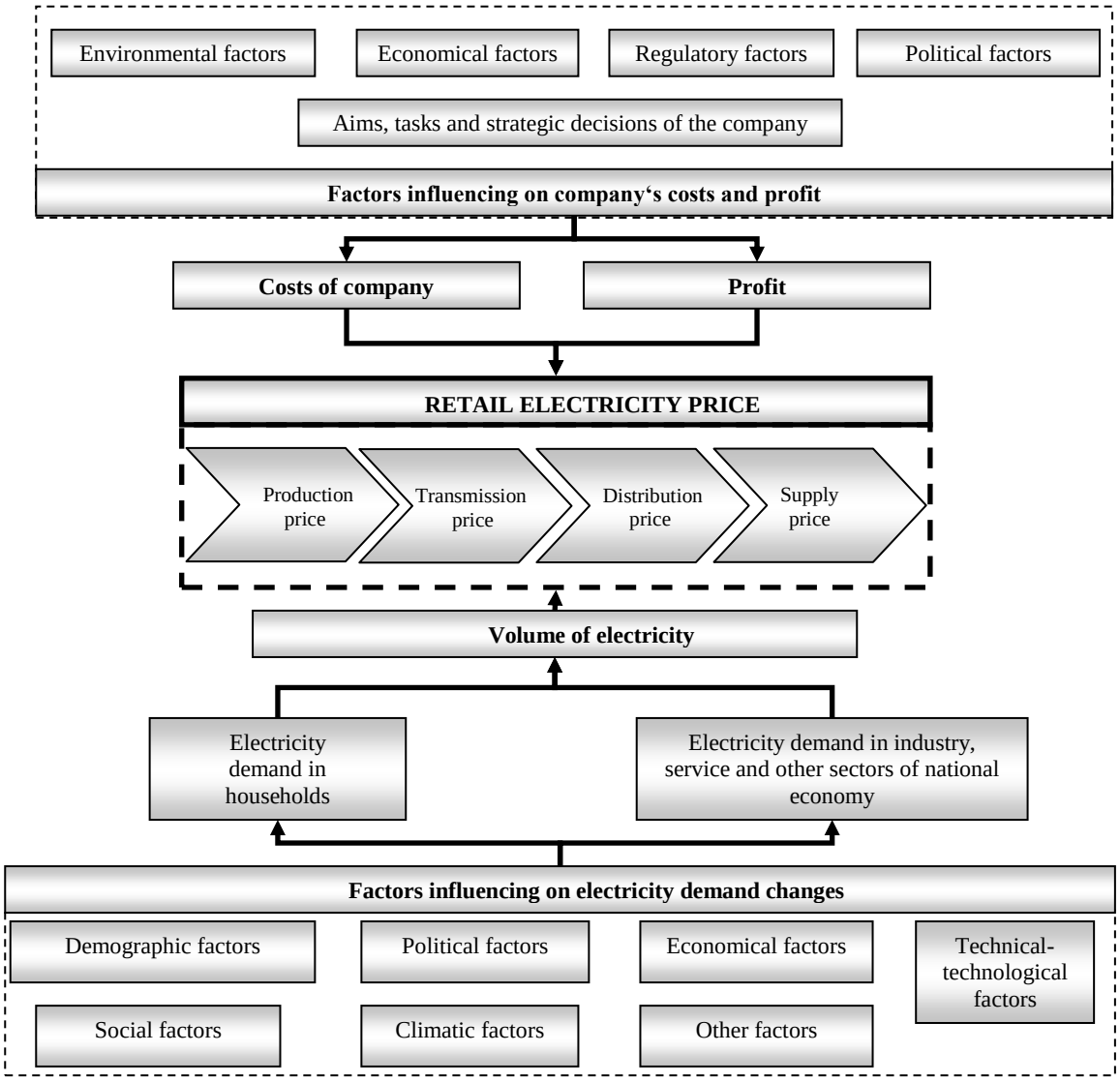

Figure 1. The system of factors of retail electricity price

With reference to Figure 1, it can be stated that electricity retail price consists of four large components. Namely, electricity production price, prices of electricity transmission and distribution services, and electricity supply price are constituent parts of retail electricity price; therefore changes of these parts obviously make retail electricity price to change too. In Figure 1 principals, how retail electricity price is calculated, are also reflected. Considering to information, provided in legal documents, retail electricity price is calculated considering the costs of the company, profit and volume of electricity consumed. Thus, three large groups of factors, forming and making retail electricity price to fluctuate are segregated and asks for more detailed analysis.

With reference to principals, how retail electricity price is calculated, it is argued that the increase of costs and profit increases retail electricity price. The results of the analysis showed that costs and profit of the company are depended on aims, tasks and strategic decisions of the company, i.e. on strategy adopted. As informational and telecommunication technologies, virtual organizations and networks are quickly developing, the constant change of environment stipulates the need to adjust and change the adopted strategy

(Strumickas & Valančienė, 2009). Under the conditions of improved strategy, company's financial results, including cost and profit, can change.

Implemented environmental policy has a direct impact on cost and profit of the company in short and long-runs too. As a result of reinforced environmental policy, additional investment into the activities of the company can be required to be directed. On the one hand these investments will contribute to increased productivity of the company, but on the other hand they will be related to increased costs of the company to service the loan.

The results of performed analysis of literature (Wolak, 1998; Serletis & Herbert, 1999; Valiukonis *et al.*, 2007; Mohammadi, 2009; Mjelde & Bessler, 2009; Muñoz & Dickey, 2009; BaltPool, 2010; Ferkingstad *et al.*, 2010) show that economical factors also influence on company's cost, profit and retail electricity price. One can notice that electricity price highly depends on fuel (oil, natural gas, coal, and uranium) prices. H. Mohammadi (2009) analyzed long-run and short-run relationships between retail electricity prices and fossil fuel (coal, natural gas and oil) prices in USA. The results of the analysis showed that in a short-run electricity price depended on coal and natural gas prices, but in a long-run the statistically significant relationships existed only between electricity retail price and coal price. E. Hjalmarsson (2000) agreed that electricity price depend both on prices of fuels used in electricity production and wage. However, he stressed that coal and uranium prices for a long time were stable and electricity sector was not a labour intensive sector; therefore he concluded that in Scandinavian countries electricity price highly dependent on water recourses. Additionally, M. P. Muñoz & D. A. Dickey (2009) and E. Ferkingstad *et al*. (2010) emphasized that electricity price was influenced by fluctuations of exchange (USD/EUR or USD/EUR) rate. G. Valiukonis *et al*. (2007) itemized the costs that emerged in electricity supply chain, i.e. all costs can be divided into two broad groups – electricity purchase costs and fixed costs. Amortization, labour costs, maintenance costs, operational costs, costs of new consumer connection to the network were prescribed to fixed costs.

