FINAL ENERGY CONSUMPTION TRENDS AND DRIVERS IN CZECH REPUBLIC AND LATVIA

Zhiqian Yu[1*], Dalia Streimikiene[2], Tomas Balezentis[3], Rimantas Dapkus[4], Radislav Jovovic[5] and Veselin Draskovic[6]

[1)] School of Economics and Statistics, Guangzhou University, P. R. China
[2),3)] Lithuanian Institute of Agrarian Economics, Vilnius, Lithuania
[4)] Aleksandras Stulginskis University, Kaunas, Lithuania
[5)] Mediterranean University, Podgorica, Montenegro
[6)] University of Montenegro, Kotor, Montenegro

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Abstract
This paper analyses the trends of final energy consumption in Latvia and Czech Republic. Analysis of final energy consumption during 2000-2013 period indicated the main driving forces of final energy consumption during and after world financial crisis of 2008. The paper aimed to evaluate the impact of economic activity and other factors on final energy consumption. The decomposition of the final energy consumption is assessed by analyzing effect of different drivers by the main end-users sector (industry, transport, households, agriculture, services), activity, demography, lifestyles, structural effects, energy savings etc. The results show that the reduction in final energy consumption in most EU members states before and after year 2008 can be related to the decline in energy intensities within end-users sectors. At the same time, the increase in final energy intensity after the year 2008 is attributed to expansion of energy demand sectors. Comparison of final energy consumption trends and drivers in Latvia and Czech Republic indicated that Czech Republic implemented more policies and measures in industry and tertiary sector and this provided for final energy consumption decreased and huge energy savings in these sectors.

Keywords: energy intensity, energy savings, decomposition analysis, Czech Republic, Latvia.

JEL Classification: Q4, Q5, Q46, Q48

* Corresponding author, **Zhiqian Yu** –yuzhiqian8866@126.com

Introduction

The Europe 2020 strategy, adopted by the European Council on 17 June 2010, is the EU's agenda for growth and jobs for the current decade. It emphasises smart, sustainable and inclusive growth as a way to overcome the structural weaknesses in Europe's economy, improve its competitiveness and productivity and underpin a sustainable social market economy. The same indicators addressed by Energy and Climate Package are provided in Strategy Europe 2020. Europe 2020 requires GHG (Greenhouse gas emissions) to be reduced by 20% in 2020 compared to year 1990 level. The share of RES (renewable energy sources) in final energy consumption to be increased to 20% in 2020. Europe 2020 requires energy efficiency to be improved by 20% in 2020 compared to year 2005 level.

The Energy Efficiency Directive sets the binding measures to help the EU Member States (MS) to reach its ambitious 20% energy efficiency target in 2020 (Vasauskaite and Streimikiene, 2014). Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption. The purpose of the Directive is to enhance the cost-effective improvement of energy end-use efficiency in Member States.

The Directive is applied to providers of energy efficiency improvement measures, energy distributors, distribution system operators and retail energy sales companies. Energy counts for all forms of commercially available energy and fuels. Among other things, the Directive sets the indicative energy saving goals for each MS, the obligations for national public authorities to achieve energy savings and to ensure energy efficient procurement including implementation of measures to promote energy efficiency. According requirements of Energy Efficiency Directive Latvia and Czech Republic as other EU MS have set a national indicative targets for energy efficiency improvement. These targets are described in detail in the National Energy Efficiency Action Plans (NAPEE) of Latvia and Czech Republic. Though analysed EU MS have set an ambitious energy saving targets the trends of final energy consumption are quite different in these selected new EU MS..

The decomposition analysis if often being applied to analyse the main driving forces of final energy consumption. The Oddysee-Muree database was used to collect data on final energy consumption and decomposition analysis of the main driving forces of changes in final energy consumption in EU MS (EC, 2015; 2016). Decomposition analysis is popular tool for analysis of energy consumption and GHG emission drivers (Balezentis et al, 2011; Alves and Mountinhob, 2013; Brizga et al, 2014; Stremikiene and Balezentis, 2016). There two broad groups of the decomposition analysis, namely Structural Decomposition Analysis (SDA) and Index Decomposition Analysis (IDA). R. Hoekstra and J. van der Bergh (2003 compared these two veins of analysis. SDA is based on the input-output analysis, whereas IDA relies on a more simple analysis of statistical data. The methodology of IDA is discussed by Ang (2004; 2015), by Xu and Ang (2013), and by others (Sun, 1998; Albrecht et al, 2002; Ang et al, 2003; 2009) and defines the two groups of the IDA methods, viz. those linked to the Divisia index and those linked to the Laspeyres index. Both methodologies were applied in recent papers dealing with final energy and GHG emission trends (Alves and Mountinhob, 2013; Brizga et al, 2014; Stremikiene and Balezentis, 2016).

The aim of this paper is to review energy efficiency policies implemented in Czech Republic and Latvia and to compare their effectiveness by analysing final energy

consumption dynamics in these countries by applying decomposition analysis and identifying the main drivers in final energy consumption in all main sectors.

Seeking to achieve this aim the main tasks are:

- to review and compare energy consumption trends in EU and two selected EU member states: Czech Republic and Latvia;
- to define and compare the main drivers of final energy consumption dynamics during 2000-2013 in Czech Republic and Latvia;
- to analyse energy efficiency policies and compare energy savings achieved in Czech Republic and Latvia;
- to develop policy recommendations based on the main findings of analysis conducted

The methods applied: comparative analysis, graphical analysis, decomposition analysis, generalization.

1. Energy consumption trends in EU

This section provides analysis of final energy consumption dynamics in EU and selected new EU MS: Latvia and Czech Republic. These selected new EU MS entered EU in 2004. These new ES MS implemented the same EU energy policies. The trends of final energy consumption and the main driving forces of final energy consumption were analysed and compared to get more information of efficiency of implemented energy policies and achieved energy efficiency improvements in selected EU MS. First, the final energy consumption dynamics in all EU MS was analysed and growth rates across the sectors were assessed. Second, final energy consumption trends in two new EU MS (Latvia and Czech Republic) were compared.

1.1 Final energy consumption dynamics across different EU MS and sectors

The conducted analysis showed that total final energy consumption in the European Union (EU) did not vary significantly over the course of 1990-2014 (Figure no. 1). Comparing the two endpoint periods, one can note a decrease of some 2%. A further look into the dynamics of the use of final energy reveals certain changes associated with economic shocks. First, there had been a step increase in energy consumption prior to year 1996. Later on, the Asian crisis provided new global economic downturn and caused a decrease in final energy consumption and slight recovery during 1997-2000. The use of energy peaked in 2006, when consumption of the final energy went up by some 10% if compared to the level of 1990. However, the subsequent economic crisis caused a decline in the energy demand. What is more, the increasing energy efficiency promoted by different policies across the EU also contributed to the trend of declining use of final energy. As a result, there had been a generally negative trend with certain fluctuations in the period from 2007 onwards.

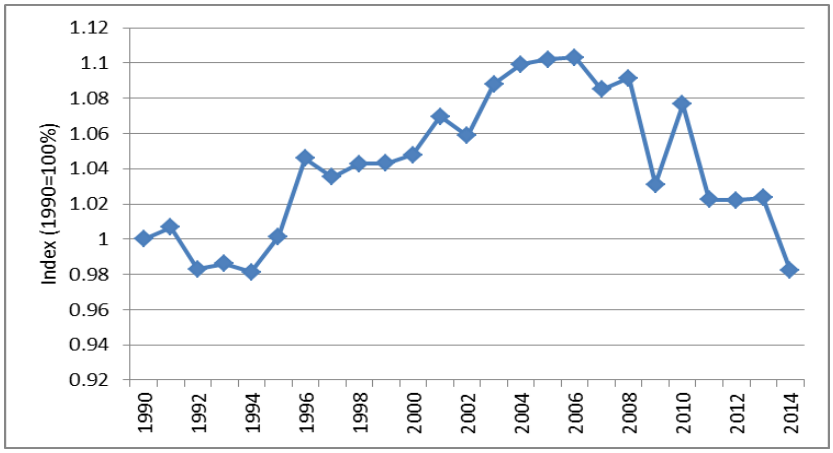

Figure no. 1: Index of final energy consumption in the EU-28, 1990=100%

The importance of different final energy consumption sectors have been altered in terms of the final energy consumption (Figure no. 2). In spite of ambitious measures to promote sustainable mobility, the share of final energy consumption in the transport sector increased from 26% in 1990 to 33.3% in 2015. The share of services sector in the total final energy consumption in EU has increased from 10% up to 13% during 1990-2015 year period. The share of final energy consumption in residential sector remained fluctuating around 25%. Agricultural sector did not see any significant changes either with the share slightly exceeding 2%. The importance of the industry had decreased from 34% to 26%. These changes provide dynamics in the general economic structure in the EU MS and the effectiveness of energy saving measures across different sectors.

