ENERGY SAVING POTENTIALS IN CZECH REPUBLIC AND AUSTRIA

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3 ABSTRACT

The aim of this seminar paper is to compare energy saving potentials in Czech Republic and Austria. These potentials are based on the EU goals and directives for 2020 and 2030. To achieve these goals EU has launched two different kinds of energy schemes, i.e. the alternative and obligation scheme. Czech Republic uses the alternative scheme by educating including energy advisory programmes that will lead to energy-efficient technology or techniques (Trade, 2014). Austria uses a combination of both the alternative and the obligatory scheme. Their target is based on the average final energy sales of all energy distributors or retail energy sales companies to customers (Bundesministerium für Wirtschaft, Familie und Jugend, 2016). The different energy schemes will be discussed. On the one hand the state of the art in these two countries is quoted as well as the implementation of efficient energy saving measures and on the other hand it will be discussed how the energy saving potential can be reached in a cost efficient way.

4 INTRODUCTION

Energy saving/efficiency can basically be defined as using less energy to provide same service or the ratio of energy used to energy invested in a given process. For example, using proper energy saving insulation materials in homes allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Another example is installing a florescent lights, LED lights, natural skylights which reduces the amount of energy required to attain the same level of illumination compare with using traditional incandescent light bulbs. Improvements in energy efficiency have been a key factor or target for European Union Commission. A target of 20% savings in the year 2020 and 30% of savings in the year 2030 was set. Technologies, production process, schemes or application of commonly accepted methods are adopted to reduce energy losses. By reducing energy usage, we reduce energy costs, which may result in financial cost savings to consumer if the energy savings offset any additional costs of implementing an energy efficiency technology. Reduction of energy usage can appear to be a solution to the problem of greenhouse gas emission by the use of renewable energy (Energy Efficiency Use, 2014).
According to National Energy Efficiency Audit Plan (NEEAP), the main potential for energy savings lies in the household sector, followed by industry then transport (Network, 2015). Improved energy efficiency in buildings, industries and transport could reduce the worlds energy needs in 2050 by one third, which will help to control global greenhouse gas emissions (Energy Efficiency Use, 2014)
EU has put in place policies for energy efficiency and until now, positive outcome has been achieved. The key framework for current energy efficiency includes the Energy Efficiency Directive, Energy Performance of Building Directive, Energy Labelling Directive and Eco Design Directive etc. EU countries are urged to implement and support in achieving the vision 2020 and 2030 target. Different schemes are used in different countries and from estimated methods, not all countries can reach the 20% target in the year 2020. As at the moment, Czech Republic and Austria are one of the countries that are estimated to reach the target if all measures and plans continue as it is now. Detailed of their scheme used and how they reach their target in terms of household, industry and transport is explained in this paper.

5 MOTIVATION

The goal of this seminar paper is to have a fundamental summary about energy savings potential in Czech Republic and Austria. One of the main focuses is on costs of saving potentials and the strategy of both Austria and Czech Republic used in achieving the EU vision 2020 targets. By using energy more efficiently, EU countries can lower their bills, reduce their reliance on external suppliers of oil and gas and most important help to protect the environment (European Commission, 2016). There should be increase of energy savings at all stages of chain from generation to final consumption. The benefit of energy efficiency must be more significant than the cost, examples are those involved in renovation/buildings. One of the greatest potential places to save energy is through building and therefore followed by industry then transport, EU measures focus on that in order to reach the vision 2020 targets.

6 EU GOALS AND DIRECTIVES

In 2012 the Energy Efficiency Directive established a set of binding measures to help EU countries in reaching the 20% energy efficiency which is one of the five headlines targets of the year 2020 strategy for smart, sustainable and inclusive growth. Under the directive, one key point is that, all EU countries are required to use energy more economical and efficient at all stages of energy chain, i.e. from its production to its final consumption. It was also emphasize in the directives provision that, all EU countries are required to transpose the directive into their laws by 5 June 2014 (Commission, Energy Efficiency Directive, 2016). Some national measures and policies where taking into account to ensure major energy savings for consumers and industries according to (Commission, Energy Efficiency Directive, 2016) these measures are:

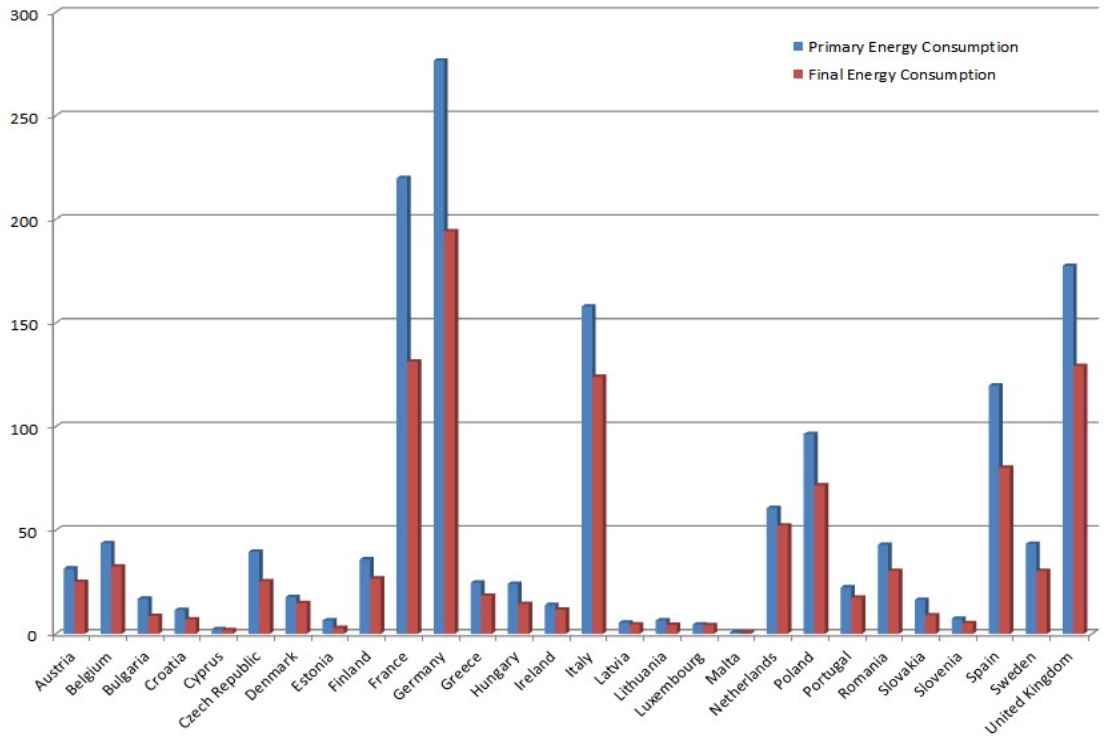
- "Energy distributors or retail energy sales companies have to achieve 1.5% energy savings per year through the implementation of energy efficiency measures
- EU countries can opt to achieve the same level of savings through other means such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs
- The public sector in EU countries should purchase energy efficient buildings, products and services
- Every year, EU governments will carry out energy efficient renovations on at least 3% of the buildings they own and occupy by floor area
- Empowering energy consumers to better manage consumption. This includes easy and free access to data on consumption through individual metering
- National incentives for SMEs to undergo energy audits
- Large companies will make audits of their energy consumption to help them identify ways to reduce it
- Monitoring efficiency levels in new energy generation capacities"

Analysis recently made by European Commission states that EU countries are on track to reach around 18-19% final energy savings by 2020. Until now, one third of these energy savings that were made since 2010 are due to collapsed economic output resulting from 2007 financial crisis (Bergamaschi, Holmes, & Lawson, 2016).

6.1 Energy Efficiency Targets for 2020 and 2030

European Commission published its vision for future energy efficiency in EU Countries. The document published is entitled Energy Efficiency and its contribution to energy security and the 2030 framework for climate and energy policy. In the document, it states how important it is to focus on proper implementation of Energy Efficiency Directive (EED), improve implementation of Energy Performance of Buildings Directive (EPBD) and also strengthened enforcement of product regulations (UP, 2015).
EU countries in order to reach the 2020 target have set their own indicative national energy efficiency targets. Depending on the country's preferences, these targets can be based on primary or final energy consumption, primary or final energy savings. The 20% energy saving target by year 2020 is roughly equivalent to turning off about 400 power stations (Commission, European Commission, 2016).

Figure 1: Absolute level of energy consumption in 2020 in Mtoe



Source: Commission, Energy Efficiency Directive, 2016

The sum of the indicative targets EU28 for primary energy consumption is 1526.9 Mtoe and for final energy consumption it is 1077.5 Mtoe. The EU28 target for primary consumption is 1483 Mtoe and final consumption is 1086 Mtoe.

The goals for 2030 are as following (European Commission 2030 Targets, 2016):

- A 40 % cut in greenhouse gas emissions compared to 1990 levels
- At least a 27 % share of renewable energy final energy consumption
- At least 27 % energy savings compared with the business-as-usual scenario
- EU countries are required to transpose the directive into their laws by 5 June 2014.