Emerged economic situation in the country and abroad influence the cost and profit of the company too. The improvement of economic conditions increases costs of resources and costs for the company. According to M. Strumickas & L. Valanciene (2009), the global financial crisis, which started in 2008, was the main factor that influenced financial results of the companies. For some period shareholders and managers of companies expected declining results of companies and started to strengthen cost control.

The EU emission trading scheme and the regulations on renewable sources are the strongest regulatory factors (Tamosiunas, 2010). As it is stated by R. Ciegis and D. Streimikienė (2006) GHG emissions trading impacts on economy through the energy price increase caused by carbon restrictions on energy sector.

M. Strumickas & L. Valanciene (2009) concludes that changes of science, technologies, politics, society, competition and other external factors may indirectly influence financial results of the companies.

The results of research showed that there was an inverse relationship between electricity prices for consumer and electricity volume consumed, i.e. the higher the volume, the lower the prices. Electricity consumption level in households increases because of several reasons. N. U. R. Khattak *et al*. (2010) found arguments that electricity consumption increases when members of households become more educated, when increases number of living rooms. P. K. Narayan *et a*l. (2007) noticed that electricity consumption increases, when real income grows. Additionally, increased living standards contribute to increasing volume of electricity consumed. Besides, P. K. Narayan *et a*l. (2007) set that in France, Germany, Italy and G. Britain electricity consumption increases when price of natural gas grows. G. S. Donatos & G. J. Mergos (1991) noticed that electricity consumption level can increase because of growing number of electricity consumers. F. Halicioglu (2008) analyzed the impact of increased level of urbanization and noticed that urbanization as a social phenomenon ensures more abilities to use electricity. As a result electricity demand increases. P. Holtedahl & F. L. Joutz (2004) observed that electricity consumption increases both due to increased number of people living in cities, real disposable income and because of increased electricity demand for cooling purposes. P. Holtedahl & F. L. Joutz (2004) and P. K. Narayan *et al*. (2007) set that electricity consumption decreases, when price of electricity increases. With reference to literature analysis performed all factors influencing on electricity demand in households were classified the following – economic, social, climatic, technical-technological, political and demographical (at theoretical level this group of factors was discussed by G. Startiene and R. Remeikiene (2009)) factors. Indicators prescribed to these factors are presented in Figure 2.

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

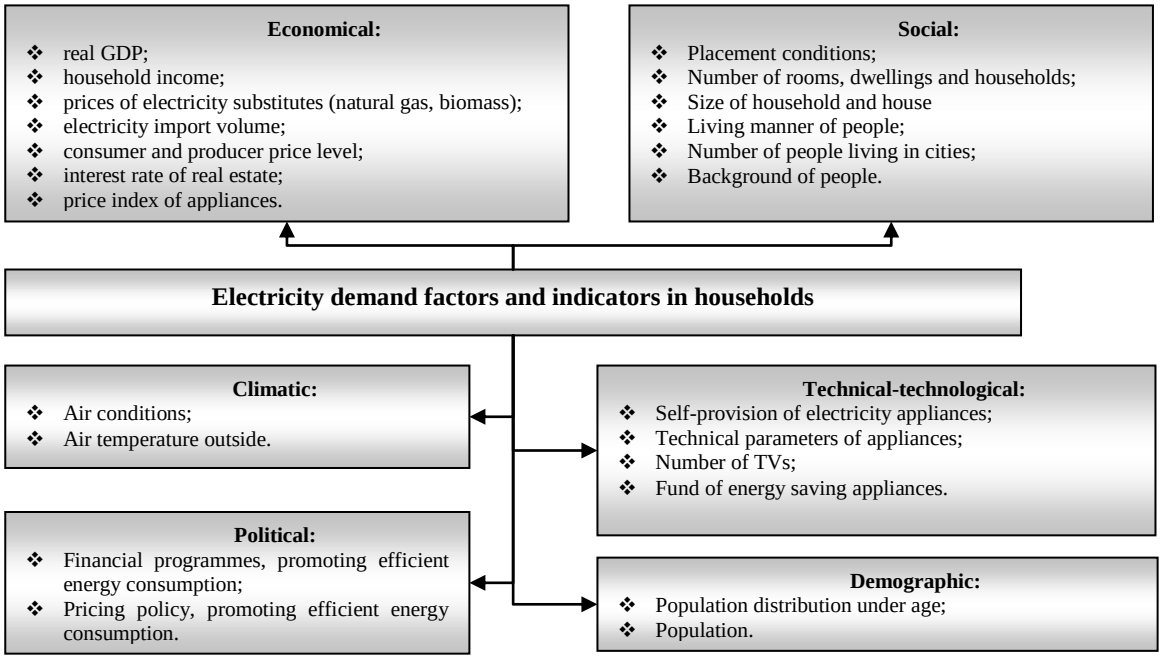

Figure 2. Factors and indicators of electricity demand in households

Based on the developed system of retail electricity price factors, analysis of Lithuanian retail electricity price is performed. The results of the analysis are presented in the following sections of the article.

Structure of retail electricity price and its development in Lithuania during 2002-2010

Electricity price for Lithuania consumer is formed considering costs that emerge in different activities of power sector. The following activities can be segregated in Lithuanian power sector – electricity production, transmission, distribution (low and medium voltage networks) and supply. Measuring costs of each activity, the price of corresponding activity is formed. In Figure 3 the development of average electricity price for Lithuanian consumer, which equipment is connected to low voltage networks, is presented.