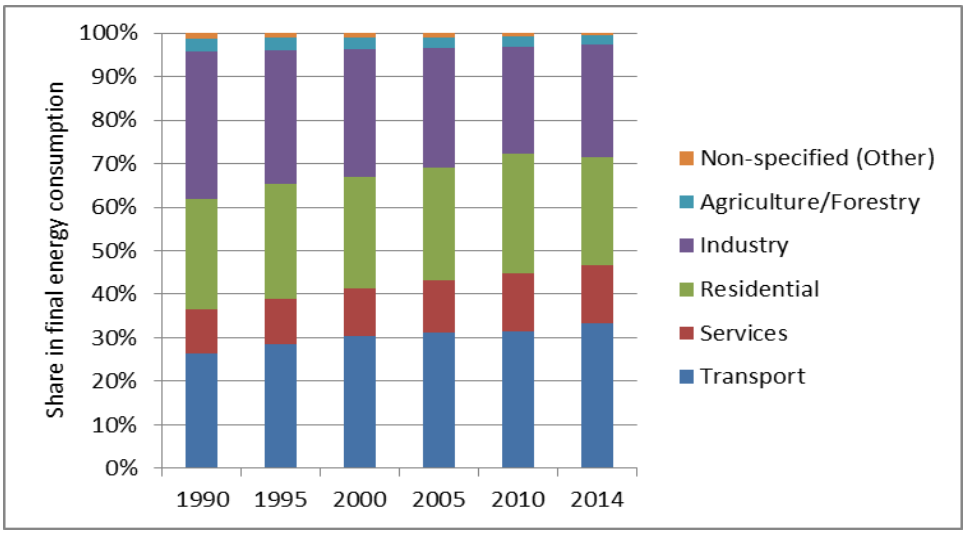

Figure no. 2: Dynamics in the use of final energy across different sectors

Table no. 1 provides the dynamics of final energy consumption in EU MS and sectors. The log-linear trends were fitted in order to derive the rates of growth accounting for stochastic variations in energy consumption (cf. Figure no. 1). Note that Table no. 2 identifies the rates of growth which exceed the EU averages (underlined figures) and country averages (boldfaced figures). Therefore, one can compare the performance of a certain sector within a particular country against the corresponding figure for the EU or the rate of growth for the total consumption of final energy in that country.

Corresponding to the results provided in Figures no. 1 and 2, Table no. 1 shows a slight increase in final energy consumption at the EU level (growth rate of 0.2% p.a.). The two sectors, namely transport and services, showed higher rates of growth in final energy consumptions and thus can be considered as the main drivers behind the increase in final energy consumption in EU MS. Country-wise, Portugal, Luxembourg, Slovenia, Croatia, Ireland, Spain, Cyprus, Austria, Malta, Greece, Finland, Italy, the Netherlands, France and Belgium provided the final energy use growth rates higher than the EU average.

Table no. 1: Final energy consumption growth rates across different countries and sectors (% per annum), 1990-2014

Region	Total	Transport	Services	Residential	Industry	Agriculture and Forestry	Non-specified (Other)
EU-28	0.2	**1.1**	**1.5**	0.1	-0.9	-1.3	-3.2
Belgium	0.3	**1.1**	**1.8**	-0.5	-0.2	-0.1	**10.9**
Bulgaria	-1.4	**2.7**	**10.2**	**-0.7**	-4.3	-4.9	-23.8
Czech Republic	-0.8	**4.2**	**1.5**	**-0.3**	-3.1	-3.8	-5.8
Denmark	0.1	**0.9**	**0.5**	0.0	-1.1	-0.6	-1.4
Germany	-0.3	-0.1	**1.1**	-0.8	**-0.2**	-32.3	-18.0
Estonia	-1.2	**1.8**	**3.1**	**0.0**	-4.3	-4.4	-26.4
Ireland	2.2	**3.9**	1.7	1.5	1.1	-0.4	-
Greece	0.9	0.9	**4.8**	**1.9**	-0.9	-3.9	**4.8**
Spain	1.9	**1.9**	**4.8**	**2.6**	0.5	1.7	**32.4**
France	0.2	**0.6**	**0.4**	**0.4**	-1.3	**0.9**	**8.7**
Croatia	1.3	**3.2**	**3.6**	0.9	-0.8	-1.0	-
Italy	0.6	**0.6**	**3.1**	**1.3**	-0.8	-0.4	-7.3
Cyprus	1.8	1.8	**6.9**	**5.4**	-2.8	**11.4**	-4.7
Latvia	-0.9	**1.7**	-1.6	-1.0	-1.9	-3.3	-1.1
Lithuania	-1.3	**1.0**	-2.6	**-0.6**	-2.9	-6.6	**9.6**
Luxembourg	1.3	**4.2**	**10.6**	-0.7	-4.1	**4.2**	-14.9
Hungary	-0.4	**2.3**	**0.8**	-1.2	-1.9	-2.7	-13.0
Malta	1.0	0.0	**15.5**	0.8	**2.9**	**5.7**	-17.3
Netherlands	0.5	**1.4**	**0.4**	-0.1	**0.6**	-0.4	**0.9**
Austria	1.6	**2.5**	**2.2**	-0.3	**2.1**	-0.1	-

Region	Total	Transport	Services	Residential	Industry	Agriculture and Forestry	Non-specified (Other)
Poland	0.1	**4.0**	**3.1**	-0.3	-2.5	-1.0	-29.5
Portugal	1.4	**2.3**	**5.2**	0.8	0.1	-2.0	-3.7
Romania	-1.4	**2.6**	**8.3**	**0.1**	-4.5	-5.9	-5.2
Slovenia	1.3	**2.9**	0.8	0.6	0.2	-0.1	**11.8**
Slovakia	-0.7	**3.6**	-3.2	**0.4**	-1.3	-6.2	**0.0**
Finland	0.8	0.8	**5.8**	-0.2	**0.8**	-0.5	-5.3
Sweden	-0.2	**0.7**	-0.3	-0.3	-0.6	-2.7	**4.0**
United Kingdom	-0.2	**0.5**	**0.8**	**0.0**	-1.5	-2.2	-6.4

Note: (i) the growth rates are based on log-linear trend; underlined figures indicate values which are higher than the EU average; (ii) boldfaced figures indicate values which are higher than the country averages; (iii) the data on non-specified final energy use have been extrapolated for Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Bulgaria, Estonia, Greece, Spain, Slovakia and Sweden; (iv) the data on non-specified final energy consumption in Croatia, Austria and Ireland, are not available.

The dynamics of change in final energy consumption in different EU MS corresponded to that observed at the EU level. The growth in final energy use in the transport sector had been observed for all the countries save Germany (-0.1% p.a.). In addition, no change had been observed in Malta. Therefore, the need of decoupling economic growth and transport activities remains an important issue in regards to development of sustainable economy in the EU.

The pattern is a bit more diverse if looking at service sector. Specifically, Latvia, Lithuania, Slovakia, Sweden, and Greece showed negative growth rates for final energy consumption in services. The small EU countries (Luxembourg, Cyprus and Malta) and the new MS (Romania and Bulgaria) have seen a quite rapid growth in the final energy use in tertiary sector with annual rates of growth from 6.9% to 15.5%.

Among the sectors analysed, households sector provided the zero point growth. The positive annual rates of change in households were observed in Romania, Slovenia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Malta, Portugal, and Slovakia. The share of households sector significantly had increased in Lithuania, Romania, Slovakia, the United Kingdom, Bulgaria, Czech Republic, Estonia, Greece, Spain, France, Italy and Cyprus, Industrial sector provided a decrease in final energy use in most EU MS. The growth of final energy use in industrial sector was evident Spain, Malta, the Netherlands, Austria, Portugal, Slovenia, Finland and Ireland. Looking at relative terms, an increased share of industry sector was observed in Germany, Malta, the Netherlands, Austria, and Finland.