6.1 Energy Efficiency Progress

Energy Efficiency communication in July 2014 release that, EU is expected to achieve energy savings of 18% - 19% by the year 2020 out of 20% target missing 1% - 2% savings. The estimated target of 20% can be reached without any additional measures if all EU countries implement all the existing legislation on energy efficiency (EC Europa, 2016).
The implementation of energy efficiency towards the future goal in EU has produced substantial benefits for Europeans. Some of the benefits are:

- Energy efficiency building now consumed half the energy as compared to 1980
- From 2001 to 2011, the energy intensity in EU Industries has decreased by almost 19%
- When energy efficient appliances are used, the consumer is expected to save € 100 billion annually. Estimation is about € 465 per household on consumers energy bills by 2020.
- EU countries in further to save energy have committed themselves to rolling out close to 200 million smart meters for electricity and 45 million for gas by 2020, leading to greater savings for consumers

- Labeling of electrical appliance like was made a law and by using the highest energy efficiency labeling class (A and above), the share of refrigerator has increased from less than 5% in 1995 to more than 90% in 2010.

There are other further benefits for energy efficiency expected in future. They include:

- For every 1% improvement in energy efficiency, EU gas imports fall by 2.6%.
- Lower energy costs for people who live and work in energy efficient buildings, as well as additional benefits such as improved air quality and protection from external noise provided by energy efficient windows.
- Business opportunities for European companies such as construction firms and manufacturers of energy-using equipment
- New jobs in construction, manufacturing, research, and other industries investing in energy efficiency (EC Europa, 2016)

7 ENERGY SCHEME USED BY AUSTRIA AND CZECH REPUBLIC

According to (Commission, eur-lex.europa, 2016) there are two different schemes, that is, the obligation approach and the alternative approach. 11 countries out of 28 EU member states choose to implement the default approach and the remaining 17 adopt the alternative approach. Czech Republic adopts the alternative approach and Austria uses both the Default and alternative scheme.

7.1 Austria

Austria has agreed to use a combination of obligation scheme and alternative policy measures as written down in (Bundesministerium für Wirtschaft, Familie und Jugend, 2016).

The target is based on the average final energy sales of all energy distributors or retail energy sales companies to customers, as an average of the years 2010-2012 transport is subtracted from the sales volume. On this basis, the cumulative savings target for Austria in accordance with Article 7(1) EED;2012/27/EU for the period 2014 to 2020 is 279 PJ. According to Article 7(2) and (3) EED;2012/27/EU, the energy savings target resulting from this calculation can be reduced by up to 25%, e.g. by counting final energy savings from measures taken between 1st January 2009 and 31st December 2013 which will continue to have an impact in 2020 (in accordance with Article 7(2)(d) EED;2012/27/EU). Subtracting 25% – corresponding to savings from early actions – from the 279 PJ savings amount, reduces the cumulative target to 210 PJ (Bundesministerium für Wirtschaft, Familie und Jugend, 2006).
According to Austria's NEEAP 2014 (Bundesministerium für Wissenschaft F. u.-N., 2016) Austria have agreed to reach following goals:

- Based on directive 2006/32/EG Austria has calculated energy saving guidance value of 80.4 PJ in the year 2016 which means that until that date Austria should save at least 80.4 PJ of end energy consumption by energy saving measures.
- The indicative national energy saving target according to directive 2012/27/EU has the goal to set the end energy consumption at a value of 1,100 PJ.
- Increasing the share of renewable energy source to 34 % of the gross end energy consumption.
- The target of 1,100 PJ is equal to a reduction of 200 PJ towards the business as usual scenario.
- The primary energy consumption should be 1,320 PJ in the year 2020.

- The PRIMES-Model[1] is calculation an end energy consumption of 1,325 PJ, however if population grow is taken in account this values increases to 1,367 PJ. So the target of 1,100 PJ leads to a reduction of 20%.

Other energy efficiency targets:

- There are voluntary agreements made with professional associations. These associations have to reduce their energy consumption by 1,800 TJ (gas and head supply companies, 1,512 TJ (electricity companies) and 7,560 TJ (oil companies).

This part describes the energy efficiency targets according to directive 2006/32/EG article 4 and directive 2012/27/EU article 3:

7.2 Czech Republic

The Czech Republic agreed to use the alternative scheme to comply with Article 7(9) Energy Efficiency Directives and the selection of the alternative measures are mainly of financial character as well as training and education, including energy advisory programmes that will lead to energy efficient technology or techniques and the effect of reducing end-use energy consumption (Trade, 2013). Adopting the alternative scheme means implementation of the scheme will be in the hands of public bodies and therefore, there will be no obligation parties to this system. Investment subsidies and financial engineering instruments from public funds are expected to be the primary mechanisms. The administration of such will be entrusted to entities that already have experience of the programme. The recommended entities in Czech Republic are: the Ministry of Industry and Trade, the Ministry of the Environment, the Ministry of Regional Development and Regions involved in the Joint Boiler Replacement Scheme. In order for the targeted goal to be successful and make it effective, the entities work hand in hand with each other rather than competing with each other. The ministry of information gathers all information from public authorities and entrusted entities, which will be process and send to European commission (Trade, 2014).
Czech Republic planed using two periods for implementing their scheme in order to reach the target. The first period will last for 4 years from 1st January 2014 to December 2017. During the first period the alternative scheme conditions are introduced and implemented for approval. The second period is implemented from 1st January 2018 to December 2020. Within the second period, modification on the first period was done to support the incentive mechanisms, which will help the overall goal to be reached by 2020 (Trade, 2014).

List of alternative policy measures by sector (Trade, 2014):

Households

- New Green Savings 2013
- New Green Savings (2014–2020)
- Integrated Regional Operational Programme
- JESSICA Programme
- Panel Programme
- Joint Boiler Replacement Scheme

[1] …."PRIMES provides detailed projections of energy demand, supply, prices and investment to the future, covering the entire energysystem including emissions for each individual European country and for Europe - wide trade of energy commodities." (EU Commission, 2016, p. 8) ….

Services

- Operational Programme Enterprise and Innovation (business entities)
- Operational Programme Enterprise and Innovation for Competitiveness (business entities)
- EFEKT Programme – investment part (public service sector, lighting)
- Operational Programme Environment (2007–2013) (public service sector)
- Operational Programme Environment (2014–2020) (public service sector)

Industry

- Operational Programme Enterprise and Innovation
- Operational Programme Enterprise and Innovation for Competitiveness

Table 1: The benefit of individual policy measures for 2015

Measures	2015 (TJ)
Regeneration of apartment blocks - PANEL 2013+ PROGRAMME	38.998
Green Savings	Completed
New Green Savings 2013	326.4
New Green Savings 2014-2020	316.2
JESSICA Programme	54.698
Integrated Regional Operational Programme 2014-2020	Projects under implementation
Joint programme boiler replacement scheme	Projects under implementation
Operational Programme Environment 2007-2013.	864.127
Operational Programme Environment 2014-2020.	Projects under implementation
State Programmes for the promotion of energy savings and the utilisation of investment grants for renewable energy sources	7.462
OP Prague, Growth Pole of the CR – building part	In preparation
Operational Programme Enterprise and Innovation	1,096
Operational Programme Enterprise and Innovation for Competitiveness	Projects under implementation
TOTAL	2,703.8

Source: Trade M. o., 2011

From Table 1, about 2,704 TJ energy were saved at the end use in 2015. The increment is as a result of draw-down of the Operational Programme Enterprise for Innovation under the responsibility of Ministry of Trade and Industry and of the Operational Programme Environment (Trade, 2014).

7.3 Comparison

There are two different schemes, which should be used by all EU countries:

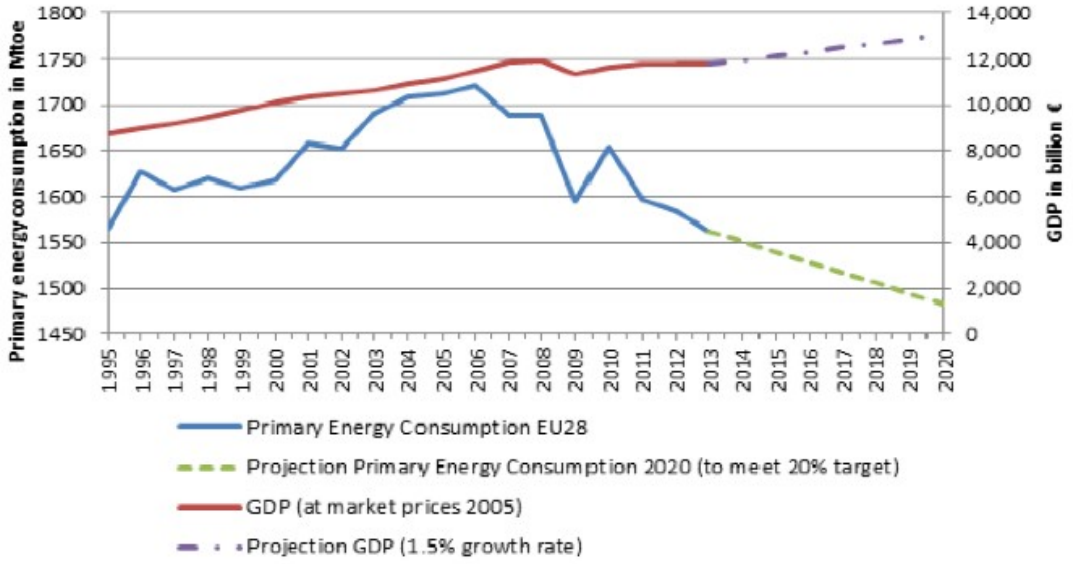
- Obligatory approach
- Alternative approach

Czech Republic has chosen the alternative scheme and Austria has chosen a combination between the default and alternative approach. Aiming at the 2020 target, the scheme used by Austria helps them to save about 200PJ as compare to Czech Republic of about 191PJ.