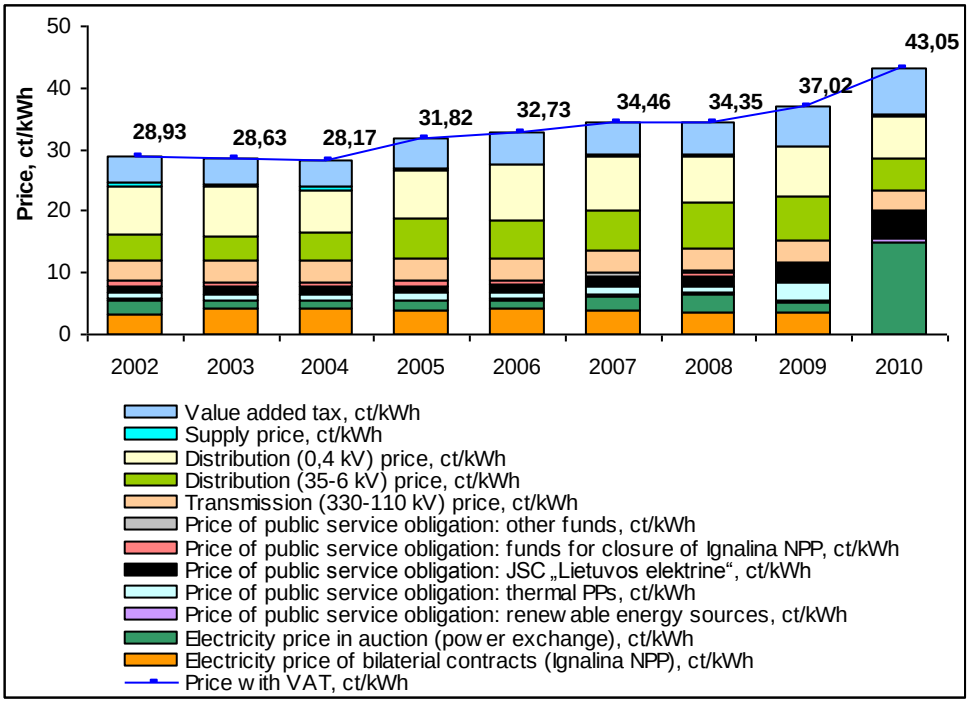

Figure 3. Electricity price for consumer structure and development in Lithuania during 2002-2010 in Lithuania, ct/kWh

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

Figure 3 shows that electricity price for consumer had a tendency to increase in Lithuania. The average growth rate of electricity price for consumer was 5.1% per annum during 2002-2010. Historically electricity distribution price made the largest share in the structure of electricity price for consumer (40-45%). In 2010 this share reduced till 28%. Electricity production price, including price of public service obligation (*further in the text PSO*) was also significant (25-30%). In 2010, after the full closure of Ignalina NPP, the share of electricity production price in the structure of price for consumer increased till 46%. With reference to data of Commission for Energy and Prices, in 2011 the share of electricity production price, including price of PSO, should be 41.2% (Commission for Energy and Prices, 2010). The analysis of structure of electricity price for consumer also disclosed that transmission and supply prices, as well VAT correspondingly made 8-12%, 1% and 15-17% in the structure of electricity price for consumer. As it is seen from Fig. 3, electricity production price, including price of PSO, was rapidly increasing during 2008-2010. Because of rapid development of electricity production price, average price for consumer also changed. It is calculated that the increase of electricity production price, including price of PSO, could increase the price for consumer by 32.7%; the increase of supply price could increase the price for consumer by 0.31%; because of changed VAT, electricity price for consumer could grow by 2.54%. As it could be noticed the transmission and distribution (medium and low voltage) prices reduced during 2008-2010. This allowed reducing the price for consumer corresponding by 0.47%, 5.54%, and 2.34%.

Different prices are applied for different groups of electricity consumers in Lithuania. The development of electricity prices for different groups of consumers is presented in Figure 4.

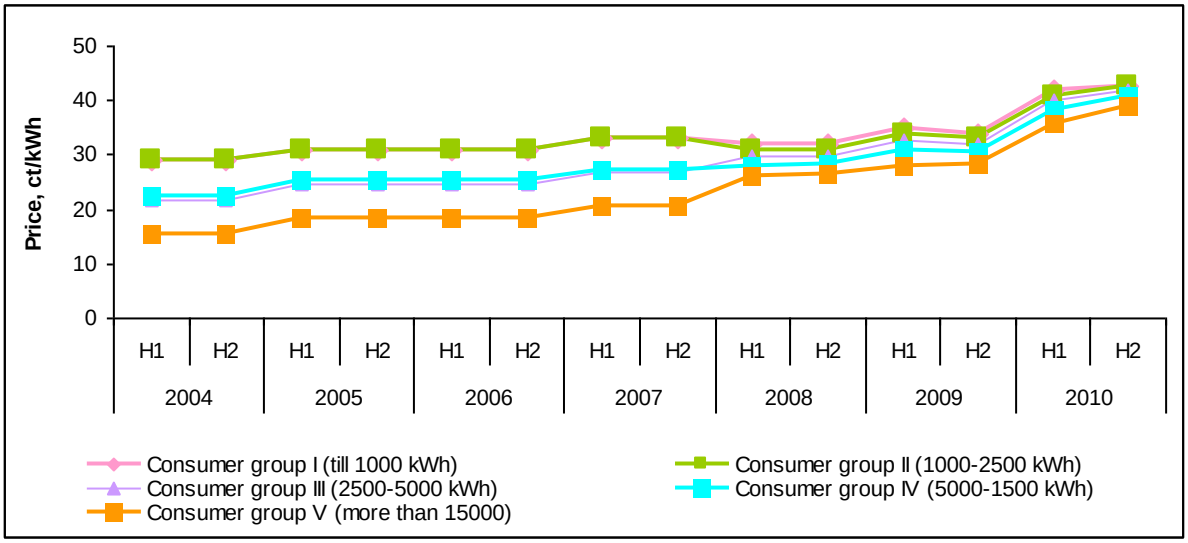

Figure 4. Electricity price for households under groups of consumers

Figure 4 represents that electricity prices for different groups of households grew differently during 2004-2010 in Lithuania. Electricity price for households, who consumed till 2500 kWh of electricity per annum, grew the slowest (by 1.9% a year). On average households, who consumed till 15000 kWh of electricity, paid by 3% more a year. The most rapidly (by 4.1% a year) price was increasing for households, who consumed more than 15000 kWh of electricity a year. Besides, since 2008, a noticeable increase of prices for all groups of households is evident. Figure 4 also shows that electricity price for a household depends on the quantity of electricity consumed. The more household consumes electricity the less it pays. The data of the first half of year 2004 show that households, who consumed the most, paid twice less for 1 kWh of electricity then those who consumed little electricity, i.e. the ratio of the lowest and the highest price was 0.53. Since 2008 this ratio was increasing and in the second half of year 2010 it made 0.89. It has to be acknowledged that the impact of quantity of electricity consumed on the electricity price for household is evident, however impact is gradually reducing.

Despite the fact that electricity price for household was increasing, however it remained one of the lowest in EU countries. In Fig. 5 development of electricity prices for EU households is presented.