Final energy consumption growth rates in Czech Republic and Latvia during investigated period 1990-2014 were negative however in both countries final energy consumption was growing at quite high rates in transport (especially high rates in Czech Republic) and in service sector of Czech Republic. In Latvia the growth rates were negative in all sectors except transport.

In the following chapter final energy consumption trends in Czech Republic and Latvia are reviewed.

1. 2 Energy consumption trends in Czech Republic and Latvia

Both new EU member states Czech Republic and Latvia joined EU at the same time in 2004. Both countries have implemented EU energy policies briefly described in introduction of the paper. However the analysis of dynamics of final energy consumption in Latvia and Czech Republic indicates that Latvia achieved better results in final energy use decrease since 1990.

In Figure no. 3 the dynamics of final energy use in Latvia and Czech Republic (1990-2014) is shown.

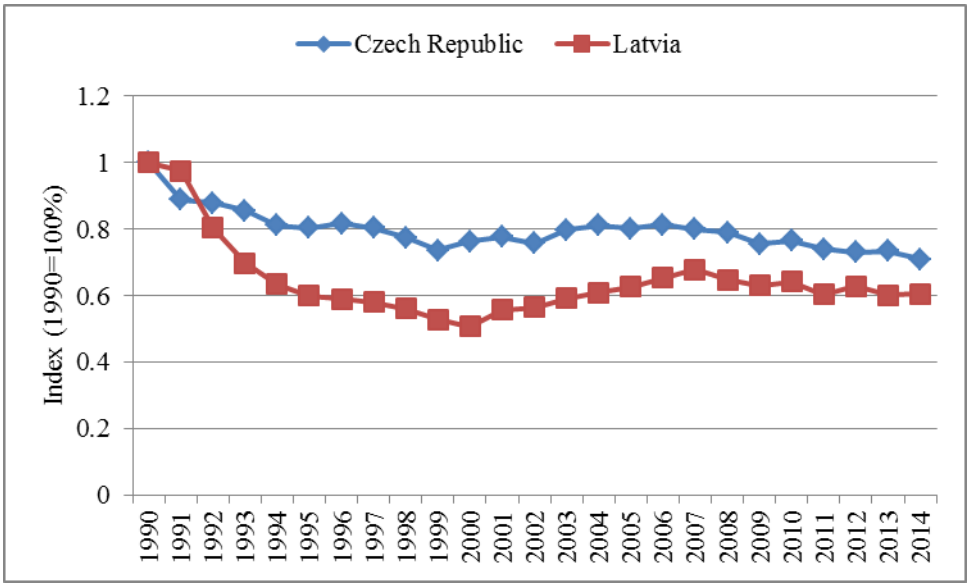

Figure no. 3: Final energy consumption dynamics in Latvia and Czech Republic, 1990-2014

As one can notice from data provided in Figure no. 3 Latvia saw steeper fluctuations in final energy consumption comparing with Czech Republic. The transition from centrally planned economy had more severe impact on Latvia's economy in 1990-1995 year period. The consequences of the economic crisis of 1998-1999 were obvious in both analysed EU MS. However, Latvia provided a significant increase in final energy use in 2000-2007 period, before economic crisis. All in all, the final energy consumption in the Czech Republic and Latvia amounted to 70% and 60% in 2014 if compared to corresponding levels in 1990.

Therefore, the dynamics of final energy use structure in the Czech Republic (Figure no. 4) and Latvia (Figure no. 5) were different in terms of sectoral shifts. However, both analysed EU MS were similar in terms that industrial sector has provided a decreasing share in final energy use, while that of services sector has expanded its share. The structure of final

energy use in Czech Republic is characterized by significant drop in the share of industrial sector, at the same time rising share of transport sector and slightly growing share of the services sector (Figure no. 3).

The Czech Republic has seen a gradual transition from industry-oriented economy in 1990 towards a service-oriented one in 2000 (Figure no. 4). Specifically, the of industry sector went from 53.2% in 1990 down to 40.8% in 2000 and further declined to 32.5% in 2014. The transport sector saw a gradual increase in its share in the final energy consumption from 8.6% in 1990 up to 27% in 2014.

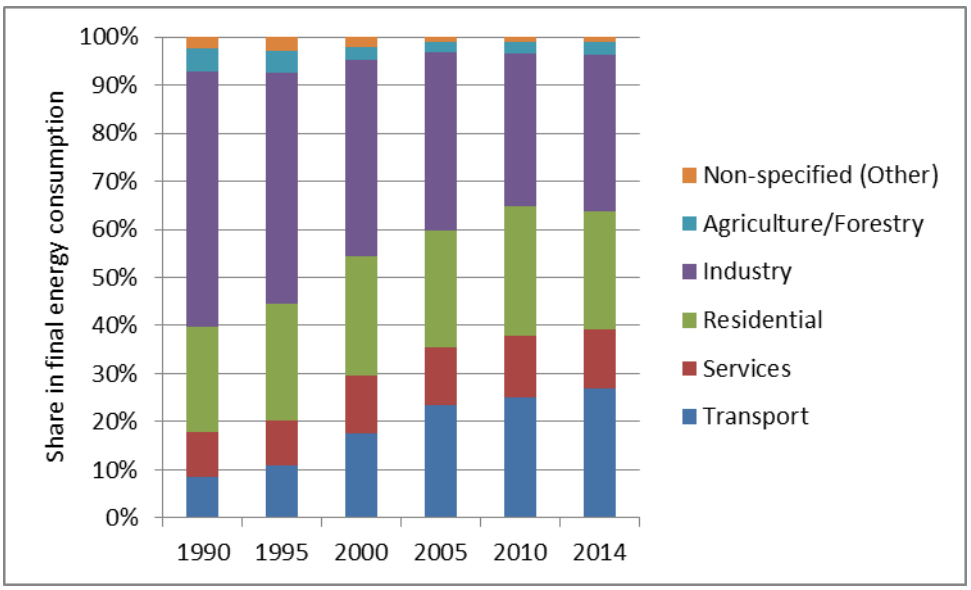

Figure no. 4: Final energy use structure in the Czech Republic, 1990-2014

Final energy use in Czech Republic was declining by 0.8% per year in 1990-2014 period. The highest rate of decline was noticed in agriculture and non-specified sector following by industry sector (Table no. 1).

The highest average annual increase in final energy use was observed in transport sector of Czech Republic following by tertiary sector. The dynamics of final energy use in the country corresponds to the economic activity of Czech Republic. Economic activity has increase during 2000 – 2008 and was shrinking after that period. The energy efficiency level is expressed by the of final and primary energy consumption. This ratio is quite low in the country and makes about 60 %. It is also slowly decreasing.

The low value of energy efficiency is provided by a high share of nuclear power generation (40%) characterized by low energy efficiency. The decreasing tendency is related to increase in electricity exports. It is partially compensated by increasing share of RES.

Besides that the Czech Republic has almost the highest primary energy intensity among EU MS. Primary energy intensity in the country is three times higher than EU average or by 40% higher when expressed at PPP. Though energy efficiency of the residential and industrial sectors have improved it has decreased in services sector. In transport sector

energy efficiency has improved very insignificantly. The energy efficiency in buildings sector has improved. The decline in final energy use in buildings was achieved by improving the status of buildings, implementing better insulation, heating systems and more efficient appliances. However these improvements in energy efficiency in buildings were compensated by increase in living standard and increased number of dwellings. The energy efficiency decreased in transport during 2000 – 2013 year period. This trend was achieved by increase of road transport instead of public transport modes and lower capacity utilisation which is obvious in road transport. Import of old used cars also plays a very negative role in energy use increase in transport sector.

Latvia showed a significant increase in final energy consumption in transport in 1990-1995 (Figure no. 5). The tertiary sector of Latvia increased its share in the final energy use from 9.4% in 1990 to 14% in 2015. Though, the latter value did not exceed its initial level at 1990 (17%). The share of industrial sector of Latvia has decreased from 31% to 16% in 1990-2015 year period.