8 STATE OF THE ART

State of the Art
As shown in Figure 2 the EU managed to decouple the GDP from the primary energy consumption (Commission, Communication from the commission to the parliament, 2014).

Figure 2: Evolution of energy consumption and GDP in the EU 1995- 2013

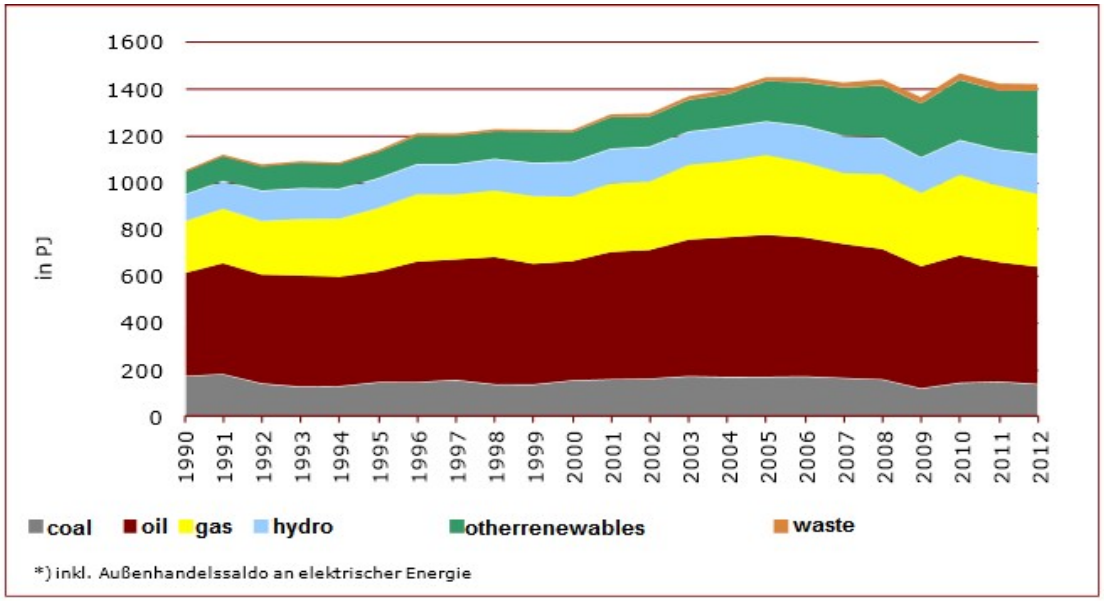


Source: Commission, Communication from the commission to the parliament, 2014

8.1 Austria

As shown in Figure 3 Austria's gross domestic energy consumption is stagnating since 2005 at a level of 1,400 PJ. In the time before 2005 there is a continuous increase.

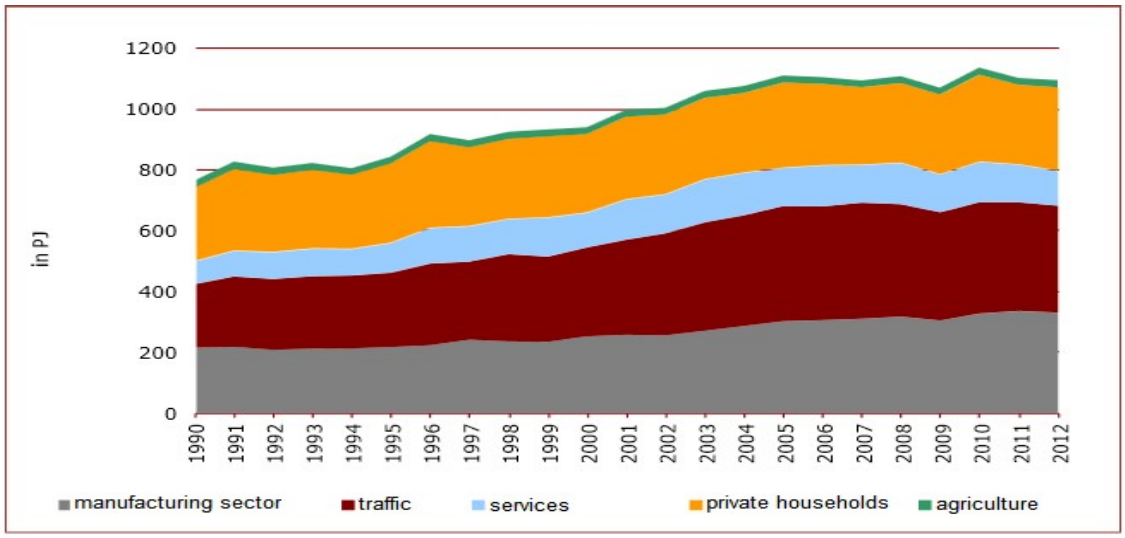
Figure 3: Austria's gross domestic energy consumption



Source: Bundesministerium für Wissenschaft F. u.-N., 2016

Figure 4 shows Austria's end energy consumption, which was constantly growing until the 2005 from that date the value, is remaining stable around 1,100 PJ.

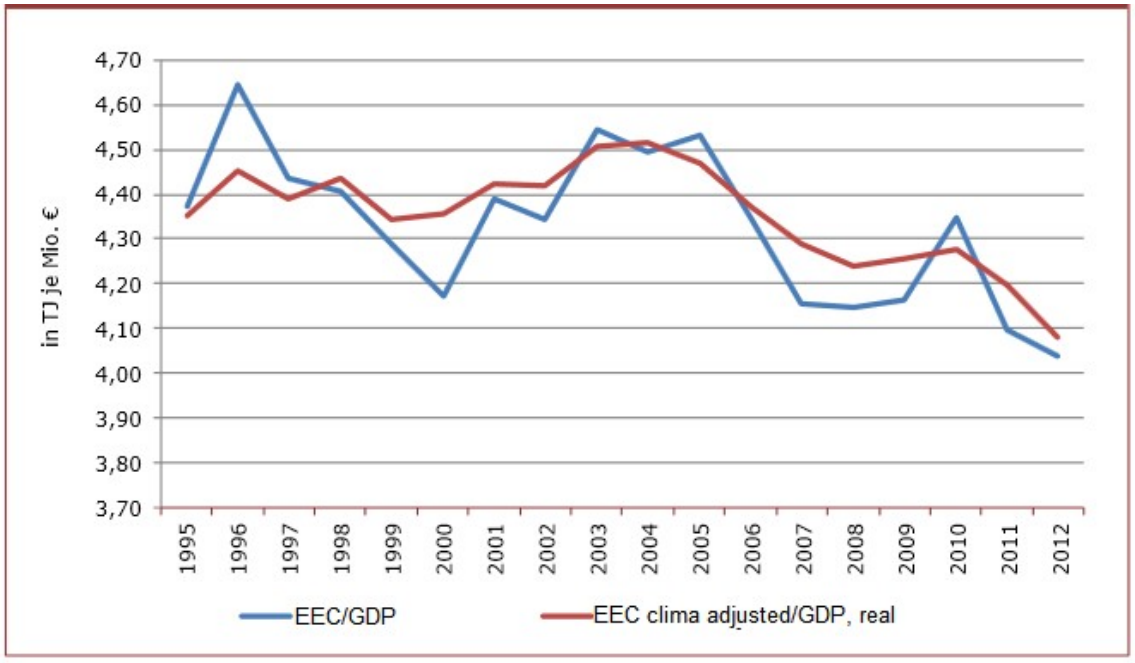
Figure 4: Austria‘s end energy consumption



Source: Bundesministerium für Wissenschaft F. u.-N., 2016

Referring to (Bundesministerium für Wissenschaft F. u.-N., 2016) there is also a decoupling of the energy consumption from the economic growth as illustrated in Figure 5.

Figure 5: Austria’s end energy consumption/GDP



Source: Bundesministerium für Wissenschaft F. u.-N., 2016

Table 2 gives an overview the estimated primary and end energy savings for 2016 and 2020.