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

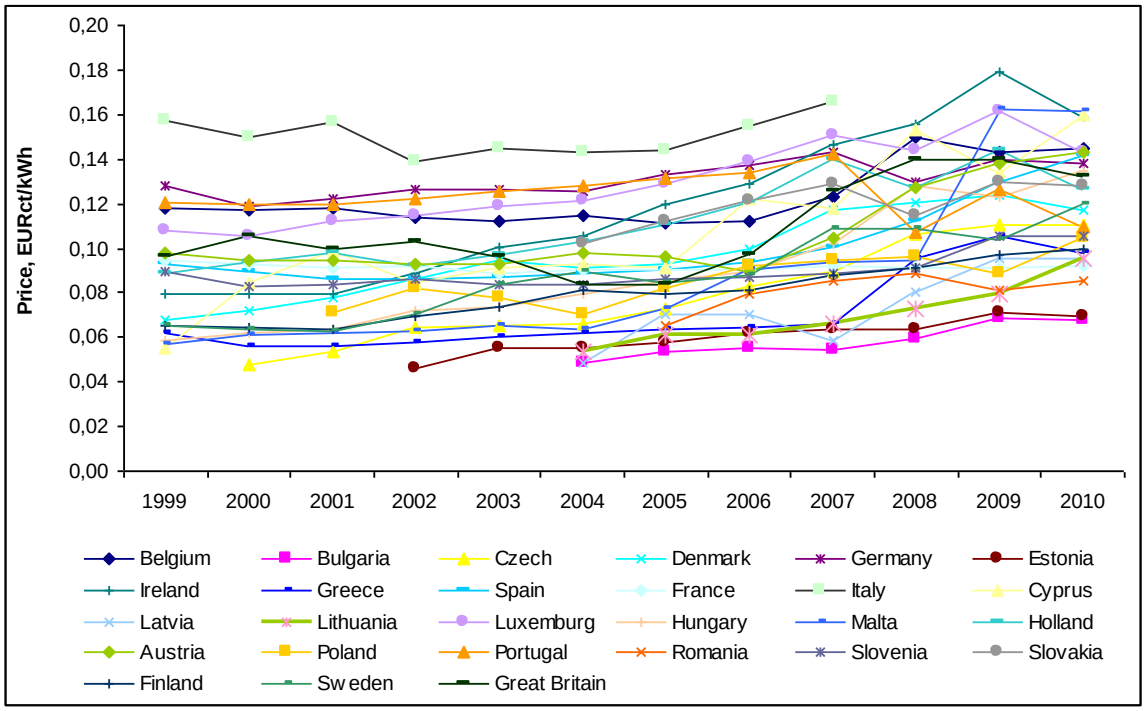

Figure 5. Development of electricity price for households in EU-27

Figure 5 showed that electricity price for households had a tendency to increase in EU countries. During the latter six years electricity price for EU households had increased by 20%. The most rapidly electricity price grew for households of Malta (by 17.3% a year), Cyprus (11.8%), Hungary (9.7%), Great Britain (9.6%), Spain (9.5%). Lithuania, Greece and Republic of Czech are among countries, in which electricity price for households grew by fast rates too. However, price in these countries remained one of the lowest. For example, during 2005-2010 electricity price for Lithuanian households grew by 9.4% a year, but it was by 21.3% lower than EU average in 2010.

The analysis performed showed that electricity price for Lithuanian consumer had a tendency to increase at fast rates; however the price remained one of the lowest in EU countries. Besides, the latest data show that electricity price for consumer highly depends on changes of electricity production and distribution prices. Seeking to better manage electricity price for consumer, it is valuable to understand factors that have an influence on price. This will be done in the following sections.

Regulating environment of retail electricity price in Lithuania

In 20 July 2000 Lithuanian Parliament adopted Law on Electricity (Zin., 2000, Nr. 66-1984). The Law set the regulation principals of electricity production, transmission, distribution and supply; as well it determined the principals of electricity sector pricing. In 29 September 2010, new edition of the Law was accepted. The following electricity pricing principals were set in the new edition:

- producer's and independent supplier's electricity selling price is not regulated, except in the cases, when producer or independent supplier takes more than 25% of selling market.
- transmission, distribution, public supply and public electricity prices are regulated by Commission of Energy and Prices. It sets the upper bound of prices of mentioned activities. Service provider itself sets and changes the concrete prices of transmission, distribution, and public supply services and public electricity.

Historically, almost all retail electricity in Lithuania satisfied the concept of public electricity, for which public electricity price is paid. Till the enactment of the Commission's for Energy and Prices decision No O3-71 of 23 April 2010, public electricity price in Lithuania was regulated by setting the upper bound for public electricity price for one year. Thus a possibility for public suppliers made to reduce costs and receive more profit. Public supplier had a right on its own account to change public electricity price; however not exceeding its upper bound. The upper bound of public electricity price was calculated by summing electricity production (acquisition) price, change of electricity production (acquisition) price and adjusting it by

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

coefficient of proportion, as well public supply price, transmission price and distribution price. In 23 April 2010 Commission for Energy and Prices accepted the decision No. 03-71 "Methodology for public electricity prices, public supply price and its upper bound setting". In this decision it is set that public supplier sets the public electricity price every six months by summing electricity acquisition price, public supply price, transmission price, including price of PSO and electricity system service price, as well distribution (medium and low voltage, depending on the network from which consumer receives electricity) prices (Commission for Energy and Prices, 2010). No public electricity price bounds now exist.

Since 1 July 2004 all consumers, except households, acquired the right to be free to choose supplier. But almost all free consumers chose the public supplier and paid for electricity under the regulated public electricity price. There was not shift to independent suppliers because public suppliers set lower tariffs for the services they provided. Since 1 July 2007 all consumers has a status of free consumer and has a right to choose independent supplier. However, because of the mentioned reason above they do not use this right and buy public electricity from public supplier. In 8 July 2009 by decision No. 740 Government of Lithuania approved Lithuanian electricity market development plan (Government of Lithuania, 2009). One of the most important aims of this plan is to create possibility for Lithuanian electricity consumers to assure themselves with electricity supply for transparent price, to freely choose electricity supplier and to use mechanisms of free electricity market. In electricity market development plan it is foreseen that during 2010-2015 public (regulated) electricity tariffs will not be applied for electricity consumers. Instead electricity consumers will have to choose independent electricity suppliers. The proceedings of refusal of public electricity prices are presented in Figure 6.