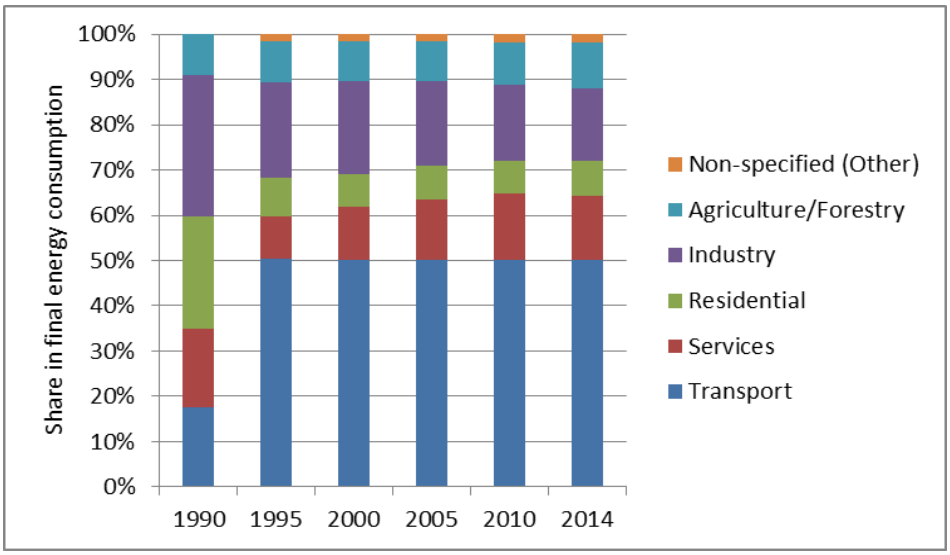

Figure no. 5: The structure of final energy consumption in Latvia, 1990-2014

Latvia's final residential energy consumption in 2013 amounted to 1.38 Mtoe and showed almost 14% decrease compared to 1995 – reaching its peak in 1996, with 1.69 Mtoe. The household sector accounted for 34.6% of Latvia's total energy end-use in 2012, and the residential final energy consumption per capita was 0.67 toe per capita.

About 67% of final energy consumption in the households was used for space heating, roughly 18% for water heating, about 7% for both cooking and electricity for appliances and lighting, and 1% for air cooling.

Energy efficiency of final energy consumption during 2000-2012 in Latvia has improved by 30% or by 2.5% annually. Due to the economic crisis, during 2008-2010 energy efficiency remained unchanged in Latvia but since 2011 the positive trends can be noticed. The best input to these positive final energy consumption trends in final energy consumption in Latvia was provided by households. The contribution of this sector in final

energy consumption of the country is the highest one, and the implemented energy efficiency measures in this sector have provided the greatest reduction in Latvian energy intensity.

In the following sections of paper the decomposition of final energy consumption across sector in Czech Republic and Latvia will be performed and the main driving forces of final energy consumption were identified.

2. Decomposition of final energy use in Latvia and Czech Republic

In this section the decomposition of final energy use in Latvia and Czech Republic is provided to define and compare the main driving forces of final energy use across sectors of economy. The Oddysee-Muree database was applied for data collection on final energy use and decomposition analysis of the main driving forces of final energy use (EC, 2015; 2016).

2.1 Decomposition of final energy use in Czech Republic

The decomposition of the final energy use is calculated by combining the sectoral decomposition and adding the contribution of different final energy consumption driving forces in final energy use sectors, such as industry, residential, transport, tertiary sector, agriculture (EC, 2016):

- Activity: change in value added in industrial, tertiary sector, agriculture, in traffic in transport;
- The effect of demography due to the increasing number of dwellings;
- The effect of lifestyles: more modern appliances and larger dwellings for households
- The effect of structural effects: industry (and tertiary), modal shit in transport
- The effect of energy savings;
- The effect of climate: households and services;
- Other effects: behaviors of households, value of product in industry, labor productivity in tertiary sector and "negative" savings due to inefficient operations in industry and transport.

Energy savings according Oddysee-Muree methodology are assessed as an indicator that measures the energy efficiency progress by main sector and for the whole economy (all final energy consumers). According Oddysee-Muree methodology, energy savings are technical savings, i.e. net of the negative savings due to inefficient operation for industrial sector and freight transport in case of low capacity utilization. For each sector, the index is calculated as a weighted average of sub-sectoral indices of energy efficiency progress; sub-sectors being industrial or service sector branches or end-uses for households or transport modes.

In Figure no. 6 the decomposition of final energy use in Czech Republic is given.

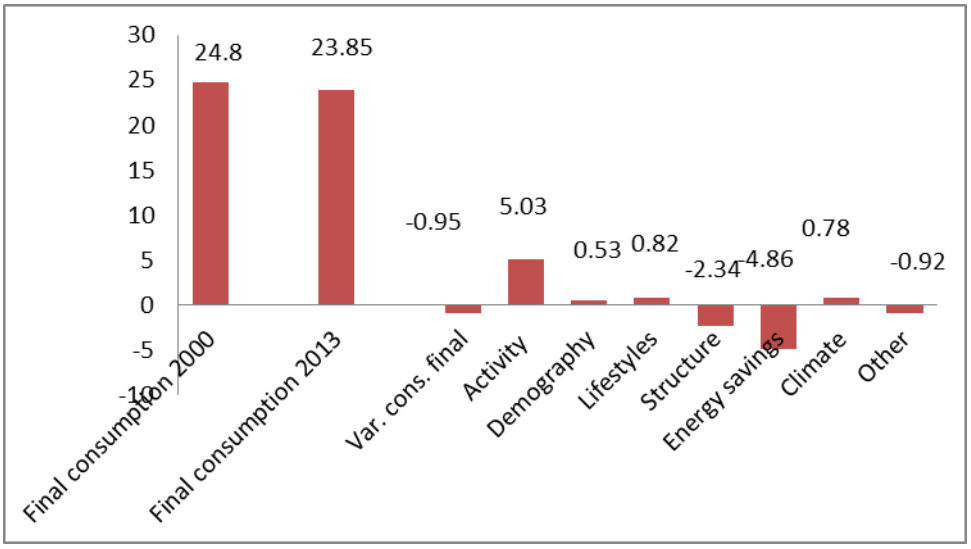

Figure no. 6: Decomposition of final energy consumption in Czech Republic (2000-2013), Mtoe

Source: created by the authors with reference to EC (2016)

As is evident from Figure no. 6 the main driving forces of final energy use growth from 2003 to 2013 in Czech Republic were related with increase in value added of economy. Energy consumption has decreased by 0.95 Mtoe or almost 4% during the same period. Energy savings have impact on decrease of final energy consumption by 20% from year 2000 level. The increase in value added has impact on increase of final energy consumption by 5.03 Mtoe. The changes in structure of final energy consumption has positive impact on reduction of final energy use. Climate, demography, lifestyles have impact on increase of final energy use in Czech Republic.

In following figures the main driving forces of final energy consumption in specific energy end-users sectors were analysed.

Decomposition of final energy use in industrial sector in Czech Republic is presented in Figure no. 7. The variation of the industrial energy use is effected by change in industrial activity ("activity effect"); structural changes ("structural effect"); energy savings effect and other effects which are mainly "negative" savings due to inefficient operations in industry.

As one can see from Figure no. 7 final energy consumption in industry in Czech Republic has reduced by 2.56 Mtoe (25%) during investigated period. Increase in value added in industry increased final energy consumption by 2.9 Mtoe (almost 30%). At the same time energy savings have effect of final energy consumption decrease by 2.1 Mtoe or 21% compared 2000 year level. Structure also effected positively decrease of industrial final energy use (3.37 Mtoe or 33%). The energy efficiency improvement in industrial sector was achieved by the decrease in the energy intensity of the chemical industry, and to improvements in the unit consumption of cement and steel. But the unit consumption of paper rose by 0.5 percent/year, but this increase had only a minor impact on industrial

energy intensity due to the limited share of the paper branch in the Czech Republic industrial sector.