Table 2: Overview over the estimated primary and end energy savings for 2016 and 2020

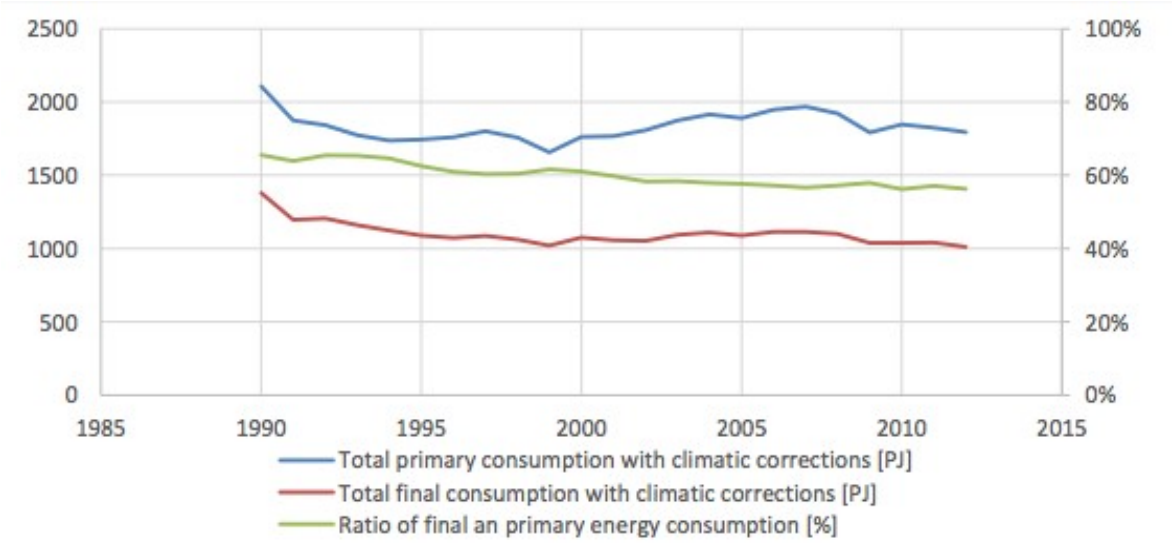
	2012 in PJ	2016 in PJ	2020 in PJ
Primary energy consumption[2]	1,308	1,314	1,320
Primary energy saving	74	96	240
End energy consumption	1,096	1,098	1,100
End energy saving	62	80	200

Source: Bundesministerium für Wissenschaft F. u.-N., 2016

The calculated end energy savings for 2012 are 61,516 TJ and the outlook for 2016 is calculated by the average values of the years 2008 to 2012 considering the lifetime of the measures and leads to energy savings of 84,234 TJ. This means the target will be overfull filled by 4.8%. The biggest savings are made due to better isolation of buildings (61.9%) another 31.9% were reached by more efficient heating systems. The remaining energy savings of 6.2% are cause by measures in traffic and electronic devices.

8.2 Czech Republic

Figure 6: Ratio of final and primary energy consumption in Czech Republic

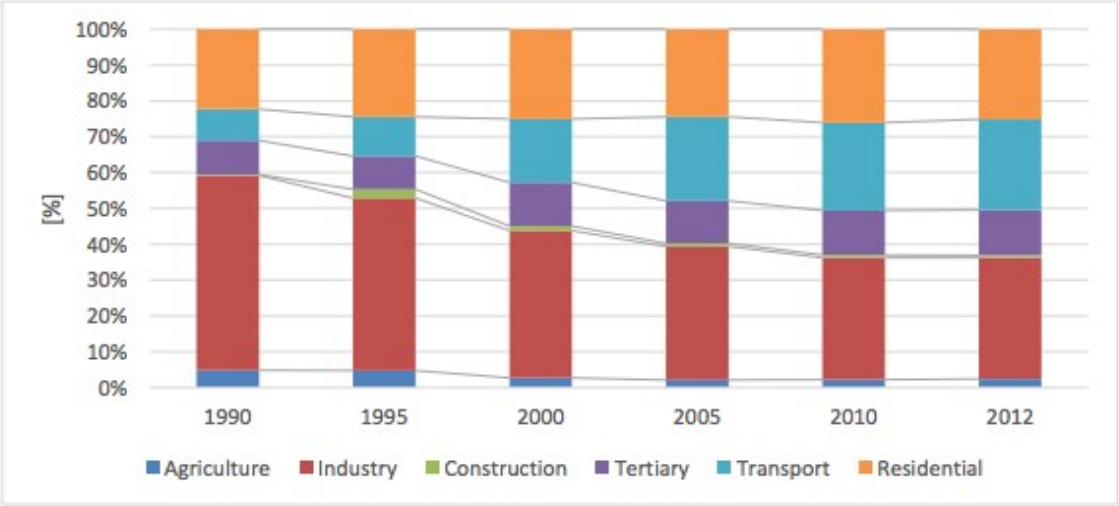


Source: Odyssee-Mure, 2015

As indicated in the graph above, the development of energy consumption rises favourable within the period of 2000-2008 and the decreases afterwards. The ratio between the primary and final energy consumption is about 60 %, relatively low and slowly decreases. The decrease in the ration is due to the high share of nuclear power generation of about 40% with low energy efficiency. The decreasing tendency is inclining by export of electricity but it is partially compensated by increasing share of renewable energy in the past years.

[2] Primary energy consumption reduced by non-energetic consumption

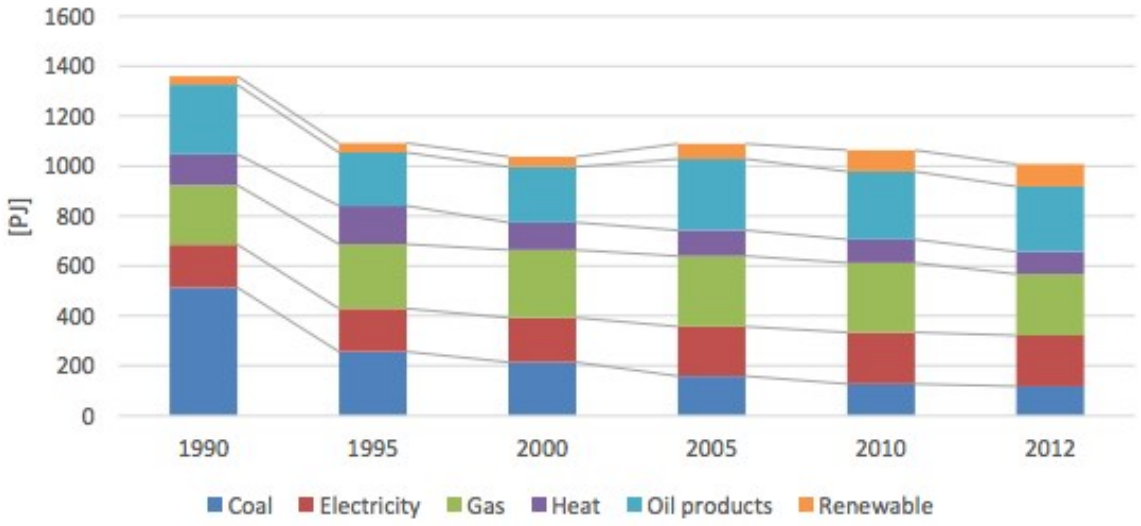
Figure 7: Structure of final energy consumption by sectors in Czech Republic



Source: Odyssee-Mure, 2015

Figure 7 shows the characteristics of final energy consumption by sector which indicates a big drop in the share of industry between the periods of 1990-2012. There is a strong rising share of transport and slightly growing share of tertiary sector.

Figure 8: Final energy consumption by energy carrier in Czech Republic



Souce: Odyssee-Mure, 2015

Figure 8 shows the characteristics of final energy by carrier which indicates that the share of coal and heat consumption decreases both in absolute and relative figures. The gas consumption remains almost stable but the consumption of renewable energy sources is growing gradually. The significant growth of oil products consumption is as results of increasing road transport (Odyssee-Mure, 2015)

Table 3: Calculation of the three-year average as the basis for the calculation of the target

	2010PJ	2011PJ	2012PJ
Final Consumption	1132.82	1087.24	1074.26
Transport	247.97	248.97	239.61
Non-energy use	112.80	105.97	114.76
Final energy consumption not sold, Own consumption	129.52	137.44	137.32
Adjusted final consumption of fuels and energy sold	**642.54**	**594.86**	**588.78**
Three-year average	**608.73**		

Source: Trade 2014

Table 4: Binding saving target

Year	Three-year average	Binding percentage of savings	Cumulative of saving
2014	608.73	1%	6.09
2015		1%	12.18
2016		1.25%	19.79
2017		1.25%	27.40
2018		1.5%	36.53
2019		1.5%	45.66
2020		1.5%	54.79

Savings achieved by Green Savings programme and the third call under the Eco-Energy Scheme of the operational Programme Enterprise and Innovation up to Maximum of 25%	6.85 PJ
New Savings Target	47.94 PJ (54.79-6.85)
Cumulative target	191.80PJ

Source: Trade, 2014

Czech Republic has chosen to step-up the build-up of savings over the period up to 2020. Aiming at the EU Target of 47.84 PJ, if the savings are evenly distributed between 2014 and 2020, the overall savings will be 191.36 with 6.83 PJ of new savings every year. (Trade, 2013)

8.3 Comparison

Austrian's gross domestic energy consumption is stagnating since 2005 at a level of 1,400 PJ and Austrian's energy consumption also stagnating at a level around 1,100 PJ. Austrians end energy consumption/GDP is decreasing since 2005 and at a level of 4.1 TJ/Million €. Czech's final energy consumption is in the year 2012 at a level of 1,000 PJ so it is lower by 100 PJ than in Austria.
The cumulative target of energy saving for Czech Republic is about 191.80PJ for estimated year 2020 and for Austria is about 200 PJ.

9 IMPLEMENTATION OF EFFICIENT ENERGY SAVING MEASURES

Historically, the Czech Republic has compiled its energy balance according to IEA methodology, which it also applies to the Updated State Energy Concept.
The Czech Republic's national indicative target has been set at 47.84 PJ (13.29 TWh) of new final energy savings by 2020. In Austria the organization "Austria Energy Agency – Monitoringstelle Energieeffizienz" is in charge to measure the energy efficiency. Methods and instruments used by both Czech Republic and Austria and how to measure it will be presented in this paper. Comparison from both countries on the instruments and methods used will also be presented. (energieeffizienz, 2016)

9.1 Austria

This section describes the measures which are used in Austria. To calculate the end energy savings the bottom-up method is used (Adensam, et al., 2016). The detailed methods how to calculate the end energy savings can be found in (Agency, 2016).