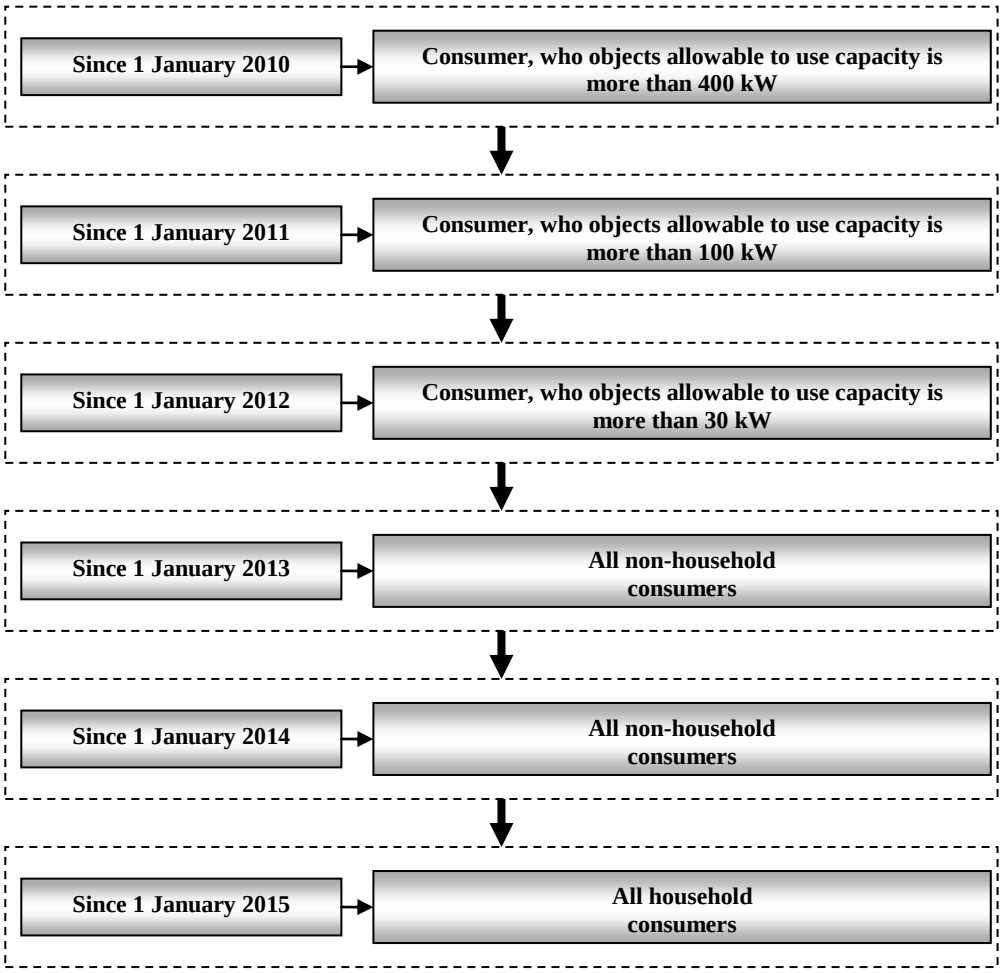

Figure 6. Consumer group, for which public electricity prices are not applied

As it is seen from Figure 6, public electricity prices will be gradually refused in Lithuania and since 1 January 2015 regulated public electricity prices will not be applied to all consumers (some exceptions are possible).

ISSN 2029-9338 (ONLINE)
ISSN 1822-6515 (CD-ROM)

Thus the results of the overview show that retail electricity price has a strong regulating touch. However, in future a gradually shift from regulated electricity prices will be done.

Results of correlation analysis

Based on the results of scientific literature analysis and prepared system of retail electricity price, 55 factors that can form electricity price for Lithuanian household was segregated. They can be prescribed to one of the following group:

- price regulating environment;
- economic situation in the country, that was analyzed by A. Kilijoniene *et al.* (2010), B. Martinkus *et al*. (2009).
- electricity production structure;
- prices of resources used in electricity production;
- investment volume, that was analyzed by V. Snieska and I. Simkunaite (2009).
- electricity consumption;

The correlation relationships of retail electricity price and its factors are presented in Figure 7.