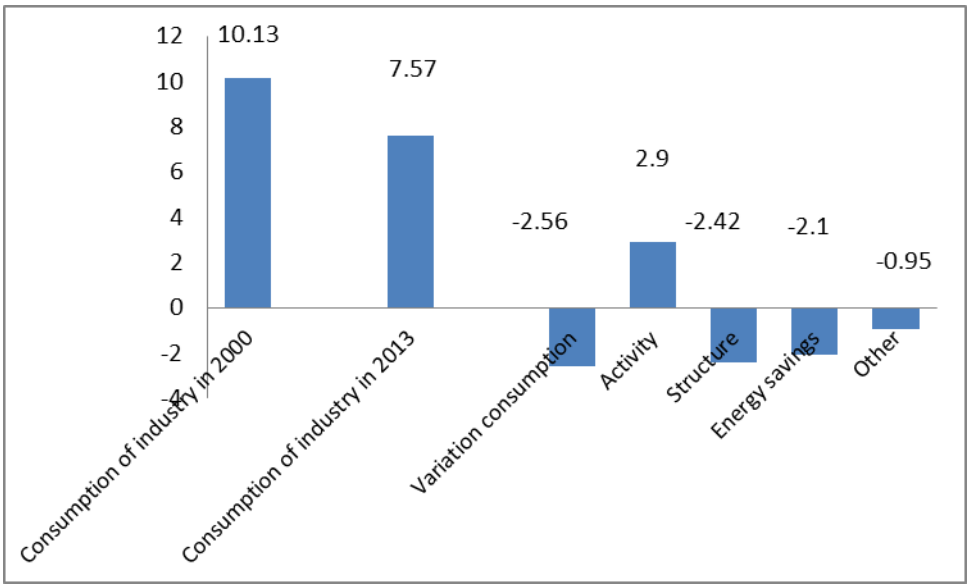

Figure no. 7: Decomposition of final energy use in industrial sector of Czech Republic (2000-2013), Mtoe

Source: created by the authors with reference to EC (2016)

In figure no. 8 the decomposition of final energy use in transport sector of Czech Republic in 2000-2013 is provided. The variation of the transport final energy use is changing under the influence of the following driving forcers (EC, 2016):

- Change in passenger traffic including air and traffic of goods etc.;
- Technical energy savings (i.e. change in the efficiency of trucks, airplanes, cars etc);
- Modal shift in land transport, i.e. change in the share of each transport mode in the total land traffic of the country.
- Other effects, i.e behavioral effects and "negative savings" in freight transport due to low capacity utilization.

As one can see from Figure no. 8 that final energy consumption in transport in Czech Republic during 2000-2013 period has increase by 1.63 Mtoe (23%). The main driving force of his increase is related to growth in value added of economy. Modal shifts and other factors also affected negatively final energy use growth in transport sector. Other effects, such as behavioural effects and negative savings in freight transport due to lower capacity utilisation also increased final energy consumption in Czech Republic transport sector.

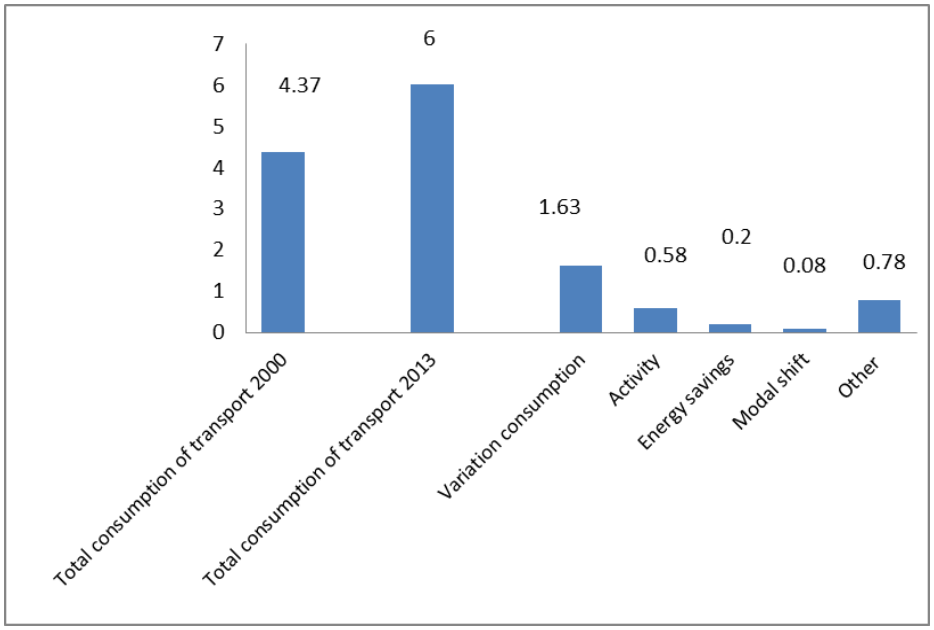

Figure no. 8: Decomposition of final energy use in transport sector of Czech Republic (2000-2013)

Source: created by the authors with reference to EC (2016)

In figure no. 9 decomposition of final energy use in residential sector in 2000-2013year period is given. The variation of residential final energy consumption is influenced by (EC, 2016):

- Climatic difference between these two dates (climatic effect);
- Change in number of occupied dwelling (more dwellings);
- Change in appliances per dwelling" (more electrical appliances, central heating);
- Change in floor area of dwelling for space heating (larger homes);
- Energy savings;
- Other effects (mainly change in heating and other behaviors);

As is evident from data presented in Figure no. 9 final energy consumption in residential sector has increased by 0.25 Mtoe (4%). Energy savings have effect on final energy consumption reduction by 1,64 Mtoe (27%). Other factors such as climate, number of dwellings, appliances per dwelling, the size of homes, heating and other behaviors have negative impact on increase of final energy use in residential sector by 1.99 Mtoe (31%).

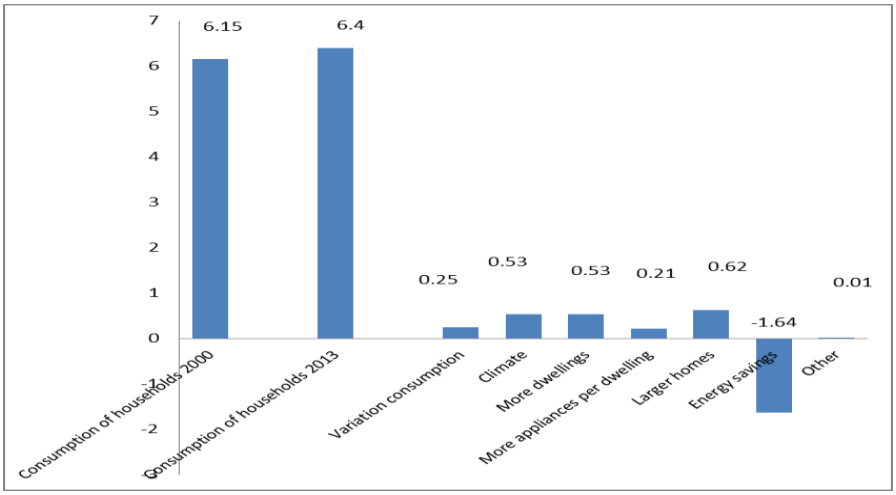

Figure no. 9: Decomposition of final energy use in residential sector of Czech Republic (2000-2013)

Source: created by the authors with reference to EC (2016)

In Figure no. 10 the decomposition of final energy use in service sector in 2000-2013 period is given. The variation of the energy consumption of service sector is influenced by the following driving forces (EC, 2016):

- Climatic difference between several years ("climatic effect")
- Change in economic activity, measured with the value added of economy ("activity effect")
- Energy savings, measured from changes in energy use per employee
- Changes in labor productivity, i.e. changes in the ratio value added per employee
- Other effects, i.e behavioral effects and "negative savings".
- As one see from figure no. 10 final energy consumption in service sector has increased by 0.04 Mtoe. Growth in value added in service sector increased final energy use by 1.53 Mtoe (52%). Climate and other factors have also negative effect on final energy consumption increase. Energy savings decreased energy consumption by 1.35 Mtoe (46%) and changes in labor productivity also have decreased final energy consumption by 0.5 Mtoe (17%) in services sector. The energy consumption growth of services up to the year 2004 was driven mainly by the rapid development of supermarkets etc.