9.1.1 Energy taxes

According to (Adensam, et al., 2016) energy savings in Austria will be around 10,909 TJ (taking short term price elasticity into account) or even up to 60,832 TJ (taking long term price elasticity into account). These savings can be seen in Table 5.

Table 5: First estimate of energy savings due to energy taxes

	Tax relevant energy consumption [TJ/a]	**Energy savings subjected to price elasticity**	
Tax		**WIFO [TJ/a]**	**PROGNOS [TJ/a]**
Electricity and eco power tax	414,897	15,765	1,269
Natural gas tax	187,839	11,072	2,395
Mineral oil tax	414,821	33,995	7,244
Entire Austria	817,557	60,832	10,909
Accumulated savings 2014-2020		424,824	76,361

Source: Adensam, et al., 2016

9.1.2 Efficient measures and their life times

In the document according the bottom up methods (Adensam, et al., 2016) are following measures defined. In the followering tables the different measures are listed. In each row the inefficient system is compared to the efficient system and the life time of the efficient system is given.

9.1.3 Lighting

shows the energy consumption for lighting in the three different sectors (household, office and hotel and gastronomy)

Table 6: Efficient measures - comparison of efficient and inefficient systems and the life time of the efficient system

	Inefficient system	Efficient system	inefficient system [W]	efficient system [W]	Usage per year [h]	Life time [years]
Lighting (household)	Blub	LED	60	11	1000	20
Lighting (office)	Fluorescent tube	LED tube	58	30	2580	15
Lighing (hotel and gastronomy)	Blub	LED	174	32	2900	6,9

Source: Adensam, et al., 2016

9.1.3.1 District heating

In terms of district heating there are three different types of buildings (Single family houses (SFH), multi-family houses (MFH) and large volume housing (LVH)) in three different conditions (existing buildings, thermal constructed and new buildings) listed. Table 7 shows the decreasing head energy demand of these three buildings types due to better insulation. The life time of the heat exchanger is estimated by 30 years according to ÖNORM M7140.

Table 7: Overview of the heat energy demand

	SFH	MFH	LVH
GFA[3] [m²]	176	825	2445
HED[4] [kWh/m²/a] of			
Existing buildings	156	107	80
Thermal constructed	83	69	50
New buildings	66	49	38

Source: Adensam, et al., 2016

9.1.3.2 Building insulation

In Table 8 the comparison of the heat energy demand of old constructed and new buildings can be seen. The lifetime of insulation of the building shell is greater than 25 years and the lifetime of windows is taken in account with 24 years.

Table 8: Comparison of the heat energy demand of old constructed and new buildings

	SFH	MFH
$HED_{constr.}$ [kWh/m²a]	200	90.0
HED_{new} [kWh/m²a]	57	46.8

Source: Adensam, et al., 2016

9.1.3.3 Solar thermal system

If solar thermal systems are used to provide the warm water and also support the heating system (by 35%) than 538 kWh/m²a can be saved using a flat plate collector and 846 kWh/m²a when an evacuated tube collector is used. The lifetime of these collectors is estimated by 20 years.

[3] Gross floor area
[4] Heating energy demand

9.1.3.4 White goods

An example for saving with white goods can be seen in Table 9.

Table 9: White goods example fridge-freezer

	10-15 years old device [kWha]	New A++ device	Life time
Fridge-freezer	500	150	15

Source: Adensam, et al., 2016

9.1.3.5 Stand-by Killer

Stand-by Killers are devices, which can switch off other devices e.g. TV when they are not used but still consuming a stand-by electricity. Stand-by killers should be used when there are more than 3 devices plugged to the stand-by killer otherwise the own consumption (0.5 W/h) of the stand-by killer might be higher than the consumption of the devices plugged into it. A more efficient alternative is a normal plug bar with flip switch because it has no own consumption. Table 10 gives an overview over the stand-by of stand-by killers and the energy savings which can be made for each appliance plugged into the stand-by killer.

Table 10: Passive stand-by of stand-by killers and energy saving due to stand-by killers

Stand-by of standy-by killer[kWh/a]	Energy savings/appliance [kWh/a]
4.38	33.14

Source: Adensam, et al., 2016

9.1.4 Payback Period

For most of the measures mentioned in 9.1.2 the payback times are calculated by following formula, where t is the payback time, c_{inv} are the investment costs in euro, con_{old} is the consumption in kWh of the old/inefficient system, con_{new} is the consumption in kWh of the new system, u are the hours in which the system is in use and p is the energy price (either electricity or gas). The energy prices were calculated by the variable energy costs according to (e-control 2016). The price for electricity are 0.18936 €/kWh and the one for gas is 0.070752 €/kWh.

$$t = \frac{c_{inv}}{(con_{old} - con_{new}) \cdot u \cdot p}$$

The gross floor area and the facades area for the three different types of houses are given in Table 11. According to (wohnnet Medien GmbH 2016) the costs for thermal insulation are 88.589 €/m².

Table 11: Gross floor area and facades area of the three exemplary houses

	SFH	MFH	LVH
GFA [m²]	176	825	2445
Facades [m²]	300	765	1863

Source: Own compilation, 2016

Table 12 shows the values uses for the payback calculation. The energy saving potentials are the same as shown in 9.1.2. Most of the measures have a reasonable payback time except the solar thermal. This very high payback time is due to the very low energy savings. Citing other references as (e.g. Energieheld GmbH 2016) the payback time for solar thermal systems with heating support are 14 years. This is a economical reasonable value.

Table 12: Table for payback calculation (References: 1: (Conrad 2016), 2: (Conrad 2 2016), (RS, 2016), 3: (Conrad 3 2016), 4-6: (wohnnet Medien GmbH 2016), 7-8: (Energieheld GmbH 2016), 9: (Conrad 4 2016), 10: (Salzburg AG 2016), 11: (Adensam, et al., 2016)

	Efficient system	Costs efficient system [€]	Old system	Old Consumption [kW]	New Consumtion [kW]	Usage/ year [h]	Payoff [years]	Ref.
Lighting household	LED	9.99	bulb	0.06000	0.0110	1000	1	1
Lighting office	LED	84.99	bulb	0.05800	0.0300	2580	29	2
Lighting hotel and gastronomy		34.99	bulb	0.17400	0.0320	2900	0	3
SFH	insulated	26576.84	non insulated	156	83		29	4
MFH	insulated	67770.95	non insulated	107	69		31	5
LVH	insulated	165042.19	non insulated	80	50		32	6
Solar thermal flat plate collector	heating support	9500.00	only gas heating	14000	13462		250	7
Solar thermal evacuated tube collector	heating support	11000.00	only gas heating	14000	13154		184	8
Fridge-freezer	A++	799.00	old device	500	150	8760	12	9
Stand-by killer domestic appliance	stand-by killer	7.90	no stand-by killer	0.00525	0.0005	8760	1	10
Stand-by killer Entertainment electronics and office appliance	stand-by killer	7.90	no stand-by killer	0.01610	0.0005	8760	1	11

Source: Own compilation, 2016

9.1.5 Determinants of Energy Savings

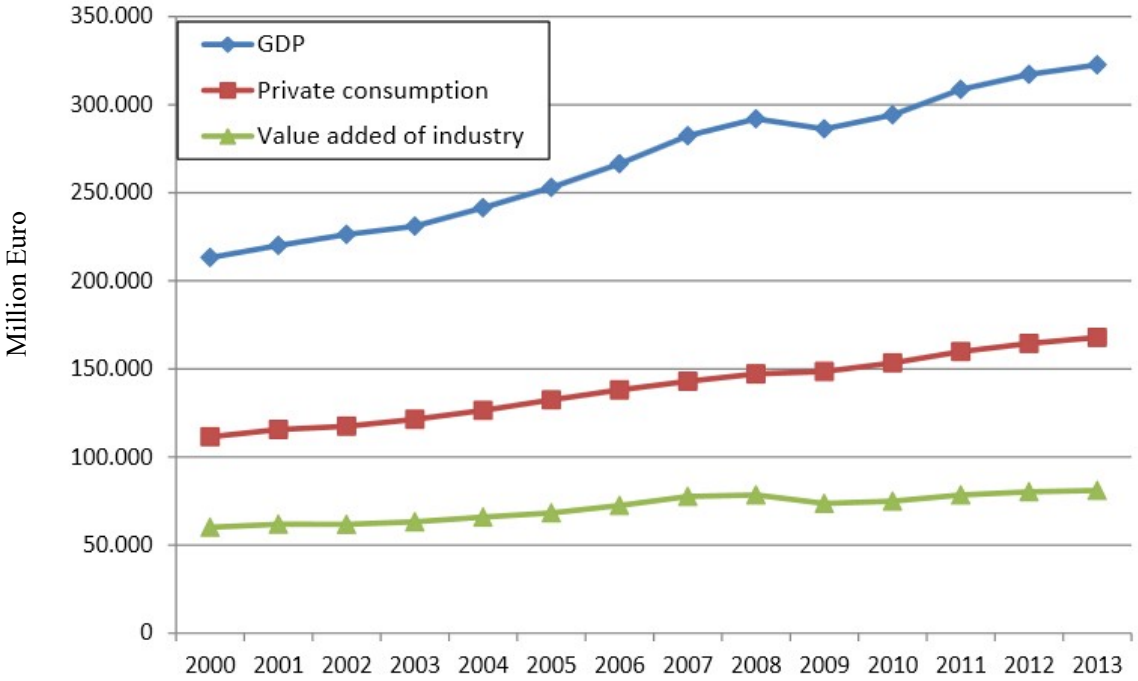
According to (Adensam, et al., 2016, p.116) the determination of the energy savings must be done by third party. For that determination all evidences and documents concerning the energy saving measures and realisation must be kept until 2018 either electronically or as a hard copy. Following requirements must be obtained:

- Evidence and documents must be readable, identifiable and traceable
- Evidence and documents can be receipts, delivery confirmation, counter reading, etc.