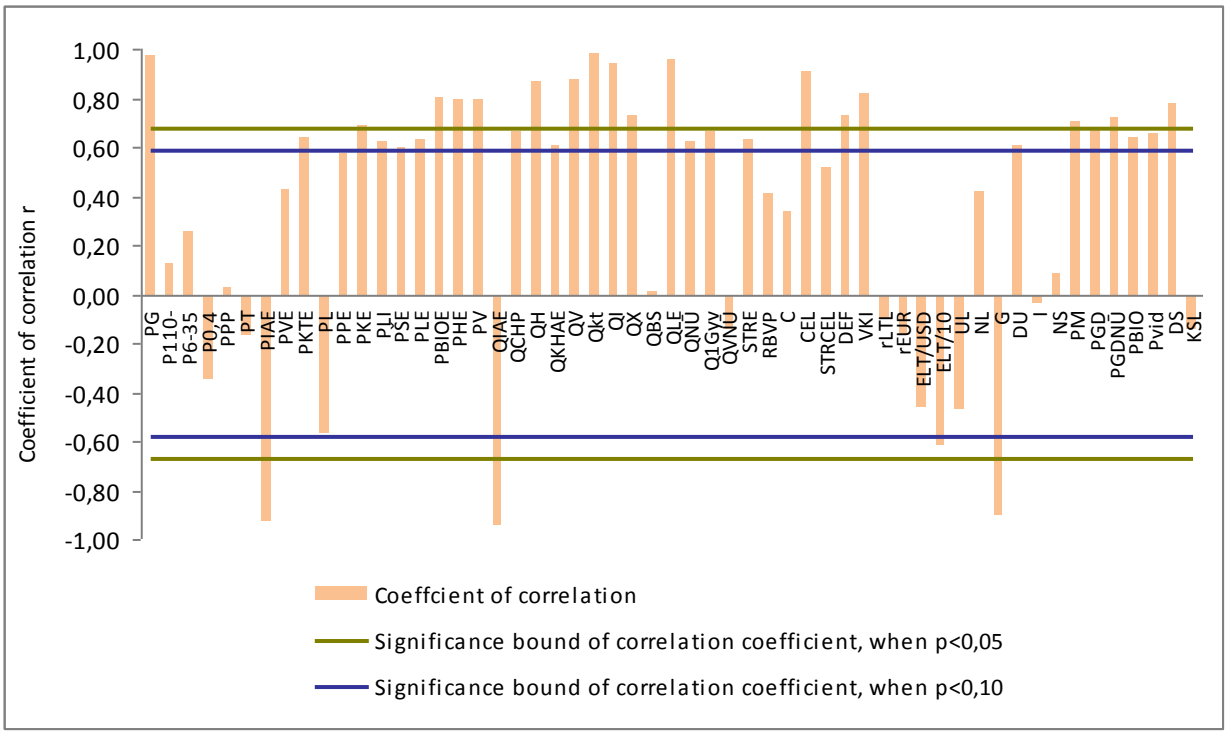

Figure 7. Correlation relationships of retail electricity price and its factors

here: P_G – electricity production price, ct/kWh; $P_{110\text{-}330}$ – transmission price, ct/kWh; $P_{6\text{-}35}$ – distribution in medium voltage network price, ct/kWh; $P_{0,4}$ – distribution in low voltage network price, ct/kWh; P_{PP} – transmission and distribution price, ct/kWh; P_T – supply price, ct/kWh; P_{IAE} – electricity purchase from Ignalina NPP price, ct/kWh; P_{VE} – electricity purchase from JSC „Vilniaus energija“ price, ct/kWh; P_{KTE} – electricity purchase from JSC „Kauno termofikacijos elektrine“ price, ct/kWh; P_L – electricity purchase from JSC „Lifosa“ price, ct/kWh; P_{PE} – electricity purchase from JSC „Panevezio energija“ price, ct/kWh; P_{KE} – electricity purchase from JSC „Kauno energija“ Petrasiunai PP price, ct/kWh; P_{LI} – electricity purchase from JSC „Litesko“ filial „Druskininku siluma“ price, ct/kWh; $P_{ŠE}$ – electricity purchase from JSC „Siauliu energija“ price, ct/kWh; P_{LE} – electricity purchase from JSC „Lietuvos elektrine“ price, ct/kWh; P_{BIOE} – electricity purchase from biofuel PPs price, ct/kWh; P_{HE} – electricity purchase from hydro PPs price, ct/kWh; P_{VE} – electricity purchase from wind PPs price, ct/kWh; Q_{IAE} – electricity production volume in Ignalina NPP, GWh; Q_{CHP} – electricity production volume in thermal PPs, GWh; Q_H – electricity production volume in hidro PPs, GWh; Q_{KHAE} – electricity production volume in Kruonis PP, GWh; Q_V – electricity production volume in wind PPs, GWh; Q_{kt} – electricity production volume in other equipments, GWh; Q_I – electricity import volume, GWh; O_X – electricity export volume, GWh; Q_{BS} – gross electricity consumption, GWh; Q_{LE} – electricity production volume in JSC „Lietuvos elektrine“, GWh; $Q_{NŪ}$ – electricity consumption in households, GWh; Q_{1Gyv} – electricity volume per capita per year, kWh/m.; $Q_{VNŪ}$ – fuel and energy consumed in household, GWh; STR_E – share of electricity consumed

in household from total fuel and energy consumed in household, %; RBVP – real gross domestic product, mln. LTL; C – real household expenditure, mln. LTL; C_{EL} – household expenditure for electricity, mln. LTL;STR_{CEL} – share of expenditure for electricity from total household expenditure, %; DEF – GDP deflator, %; VKI – consumer price index, when 2000 m.=100%; r_{LTL} – interest rates of new loans in for non-financial companies, %; r_{EUR} – interest rates of new loans for non-financial companies, %; $E_{LTL/USD}$ – LTL/USD exchange rate; U_L – employment rate, %; N_L – unemployment rate, %; G – population, thousand; DU – real wage, LTL/mėn.; I – investments of electricity transmission and distribution companies, mln. LTL; NS – depreciation costs of electricity transmission and distribution companies, mln. LTL; P_M – fuel-oil price, LTL/tne; P_{GD} – natural gas price for electricity and heat companies, LTL/tne; $P_{GDNŪ}$ – natural gas price for households, LTL/tne; P_{BIO} – biomass price, LTL/tne; P_{vid} – average fuel price, LTL/tne; DS – labor costs of employee from electricity, gas and water sector, LTL/month.; KS_L – fuel costs in CHPs, gne/MWh.

As it is seen from Figure 7, direct and indirect relationships existed between electricity price for households and segregated indicators. Direct relationships linked electricity price for households and 41 indicator and indirect – price and 13 indicators. After significance of correlation coefficient is tested, it is set that considering 5% significance level statistically significant direct relationships were between electricity price for households and 19 indicators, but indirect relationships linked electricity price for consumer and 3 indicators.

Since number of analyzed observations was not large, therefore it was decided to increase significance level till 10%. It is set that subject to 10% level of significance, there existed direct relationship between electricity price for household and the following indicators:

- electricity production price;
- electricity production volume in CHPs and Kruonis PP, hydro and wind PP, as well in other equipment;
- electricity import and export volume;
- price of electricity from PPs that provide public services;
- household expenditure for electricity;
- GDP deflator and consumer price index;
- prices of fuel-oil, natural gas for electricity and heat producers, biomass and average fuel price;
- the share of electricity consumed in households from the total fuel and energy consumed in this sector;
- electricity volume per capita;
- real wage;
- labour costs of employee of electricity, gas and water sector.

Values of calculated correlation coefficients showed that development direction of electricity price for household coincided with development direction of its factors. The strongest relationship linked electricity price for household and electricity production price.

The results of correlation analysis disclosed other relationships. It was set that subject to 10% level of significance statistically significant indirect relationships linked electricity price for household and the following indicators:

- price and volume of electricity produced in Ignalina NPP;
- population;
- LTL/ 100 RUB exchange rate.

The identification of indirect relationships showed that electricity price for Lithuanian households increased, when price and volume of electricity produced in Ignalina NPP, number of population and exchange rate LTL/ 100 RUB decreased.

Based on the electricity price for households factors discussed in this section, further in the work additional methods will be applied to link electricity price and its factors.

Results of multiple linear regression

Based on the results of analysis above, three multiple linear regression equations, enabling to link electricity price for household and its factors into a single set, are prepared. The equations are assigned to:

1. describe electricity price for household by macroeconomic factors and factors that impact on electricity production costs;
2. assess the impact of changes of electricity production structure on electricity price for household;

3. to assess the impact of quantities and prices of electricity production factors and macroeconomic indicators on electricity price for household, as well impact of changes of electricity production structure on electricity price for household.