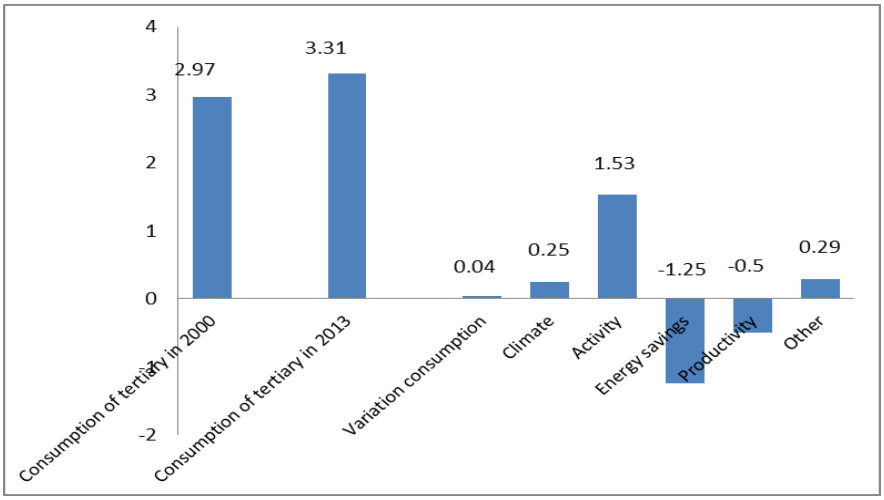

Figure no. 10: Decomposition of final energy use in service sector of Czech Republic (2000-2013)

Source: created by the authors with reference to EC (2016)

Decomposition of final energy use in agriculture of Czech Republic is given in figure no. 11. The variation of the final energy use of agriculture is effected by the variation of the value added and energy savings.

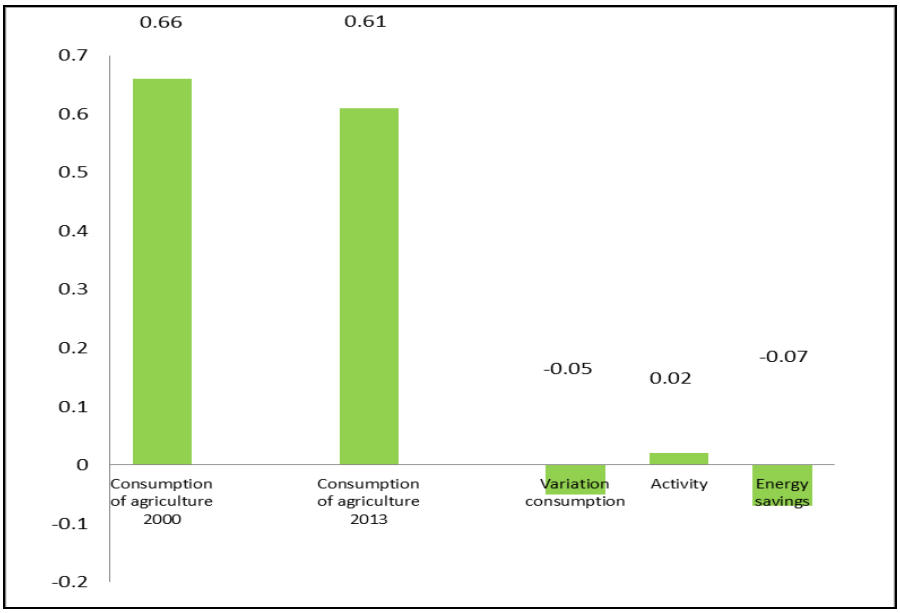

Figure no. 11: Decomposition of final energy consumption in agriculture of Czech Republic (2000-2013)

Source: created by the authors with reference to EC (2016)

As one can see from Figure no. 11 final energy use has decreased in agriculture by 0.05 Mtoe (8%). The increase in value added in agriculture had impact on increase of final energy use by 3% in Czech Republic. Energy savings provided for the decrease of final energy consumption by 0.07 Mtoe (11%).

2.2 Decomposition of final energy use in Latvia

The decomposition of the final energy use during 2000-2013 period is calculated by combining the sectoral decomposition and adding the contribution of different final energy use driving forces in final end-use sectors (households, transport, industry, services, and agriculture as in the case of Czech Republic.

In figure no. 12 decomposition of final energy use changes in Latvia is given.

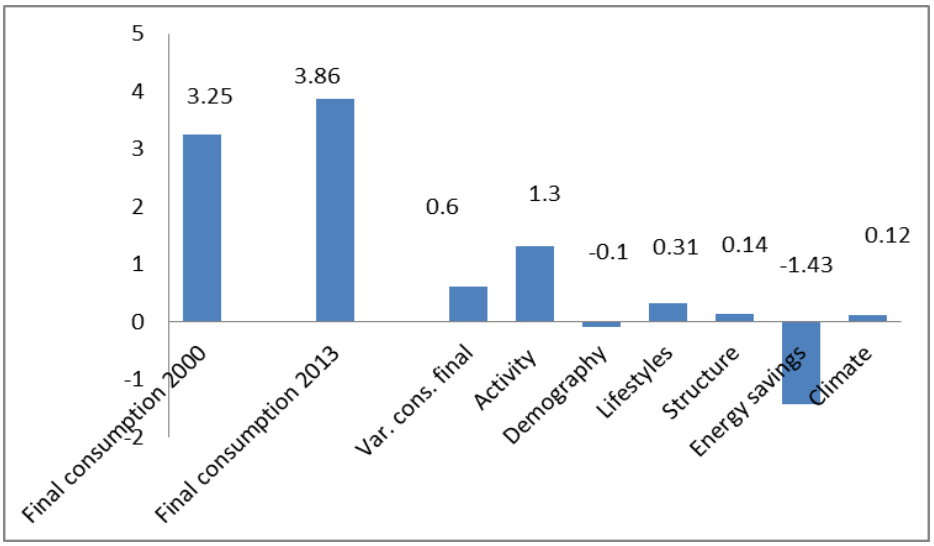

Figure no. 12: Decomposition of final energy use of Latvia (2000-2013), Mtoe

Source: created by the authors with reference to EC (2016)

As on can see from Figure no. 12 final energy use of Latvia increase by 0.6 Mtoe (18%) during investigated period. Increase in value added provided for increase of final energy use by 1.3 Mtoe (40%). Lifestyles, structure of final energy use and climate affected increase of final energy use by 0.57 Mtoe (18%). Energy savings and demography provided for 1.44 Mtoe (44 %) decrease of final energy use of Latvia.

In figure no. 13 decomposition of final energy use in industry in Latvia is given.

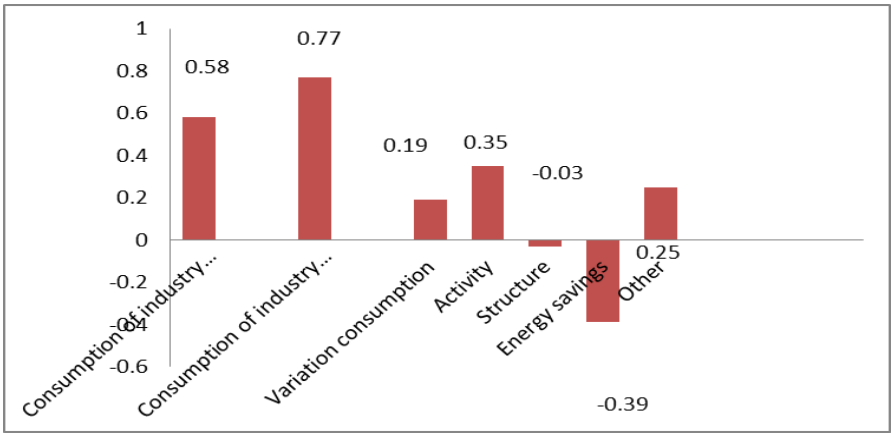

Figure no. 13: Decomposition of final energy use in Latvian industry (2000-2013)

Source: created by the authors with reference to EC (2016)

As one can see from figure no. 13 final energy consumption has increased by 0.19 Mtoe (36%) in Latvian industry during investigated period. Increase of value added of industry was the main driving force of final energy consumption increase in Latvian industry 0.35 Mtoe (60%). Energy savings provided for 0.39 Mtoe (67%) of final energy use decrease in the same period. Other effects were mainly "negative" savings due to inefficient operations in industry by providing for increase in final energy use Latvian industry by 0.25 Mtoe (43%).

In Figure no. 14 decomposition of final energy use in transport of Latvia is given.