9.1.6 Economic Potential

Austrian's GDP is around 325 billion euro in 2013 as shown in Figure 9. The average GDP growth since 2000 is 3.3%. Just in 2009 the GDP was decreasing due to world financial crises beside that there is an increasing trend visible. The value added of industry rise by 2.4% per year in the period 2000-2013. In the same time the private consumption had a growth of 3.2% each year. Even in 2009 it increased by 0.9% (Agency, 2016). As already shown in Figure 5 Austria had decoupled its energy demand from the GPD. This means if Austria is continuing its trend of economic growth Austria will have a huge economical potential.

Figure 9: Development of GDP, private consumption and value added of industry



Source: Agency, 2016

9.2 Czech Republic

Article 7 of EED;2012/27/EU establishes a binding end-use energy savings target by 2020 equivalent to achieving new savings of 1.5% of the annual energy sales to final customers. The calculation of the measures is stated in Table 4 (Trade, 2014)

9.2.1 Efficient measures

The Government of Czech Republic has chosen to implement a set of other policy measures in accordance with Article 7 of EED;2012/27/EU. Among the list of policy measures offered and described by the directives, Czech Republic decides to make use of financial schemes and instrument. In addition to that, training and education including energy advisory programs that leads to the application of energy efficient technology or techniques, which they believe, will have tremendous effect on reducing end-use energy consumption (Odyssee-Mure, 2015).

Table 13: Main Energy efficiency Policy measures and their impacts

Sector	Main objectives and measures	Impacts
Cross-sectoral	Benefits of implementing the recommendations of mandatory energy audits Eco-design Directive for Energy-using Products	Average annual savings 760 TJ in the period 2008 – 2016 Average annual savings 123 TJ in the period 2011 – 2020
Industry	Promotion of energy savings in industry in the Operational Programme Enterprise and Innovation for Competitiveness	Average annual savings 2,286 TJ in the period 2016 – 2020
Buildings	Promotion of energy savings in family houses in the Green Savings Programme Integrated Regional Operational Programme	Average annual savings 2,043 TJ in the period 2014 – 2020 Average annual savings 1,286 TJ in the period 2014 – 2020
Transport	Emission and performance standards for new passenger cars	Average annual savings 764 TJ in the period 2013 – 2020
Public Services	Operational Programme Environment 2014 – 2020 Extension of the role of public sector in demonstrating new technologies	Average annual savings 283 TJ in the period 2014 – 2020 Average annual savings 288 TJ in the period 2007 – 2020

Source: Odyssee-Mure, 2015

The EU directive allows the savings commitment to be reduced by up to 25% of the original target in four ways. The Czech Republic made use of the option provided for in Article 7(2)(a) and (d) of the Directive, i.e. the commitment was calculated using the stated percentages (1% in 2014 and 2015; 1.25% in 2016 and 2017; 1.5% in 2018, 2019 and 2020) as indicated in Table 3 and Table 4. From the Table 4, 6.85 was deducted from that amount which is the energy savings achieved by the Green Savings Programme and the third call under the Eco-Energy Scheme of the Operational Programme Enterprise and Innovation. The Green Savings Programme and the third call of Eco-

Energy Scheme of the Operational were introduced in December 31st 2008. Monitoring, processing and reporting system was put in place under this programme and the results were regularly evaluated. The programme focus on long term savings and promote the installation of heating sources using renewable energy and investments in energy savings when structures are retrofitted or newly built, as well as savings in technology and buildings in the business sector, they are expected to have an impact even beyond 2020 (Trade, 2014).

9.2.2 Payback Period

The public authority or entrusted party establish some measures with a payback period that is longer than 10 years. The payback period for business sector is less than 5 years. The main aim is to support all the measures, which are expensive, compared to other measures and also have a long life time. Shorter payback measures are mostly preferred when applying for subsidy. The amount of energy savings measures is calculated by comparing energy needs in the current situation and after the implementation of energy savings measures. Owing to the longer payback period, a state support should be taken into account if not, the measure is not implemented (Trade, 2013).
The amount of the grant for energy saving will be set on the basis of experience gained from previous programs. In general, it should be at a level reducing the payback period to duration generally acceptable in a given sector.

9.2.3 Determinants of Energy Savings

The amount of energy savings can be determined by comparing the energy performance of the best available technologies with

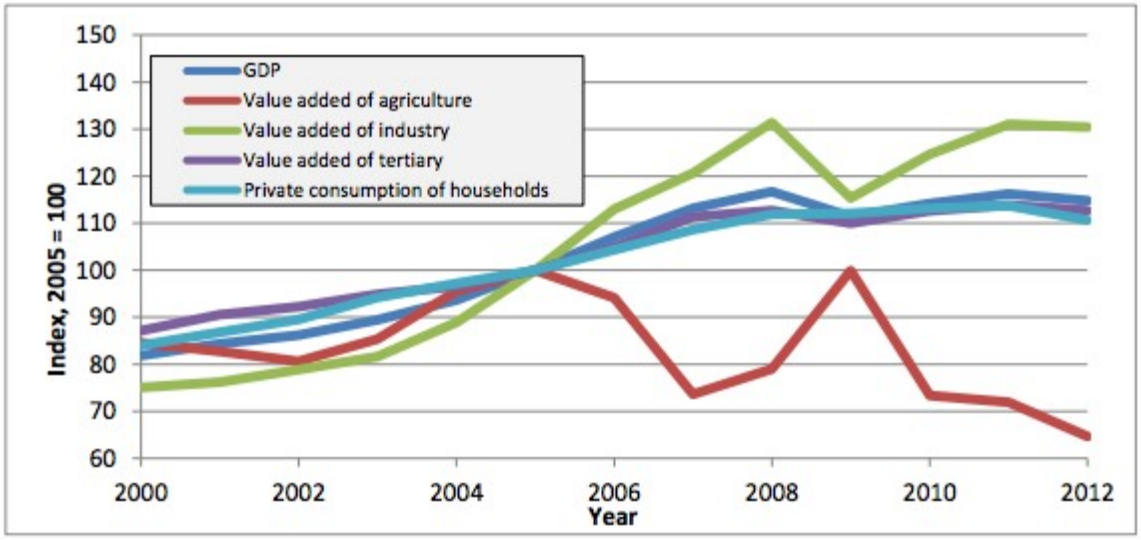
- Commercially available data today. That is, the technology of energy performance that would otherwise have been acquired.
- The technology of energy performance, which is being replaced or currently used most widely. The parameters, which are commonly available 10-20 years ago.

Transparency is used in calculating the amount of energy with specification of all relevant assumptions and calculation procedure in accordance with the principles in section 6-calculation savings. (Trade, 2013). The greater the amount of energy saved, the higher the intensity of support. In order to apply for support, you should demonstrate your savings by means of an audit certified by and auditor. Depending on the approach, a minimum required savings of about 20% may be set for which it will be possible to apply for financial support. The amount of energy will be determined on the basis of information on currently supported projects and market sensitivity. If the applicants manage to achieve a higher level of energy savings, he/she will get a bonus.

9.2.4 Economic Potential

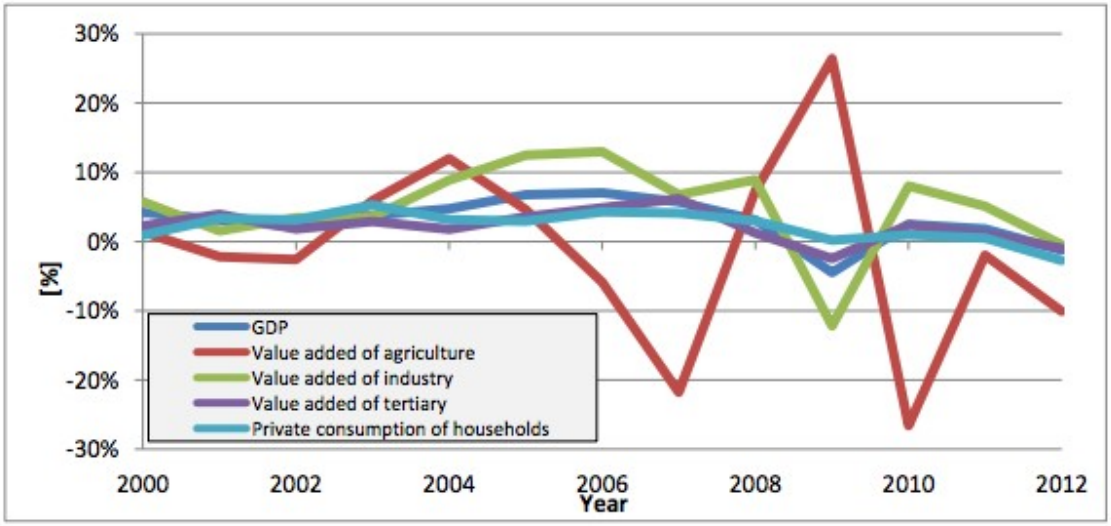
The amount of savings will be calculated by comparing energy needs in the current situation and the situation after the implementation of energy-saving measures. In view of the longer payback period, a scenario where such a measure is implemented without state support is not taken into account.
The amount of the grant will be set on the basis of experience gained from previous programs. In general, it should be at a level reducing the payback period to duration generally acceptable in a given sector (e.g. under 10 years for households, under 5 years for industry, etc.)