The first linear regression equation is dedicated to describe electricity price for household by macroeconomic indicators and indicators describing electricity production costs (i.e. by prices of biomass and natural gas, investments, labour costs, employment rate, real GDP). It turned out that coefficient of several indicators are insignificant in the model, therefore they were eliminated. Eliminating statistically insignificant variables from the model, the following equation of electricity price for household was developed:

$$P_{N\bar{U}(t)} = -99.9278 - 0.1057 \cdot P_{BIO(t)} + 0.0339 \cdot DS_{(t)} - 0.0236 \cdot I_{(t)} + 1.7815 \cdot U_{L(t)} + \varepsilon \qquad (1)$$

here: $P_{N\bar{U}(t)}$ – electricity price for households at time t, ct/kWh
$P_{BIO(t)}$ – biomass price at time t; LTL/toe;
$DS_{(t)}$ – labor costs at time t, LTL per month;
I(t) – investments of electricity transmission and distribution companies at time t, million LTL;
$U_{L(t)}$ – employment rate at time t, %;
ε – error.

(1) equation shows that electricity price for household can be described by four factors – price of biomass, labor costs of electricity sector employee, investments of transmission and distribution companies, and employment rate. It is calculated that direct relationship existed between electricity price for households and employment rate and labor costs. If employment rate increases by 1 percentage point, then electricity price for households increases by 1.78 ct/kWh. It is easy to explain the relation set. Usually, when employment increases, then GDP, as well wage increases too. Naturally, if there is an improvement in welfare, then demand for goods and services (as well consumed volume of electricity) increases and the price level of goods and services (including price for electricity) grows too.

The increase of labor costs of electricity sector obviously increases the costs of electricity producing, transmitting, distributing and supplying companies. If other factors do not change, then electricity cost and selling price for household increase. It is calculated that if labor costs per month increases by 1 LTL, then electricity price for household increases by 0.03 ct/kWh.

As it is seen from equation (1), electricity price for household and investments of transmission and distribution companies in the model are indirectly related. It is calculated, if transmission and distribution companies additionally invest 1 million LTL, then electricity price for households will reduce by 0.02 ct/kWh.

The equation prepared allowed to assess the impact of biomass price on electricity price for household. It is set the indirect relationship between electricity price for household and price of biomass. Biomass price has not a direct relationship with electricity price for household. The reason for this is the following – electricity producers that provide PSO in energy sector for each kilowatt-hour of produced and supplied electricity receives a fixed tariff. Despite the fact that during 2002-2007 price of biomass increased, electricity tariff for electricity production from biomass did not changed and was 20 ct/kWh. Biomass electricity producers seeing that biomass price increased could adjust only electricity production volume. During this period electricity production volume was low. As a result changing price of biomass had not a big effect on electricity production price. During 2008-2009 price of biomass stabilized in the market, and later started to reduce. At that time tariff for electricity produced in power plants using biomass was reconsidered and increased. Producers react to changes in the market and increased electricity production volume in biomass PPs. If 0.06 TWh of biomass electricity was produced in 2008, then 0.15 TWh was produced in 2010. Thus set relationship between electricity price for household and price of biomass do not contradict the statement that when price of biomass reduces, electricity production volume in biomass PPs increases and electricity production price and price for household increases as well. It is calculated that under the assumed conditions, electricity price for household increases by 0.11 ct/kWh, when price of biomass reduces by 1 LTL/toe.

The equation (1) is statistically significant (value of coefficient of determination is 98.2%). Standard error of the equation is 0.62 ct/kWh.

As it can be noticed from equation (1), electricity production structure does not reflect in it. In 2010 evident changes in electricity production structure appeared. After the closure of Ignalina NPP electricity demand in Lithuania was satisfied by increased volume of electricity import and electricity production in JSC "Lietuvos elektrine".

Seeking to assess the impact of electricity production structure on electricity price for households, additional regression equation was prepared:

$$P_{NUU(t} = 22.8320 + 0.0205 \cdot Q_{V(t)} + 0.0080 \cdot Q_{LE(t)} + \varepsilon \quad (2)$$

here: $Q_{V(t)}$ – electricity production volume in wind PPs at time t, GWh;
$Q_{LE(t)}$ – electricity production volume in JSC "Lietuvos elektrine" at time t, GWh;
ε – error.

As it is seen from equation (2) electricity price for households can be described by two factors – by electricity production volume in wind PPs and by electricity production volume in JSC "Lietuvos elektrine". It is calculated that if electricity production volume increases in this type of power plants, then it is expected that electricity price for household will increase as well. The impact of other production sources (hidro PPs, CHPs, and import) on electricity price for household was also assessed. However, it emerged that the impact of these factors on electricity price for household was statistically insignificant; therefore these factors were eliminated from the model.

Equations (1) and (2) were combined and additional factors were chosen. As a result a new regression equation was created. It enabled to assess the impact of prices and quantities of electricity production factors, macroeconomic indicators, as well electricity production structure on electricity price for households. The created model of electricity price for household is the following:

$$P_{NUU} = -41.2447 + 0.0005 \cdot C_{(t)} + 0.0401 \cdot DS_{(t)} - 0.0054 \cdot I_{(t)} - 0.0027 \cdot Q_{I(t)} - 0.1614 \cdot P_{BIO(t)} + 0.0087 \cdot Q_{LE(t)} + \varepsilon \quad (3)$$

here: $C_{(t)}$ – household consumption expenditure at time t, million LTL;
$C_{(t)}$ – electricity import volume at time t, GWh.

Equation (3) shows that increasing domestic demand (it is represented by household consumption expenditure), labor costs and electricity production volume in JSC "Lietuvos elektrine" increases electricity price for household. Relationships of equation show that positive impact of volume of JSC "Lietuvos elektrine" on electricity price for household can be reduced if more electricity is imported from neighboring countries, where electricity is cheaper. Equation (3) reflects that electricity price for household increased because of biomass price reduction during the latter several years. It is worth noting that investments into transmission and distribution networks contributed to a reduction of electricity price for household. The created equation is statistically significant. Its standard error is 0.18 ct/kWh.

The results of regression analysis showed that electricity price for household can be well described by eight factors – price of biomass, labor costs of employee from electricity sector, investment into transmission and distribution, employment level, electricity production volume in wind PPs and JSC "Lietuvos elektrine", electricity import volume and household expenditure.

Conclusions

1. The analysis of scientific literature showed that electricity retail price consists of four large components – electricity production price, electricity transmission and distribution services prices, and electricity supply service price. Three large groups of factors that form retail electricity price are segregated. They are costs and profit of the company, and volume of electricity consumed. It is set that costs and profit depends on aims, tasks and strategic decisions of the company, environmental, economical, regulating and political factors; whereas electricity demand is impacted by demographic, political, economical, technical-technological, social, climatic and other factors.
2. Electricity production, distribution and transmission services' prices make the largest shares in the structure of retail electricity price. Electricity production price is this part of the retail price, which the mostly influence change of electricity price for consumer. The tendency analysis showed that electricity price had a tendency to increase in Lithuania. During the latter several years it was the lowest in EU-27; however at the same time its growth rates were the highest.