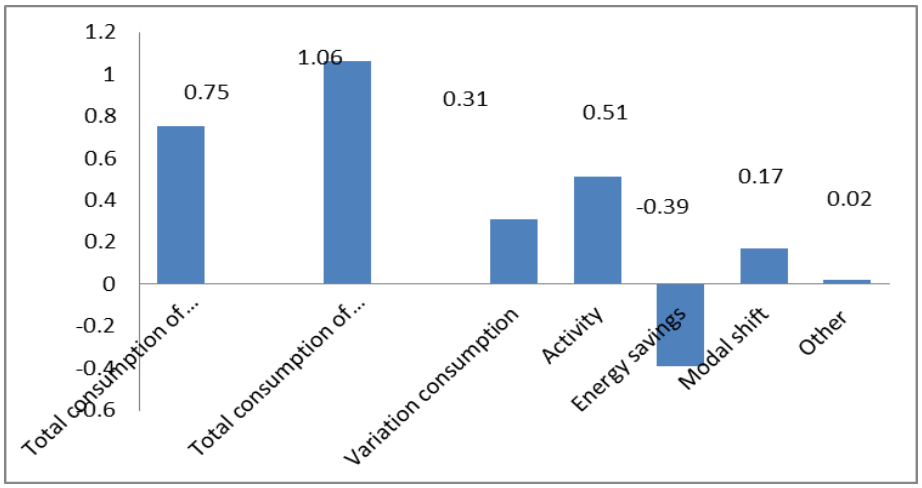

Figure no. 14: Decomposition of final energy use in transport sector of Latvia (2000-2013)

Source: created by the authors with reference to EC (2016)

Final energy use in transport sector has increased by 0.31 Mtoe (41%) in Latvia. The main driving forces of final energy use was increase in value added providing by increase of final energy use by 0.51 Mtoe (68%). The modal shift and other factors also had impact on increase of final energy use in transport by 0.19 Mtoe (25%). Energy savings provided for final energy consumption reduction by 0.39 Mtoe (52%).

In Figure no. 15 the decomposition of final energy use in residential sector of Latvia is provided.

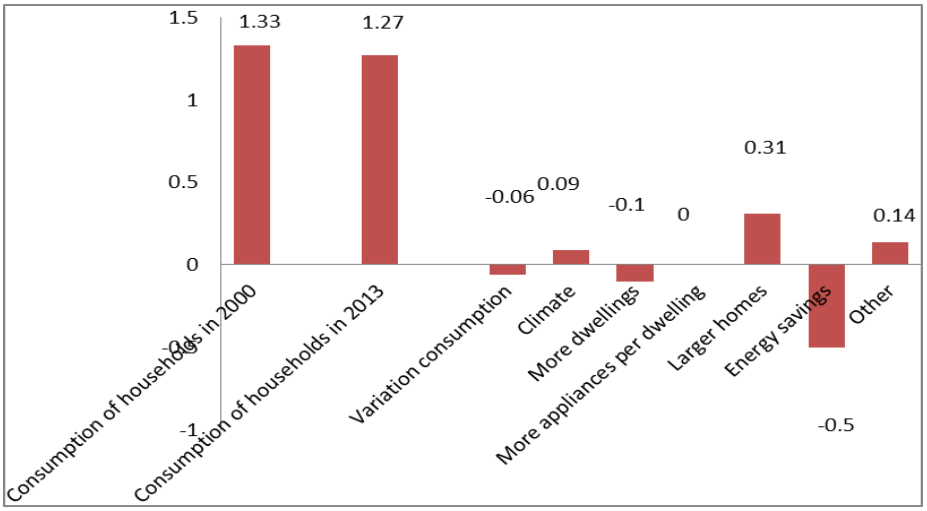

Figure no. 15: Decomposition of final energy use in residential sector of Latvia 2000-2013

Source: created by the authors with reference to EC (2016)

As one can see from figure no. 15 final energy use has decreased in Latvian residential sector by 5%. The larger homes, climate and lifestyles have impact on for final energy consumption increase in Latvian residential sector by 0,54 Mtoe (40%). Energy saving and reduction in dwellings has impact on reduction of final energy use in residential sector by 0.6 Mtoe (45%).

In figure no. 16 the decomposition of final energy use in services sector in Latvia is given.

As one can see from Figure no. 16 final energy consumption in Latvian services sector has increased by 0.38 Mtoe (80%). The increase of value added provided for increase of final energy use by 0.5 Mtoe (106%). Climate and behavioral effects and "negative savings" had impact on increase of final energy use by 0.28 Mtoe (60%). Energy savings and productivity increase effected final energy use decrease by 0.4 Mtoe (85%).

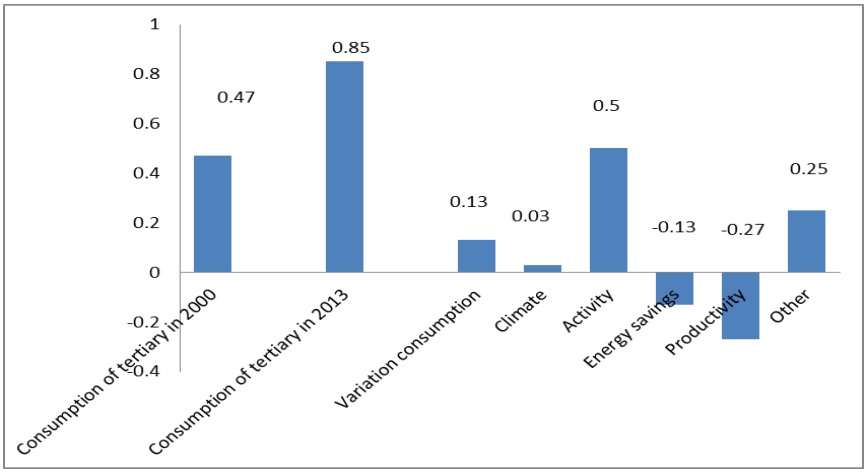

Figure no. 16: Decomposition of final energy use in services sector in Latvia (2000-2013)

Source: created by the authors with reference to EC (2016)

In Figure no. 17 the decomposition of final energy use in agriculture sector of in Latvia is given.

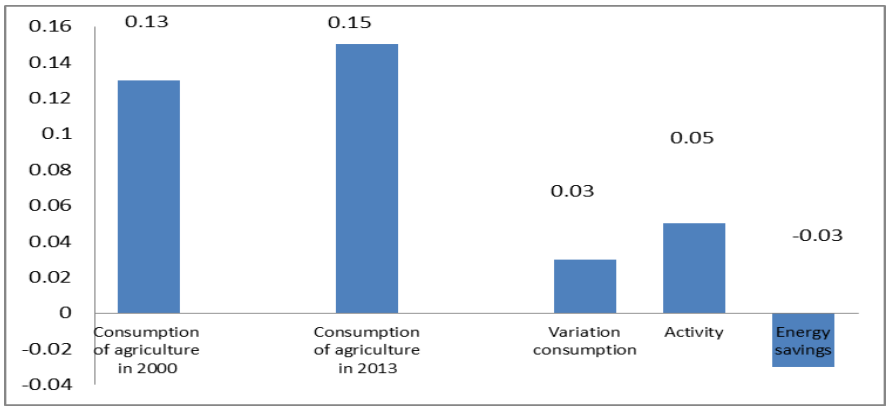

Figure no. 17: Decomposition of final energy use agriculture sector of Latvia (2000-2013)

Source: created by the authors with reference to EC (2016)

As one can see from Figure no. 17 the final energy use in agriculture has decreased by 0.03 Mtoe (23%). The increase of value added of agriculture provided for final energy use increase by 0.05 Mtoe and energy savings provided for final energy use decrease by 0.03 Mtoe.

Comparing Latvia and Czech Republic one can noticed that final energy use in Czech Republic has decreased by 4% but in Latvia it has increased by 18% during 2000-2013. In Latvia final energy consumption declined just in agriculture and left almost stable in

residential sector. In industrial sector final energy use has declined by 25% in Czech Republic and in Latvia it has increased by 36%. In service sector final energy use in Latvia has increased by 80% and in Czech Republic left stable. Final energy consumption in transport sector has increased by 23% in Czech Republic and by 41% in Latvia. As decomposition of final energy consumption in Latvia and Czech Republic showed quite different results in terms of energy savings, the analysis of energy efficiency policies is provided bellow.

3. Energy saving policies in Czech Republic and Latvia

In this chapter the review of energy efficiency policies in Latvia and Czech Republic is provided seeking to identify the reasons of the better results revealed by decomposition of final energy use in Czech Republic.

3.1 Energy saving policies in Czech Republic

New State Energy Policy (SEP) was adopted in Czech Republic in 2015. It defines political, legislative and administrative framework for reliable, affordable and long-term sustainable energy supply for the population and national economy. This is the main strategic energy policy document of Czech Republic providing the main targets for energy sector development until 2040. The main strategic objectives of the Czech Republic SEP are: security of energy supplies; competitiveness and sustainability.