Figure 10: Indices of GDP and value added at constant prices of 2005 in Czech Republic



Source: Odyssee-Mure, 2015

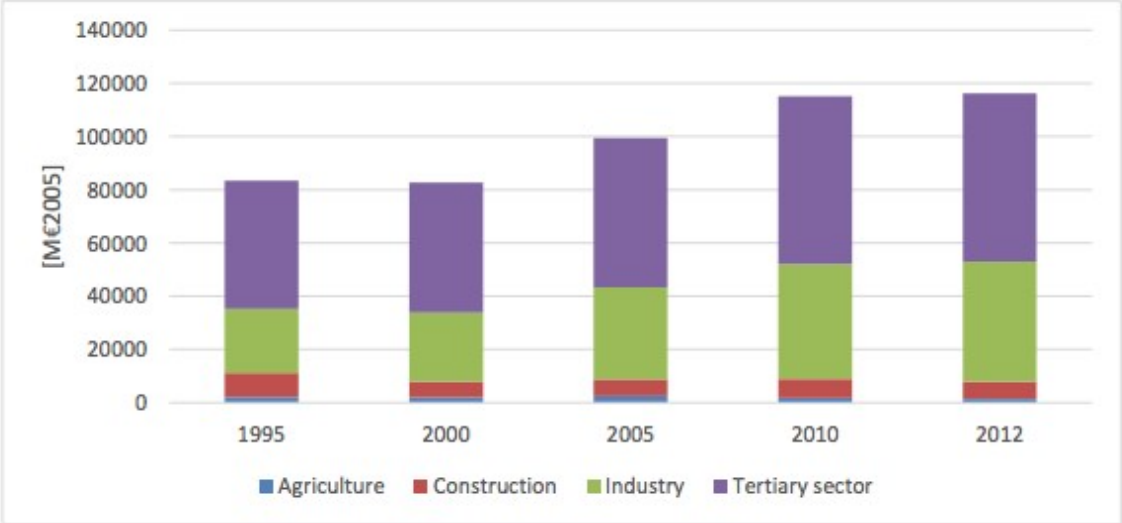
Figure 11: Yearly growth rate of GDP and value added at constant prices of 2005 in Czech Republic



Source: Odyssee-Mure, 2015

From 2000-2008, the economy of Czech Republic has been characterised by a high economy growth reaching even more than 6% yearly. The economic recession of Czech Republic after the year 2008 was one from the longest and deepest in the whole of EU and in 2014, the countries economic grow. The development of economic activity in 2015 is quite promising. (Odyssee-Mure, 2015)

Figure 12: Developement of value added by sector in Czech Republic



Source: Odyssee-Mure, 2015

Figure 13: Structureof value added by sectors in Czech Republic

Source: Odyssee-Mure, 2015

The industry as shown in the graph (Figure 13), the industry has a high share on GDP formation in Czech Republic which is about 40% and its share is increasing. The industry is the dominant driver of national economy in Czech Republic. (Odyssee-Mure, 2015)

10 HOW TO REACH THE TARGET IN COST EFFICIENT WAY

This section explains how the targets are reached in a cost efficient way in the three sectors household, industries and transportation.

10.1 Austria

Following the budgets for Austrian's measures are quoted and the consumptions by sector are listed.

10.1.1 Refurbishment

In 2013 Austria has budgeted 123 million of euro for thermal insulation and the shift to an environmental friendly in the private as well as in the industrial sector. Private persons can make use of a non-repayable grant over 9,300 euro if their houses are older than 20 years. Vor partly refurbishments a grant over 4,300 euro can be utilised. Industrial can also make us of a non-repayable grant over 35% of eligible costs (BMWFJ, 2016).

10.1.2 Climate and Energy Fund

The main aim of the fund is to support research and development in the field of renewable energy technologies and climate research. In 2013 Austria spent approx. 124 million euro for this fund (BKA, 2016, p. 13).

10.1.3 Federal Environment Fund

Due to the federal environment fund GHG emission reduction measures (including renewable energy or energy efficiency) are supported. For the industrial sector a total of 80 million euro and for the private sector approx. 780 million euro are budgeted respectively. Renewable energies in the industrial sector is supported by 39 million euro annually. The leveraged renewable energy investments in the private sector were 251 million euro. The fund also supports energy efficiency projects in the industrial sector by 29 million euro annually (BKA, 2016, p.13-15).

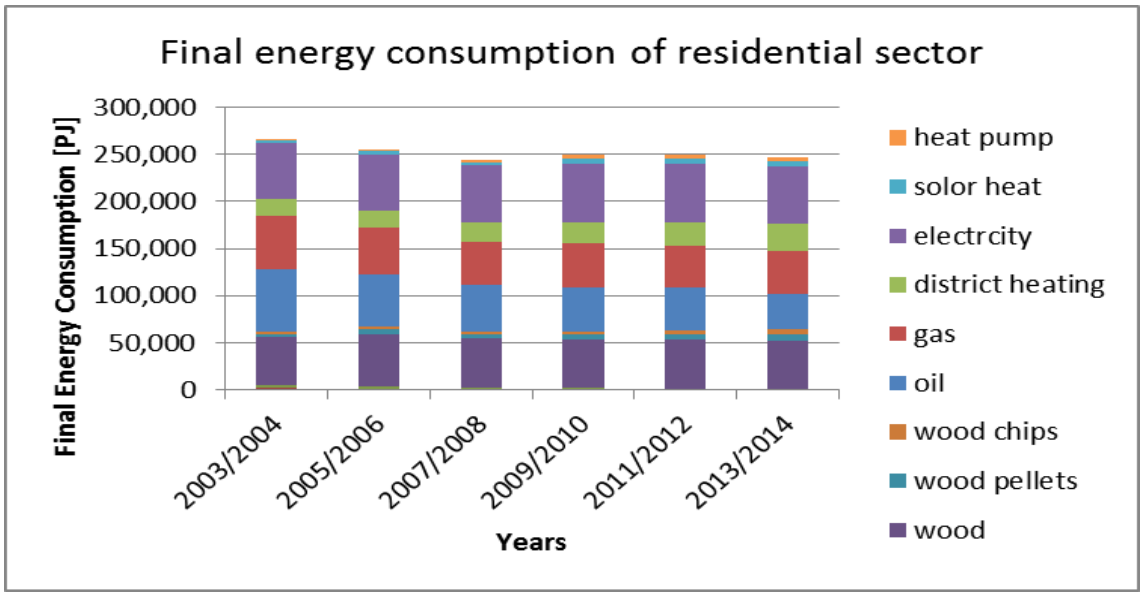
10.1.4 Biofuel target

According to (BMLFUW, 2016) in 2014 87,763.60 tons of bioethanol were put on the marekt as well it is stated that for each liter bioethanol added to the fossil fuel a tax refund of 0.442 euro is paid. 1000 l ethanol is equal to 790 kg (Bundesverband der deutschen Bioethanolwirtschaft e.V., 2016). This means that 87,783.60 tons are equal to 111 million liter bioethanol. Multiplied by the tax refund tax losses of 49 million euro are created.

10.1.5 Households

As shown in Figure the final energy consumption of residential sector drop by 7.2% between the years 2003/2004 and 2013/2014. Between the years 2005/2006 and 2011/2012 it dropped by 2.4%. In the years 2009/2010 and 2011/2012 the consumption increased again, however over the whole interval there is a decrease on the final energy consumption of residential sector.

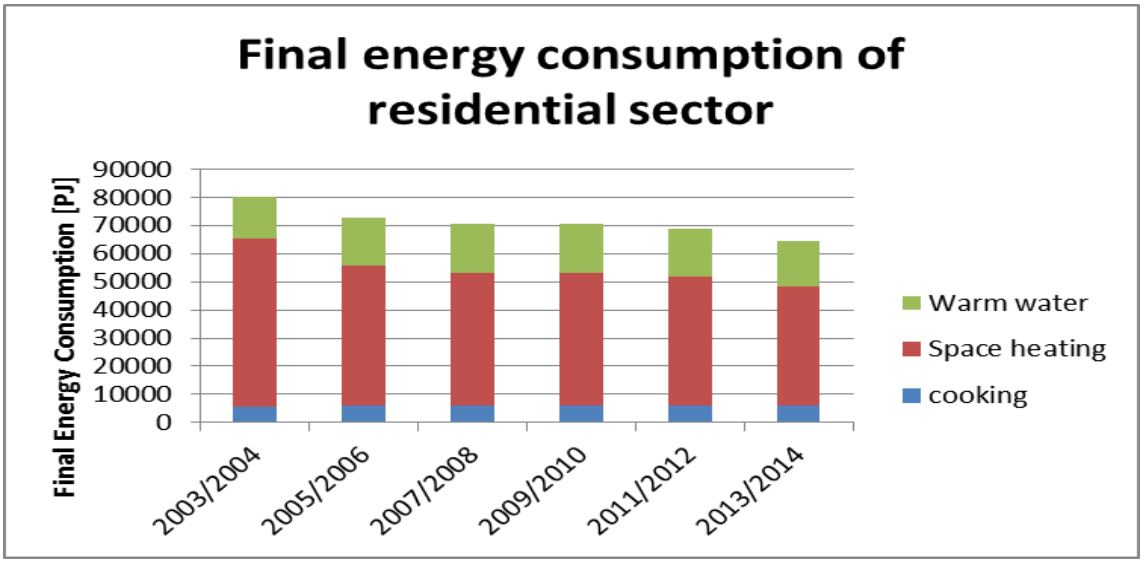
Figure 14: Final energy consumption of residential sector by energy carriers in Austria



Source: Statistik Austria 2016

Figure 15 shows that there was a stable consumption in warm water and cooking, however the consumption for space heating was decreasing in from 2003/2004 to 2013/2014. This reduction is caused by better insulted houses and more efficient heating systems.