3. The results of correlation analysis showed that at 10% of significance level there existed direct relationships between electricity price for household and the following indicators: electricity production price; electricity production volume in thermal PPs and Kruonis PSP, hydro and wind PPs and in other plants; electricity import and export volume; prices of electricity produced in PPs providing public services (in thermal and RES PPs); household expenditure for electricity; GDP deflator and consumer price index; prices of fuel oil and natural gas for electricity producers and households, as well biomass and average fuel prices; electricity production volume and the share of electricity in total fuel used in households; electricity consumption per capita; neto real wage; labour costs of energy sector employee. It is set that given 10% significance level there exist indirect relationships between electricity price for household and price and volume of electricity produced in Ignalina NPP; population; LTL/100 RUB exchange rate.
4. The results of regression analysis showed that electricity price for household can be described by eight factors. The impact of price of biomass, investment into transmission and distribution, and electricity import volume on electricity price for household is inverse, whereas the impact of labor costs of employee from electricity sectors, employment level, electricity production volume in wind PPs and JSC "Lietuvos elektrine", and household expenditure is positive.

References

1. BaltPool (2010). Prekybą Lietuvos biržoje reglamentuojantys dokumentai: Lietuvos diena–prieš elektros rinkos reglamento priedas Nr. 7. [interactive] [viewed 2011-08-14]. Internet address: http://www.baltpool.lt/index.php?-2083409169.
2. Ciegis, R. & Streimikiene, D. (2006). The Challenges of GHG Emission Trading for Lithuania. Inzinerine Ekonomika-Engineering Economics, 5(50), 55-65.
3. Donatos, G. S. & Mergos, G. J. (1991). Residential demand for electricity: The case of Greece. Energy Economics, 13(1), 41-47.
4. Ferkingstad, E., Løland, A. & Wilhelmsen, M. (2010). Causal modeling and inference for electricity markets. Energy Economics. In Press, Corrected Proof.
5. Halicioglu, F. (2007). Residential electricity demand dynamics in Turkey. Energy Economics, 29(2), 199-210.
6. Hjalmarsson, E. (2000). Nord Pool: A power Market Without Market Power. Working Paper in Economics. No 28. Goteborg University.
7. Holtedahl, P. & Joutz, F. L. (2004). Residential electricity demand in Taiwan. Energy Economics, 26(2), 201-224.
8. Khattak, N. U. R., Tariq, M. & Khan, J. (2010). Determinants of Household's Demand for Electricity in District Peshawar. European Journal of Social Sciences, 14 (1), 7-16.
9. Kilijoniene, A., Simanaviciene, Z. & Simanavicius, A. (2010). The Evaluation of Social and Economic Development of the Region. Inzinerine Ekonomika-Engineering Economics, 21(1), 68-79.
10. Lietuvos Respublikos Seimas (2000). Lietuvos Respublikos elektros energetikos įstatymas Nr. VIII-1881, 2000-07-20. Valstybės žinios, 2000-08-04, Nr. 66-1984. [interactive] [viewed 2011-08-31]. Internet address: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=106350&p_query=&p_tr2=2
11. Lietuvos Respublikos Vyriausybė (2009). Nutarimas Nr. 740 „Dėl Lietuvos elektros rinkos plėtros plano patvirtinimo". [interactive] [viewed 2012-01-02]. Internet address: http://www.neeta.lt/foto/LRV_nutarimas_elektros_rinkos_pletros_planas_090708.pdf
12. Martinkus, B., Stoskus, S. & Berzinskiene, D. (2009). Changes of Employment through the Segmentation of Labour Market in the Baltic States. Inzinerine Ekonomika-Engineering Economics(3), 41-48.
13. Mjelde, J. W. & Bessler, D. A (2009). Market integration among electricity markets and their major fuel source markets. Energy Economics, 31(3), 482-491.
14. Mohammadi, H. (2009). Electricity prices and fuel costs: Long-run relations and short-run dynamics. Energy Economics, 31(3), 503-509.
15. Muñoz, M. P. & Dickey, D. A. (2009). Are electricity prices affected by the US dollar to Euro exchange rate? The Spanish case. Energy Economics, 31(6), 857-866.
16. Narayan, P. K., Smyth, R. & Prasad, A. (2007). Electricity consumption in G7 countries: A panel cointegration analysis of residential demand elasticities. Energy Policy, 35(9), 4485-4494.
17. Serletis, A. & Herbert, J. (1999). The message in North American energy prices. Energy Economics, 21(5), 471-483.

18. Snieska, V. & Simkunaite, I. (2009). Socio-Economic Impact of Infrastructure Investments. Inzinerine Ekonomika-Engineering Economics(3), 16-25.
19. Startiene, G. & Remeikiene, R. (2009). The Influence of Demographical Factors on the Interaction between Entrepreneurship and Unemployment. Inzinerine Ekonomika-Engineering Economics(4), 60-70.
20. Strumickas, M. & Valanciene, L. (2009). Research of Management Accounting Changes in Lithuanian Business Organizations. Inzinerine Ekonomika-Engineering Economics(3), 26-32.
21. Tamosiunas, A. (2010). Managing Corporate Strategic Changes in the Context of Climate Change. Inzinerine Ekonomika-Engineering Economics, 21(1), 19-31.
22. Valiukonis , G., Paltanavičius, G., Gudelis, V. & Čirgelienė, R. (2007). Elektros energijos gamybos kainų ir tarifų vartotojams prognozė nutraukus Ignalinos AE II-ojo bloko eksploataciją. UAB „Verslo raktas“. Kaunas.
23. Valstybinė kainų ir energetikos kontrolės komisija (2010). Nutarimas Nr. O3-71 dėl Valstybinės kainų ir energetikos kontrolės komisijos 2009 m. lapkričio 9 d. nutarimo Nr. O3-199 „Dėl Visuomeninių elektros energijos kainų, visuomeninio tiekimo paslaugos kainos ir jų viršutinių ribų nustatymo metodikos“ pakeitimo. [interactive] [viewed 2011-08-31]. Internet address: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=370988&p_query=&p_tr2=2
24. Wolak, F. A (1998). Market Design and Price Behavior in Restructured Electricity Markets: An International Comparison. Pricing in Competitive Electricity Markets. Kluwer Academic Publishers, 127-149.