The National Energy Efficiency Action Plan (NEEAP) is the main document of Czech Republic energy efficiency policy. The 1st and 2nd NEEAPs require reaching 9% energy savings in 2016. The 2nd NEEAP requires savings of 19,724.4 TJ for the period 2008 – 2010 and savings were even higher - 27,097 TJ. The Czech Republic energy saving target in the 3rd NEEAP - 47.78 PJ in 2020. It corresponds to 6.83 PJ or 1.5 % of annual savings. About 28 percent of those savings should be achieved in the household sector, 18 percent in the transport sector, 11 percent in the industrial sector, 9 percent in services and 1 percent in the agricultural sector; the remaining 33 percent would be achieved through transversal measures.

The Czech government decided to use an alternative scheme to comply with Article 7 of the Energy Efficiency Directive and the selected alternative measures are mainly of financial character. The "Operational Programme Enterprise and Innovation for Competitiveness" is currently the most important measure supporting energy savings in industry.

The Energy Management Act amended in 2010 sets minimum requirements regarding energy demand in buildings, energy audits in buildings and energy labelling of electrical appliances. It also promotes the use of CHP and renewable energy sources (a national program is elaborated and updated every four years)**.** Between 2009 and 2012 the Czech Republic invested about €1bn ($0.75bn) in the Green Investment Scheme, which provides grants covering up to 50 percent of residential insulation costs.

The largest Czech programme promoting energy efficiency and RES is "Green Savings Programme", designed mainly for owners of family houses. The programme launched in 2009 and it is supposed to continue up to 2020. Buildings, which are owned by public

sector have to have almost zero energy consumption from 1 January 2018 in Czech Republic. All collective houses must have building energy certificate from 1 January 2019. Domestic producers or importers of energy-consuming appliances are obliged to place energy labels on these appliances prior to placing them on the market. The information on the label must be accurate and in the Czech language. Energy audit act regulates conditions for the performance of the obligatory energy audit of energy management in public buildings.

Transport does not represent a priority in the Czech energy efficiency improvement efforts. The most significant potential of energy efficiency improvements will be achieved by reduction in energy demand of passenger cars put on the domestic market. Emission performance standards for new passenger cars. Legislative-information nature (application of energy labelling of passenger cars according to the level of produced CO2 emissions per mileage). Financial incentives (introduction of the "feebate" system for the sale of new vehicles according to the absolute level of CO2 emissions/km, and possibly adjustment of the current form of road tax similarly). Concluding voluntary agreements on the implementation of technological measures to improve energy efficiency of new vehicles.

Review of energy efficiency policies in Czech Republic show that very good results energy efficiency improvements or huge energy savings were achieved in industry and tertiary sector due to selected alternative measures for implementation Energy Efficiency Directive which are mainly of financial character. The achievements in households sector are also very good due to implemented Green Savings Programme, Green Investment Schemes etc. implemented in housing sector. As transport does not represent a priority in the Czech energy saving efforts the achievements in this sector are not so impressing.

3.2 Energy saving policies in Latvia

Improving energy efficiency (EE) and increase share of RES is set as a Latvia national priority, which allows for the cost-effective increase in of energy security of energy supply, sustainability and competitiveness of economy, at the same time creating new jobs and promoting economic growth (Streimikiene and Sarvutyte-Grigaliuniene, 2013). The national energy efficiency (EE) target set for Latvia requires to achieve energy savings of 0.67 Mtoe in 2020. This is equivalent to final energy savings of 0.457 Mtoe, providing for energy savings in buildings, industry, services and transport and district heating systems. Meeting the above-noted EE target is related to renewable energy (RES) target to increase the share of RES in gross final energy consumption up to 40%, as well as reduction of GHG emissions by 20% comparing with 1990 level.

The main energy policy document in Latvia is Latvia's long-term energy strategy 2030 - Competitive Energy for Society. The aim of this strategy is to build and develop competitive energy for society, including more effective energy system development. The Energy Strategy emphasizes the main objectives of the energy policy: Competitive economy; sustainable and secure energy. Sustainable energy means reduced dependency on imported energy resources, new and efficient technologies and other measures to improve energy efficiency. Security of energy supply means stable energy supply and developed infrastructure provided to energy users. Also Latvian government also adopted mid-term energy policy document - Energy Development Guidelines for 2007-2016. These Guidelines aims to promote energy efficiency as one of the key priorities for the energy

sector development. Ministry of Economics has developed Energy Development Guidelines for 2014-2020, which links Latvia's energy policy to the EU 2030 energy package.

The new Latvia's energy strategy defines the following indicators in year 2020 in compliance with EU energy efficiency policy and new Energy Efficiency Directive 2012/27/EU: total savings of primary resources in year 2020 – 0.670 Mtoe (20% reduction against the baseline), total cumulative energy savings – 0.85 Mtoe (9897 GWh),

The Law on the Energy Performance of Buildings was adopted in 2012 makes the general legal framework of setting the mandatory minimum energy performance requirements for buildings, recasts the general principles of mandatory energy efficiency certification for buildings, verification of buildings heating and ventilation systems. The Cabinet of Ministers introduced energy efficiency classes of residential buildings and non-residential buildings. The new buildings shall be almost zero energy buildings: for municipal buildings – starting from the 1st January 2019, for other residential and non-residential buildings – starting from the 1st January 2021. The particular policy is focused to the residential buildings with the worst specific average heat energy consumption. As multi-apartment buildings energy efficiency measures (including renovation, if necessary) are obliged in case the annual heat consumption (average for last 3 years) exceeds: (i) 200 kWh/m2 annually for heat and hot water, or (ii) 150 kWh/ m2 annually for heat only.

To co-operate with industrial sector, the government has adopted the framework for signing the voluntary agreements on energy efficiency, promoting energy audits and energy management systems in industrial enterprises. In transport sector, to promote more efficient cars and efficient driving, the government applies a mix of fiscal, legislative (both normative and informative), public procurement and transport infrastructure development measures. Fuel excise tax and differentiated tax rates for passenger cars depending on age and engine size, as well as new cars registration tax based on specific CO2 emissions, make strong synergy effect.

Though Latvia has implemented several important measures for energy efficiency improvement the best achievements so far are in households sector providing final energy consumption decrease mainly due to achieved significant energy saving. The programs implemented in industry such as frameworks for signing the voluntary agreements on energy efficiency, promoting energy audits and energy management systems in industrial enterprises didn't provide for energy efficiency improvement in industry and tertiary sector. The policies implemented in transport sector are not very ambitious and effective to provide significant energy savings in this sector.

Conclusions

The structure of final energy use in Czech Republic is characterized by a big drop in the share of industry, rising share of transport and slightly growing share of service sector. Czech Republic has seen a gradual transition from industry-oriented economy in 1990 towards a service-oriented one since 2000. Latvia saw a steep increase in the final energy use in transport sector during 1990-1995 and the share of industry almost halved during the same period.

Comparing Latvia and Czech Republic one can noticed that final energy use in Czech Republic has decreased by 4% but in Latvia it has increased by 18% during the same

period. In Latvia final energy consumption declined just in agriculture and left almost stable in households. In industry final energy consumption declined by 25% in Czech Republic and in Latvia it has increased by 36%. In tertiary sector final energy consumption in Latvia increased by 80% and in Czech Republic left stable. Final energy consumption in transport has increased by 23% in Czech Republic and by 41% in Latvia.

Review of energy efficiency policies in Czech Republic showed that very good results in energy efficiency improvements or huge energy savings were achieved in industry and tertiary sector due to selected alternative measures for implementation Energy Efficiency Directive which are mainly of financial character. The achievements in households sector are also very good due to implemented Green Savings Programme, Green Investment Schemes etc. implemented in housing sector. As transport does not represent a priority in the Czech energy saving efforts the achievements in this sector are not so impressing.

Review of energy efficiency policies implemented in Latvia indicated that priority was households sector. Though Latvia has implemented several important measures for energy efficiency improvement the best achievements so far are in households sector providing final energy consumption decrease mainly due to achieved significant energy saving. The programs implemented in industry such as frameworks for signing the voluntary agreements on energy efficiency, promoting energy audits and energy management systems in industrial enterprises didn't provide for energy efficiency improvement in industry and tertiary sector. The policies implemented in transport sector are not very ambitious and effective to provide significant energy savings in this sector.

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