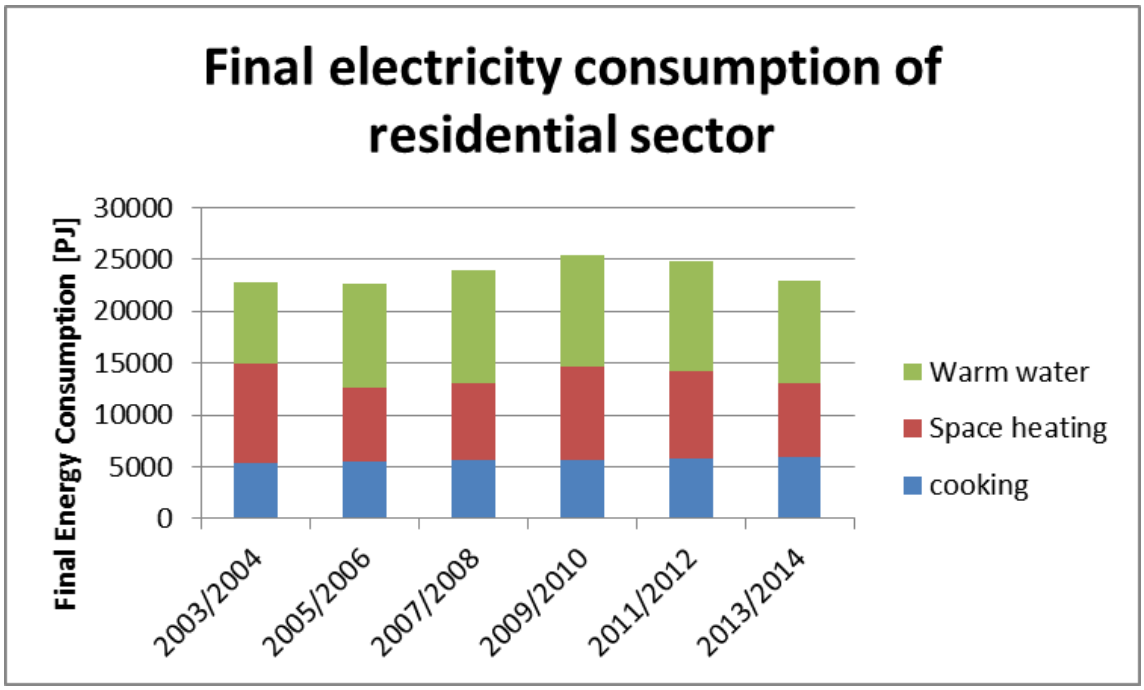
Figure 15: Final energy consumption of residential sector by energy use in Austria



Source: Statistik Austria 2016

In Figure 16 the electricity consumption of residential sector is shown. Compared with Figure 15 it can be assumed that most of the households in Austria are using electricity for cooking. Around half of Austrians households are using electricity for heating but just one sixth are heating their homes by the use of electricity. Over the whole interval the electricity consumption is fluctuating which is mainly caused by the warm water and space heating consumption.

Figure 16: Final electricity of residential sector in Austria

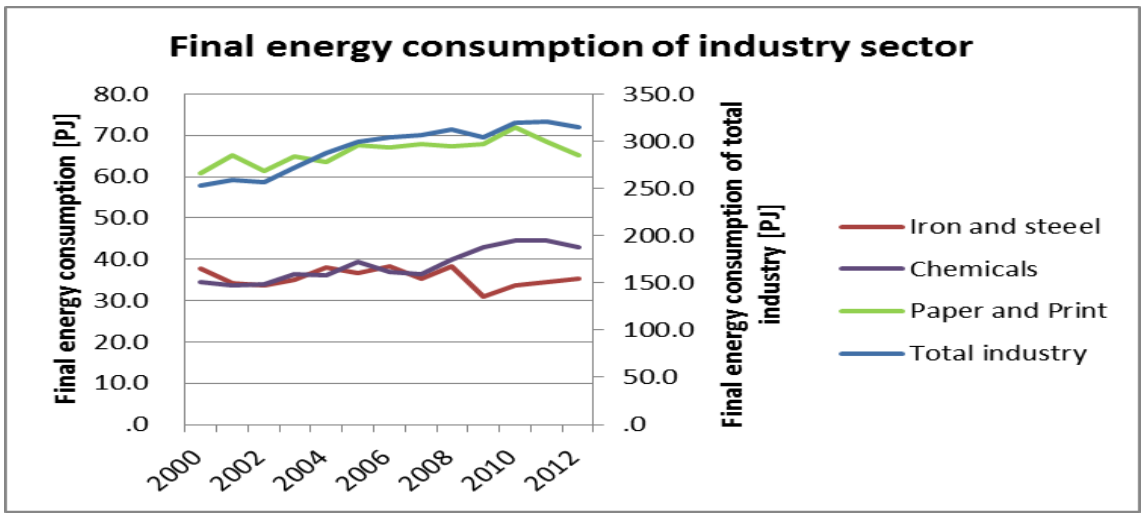


Source: Statistik Austria 2016

10.1.6 Industries

The final energy consumption of industry sector is rising in the interval of 2000 to 2010. From 2010 it is decreasing. This decrease is due to efficient measures. One can see the impact of the finical crisis in 2008 especially in iron and steel industry as well as in total industry. As shown in Figure 17 the final energy consumption of just iron and steel were decreasing over the whole interval by 6.2%. The final energy consumption of chemicals, paper and print and total industry were rising by 24.6%, 7.0% and 24.4% respectively.

Figure 17: Final energy consumption of industry sector in Austria



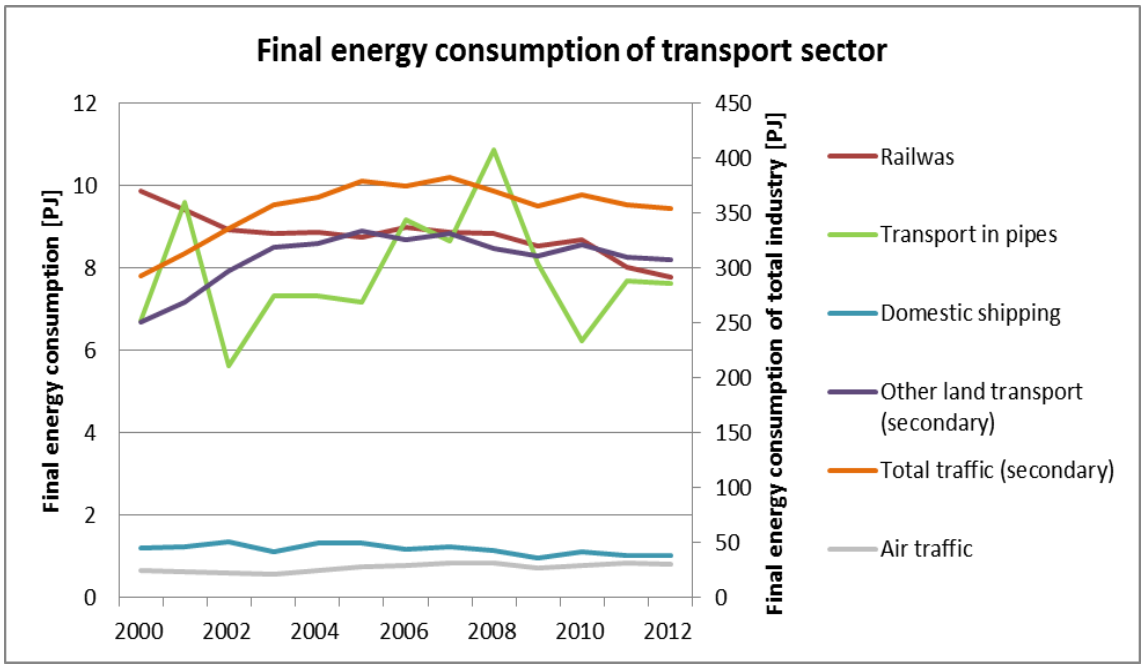
Source: Austria, 2016

10.1.7 Transportation

As Figure 18 shows the total traffic reached its peak in 2007 and from then on it decreased. The total interval of energy consumption in transport sector raised is by 20.9%. It can be seen that the

total traffic is following other land transport just with an offset. Air traffic and domestic shipping plan a minor role in the transport.

Figure 18: Final energy consumption of transport sector in Austria



Source: Austria, 2016

10.2 Czech Republic

10.2.1 Households

The variation of energy consumption in Households changes under the influence of (Odyssee, 2015)

- Climate difference between low temperature and high temperature
- Number of occupant in the household. i.e. more occupants more energy consumption
- Number of electrical appliances used and also the size of the household for central heating.

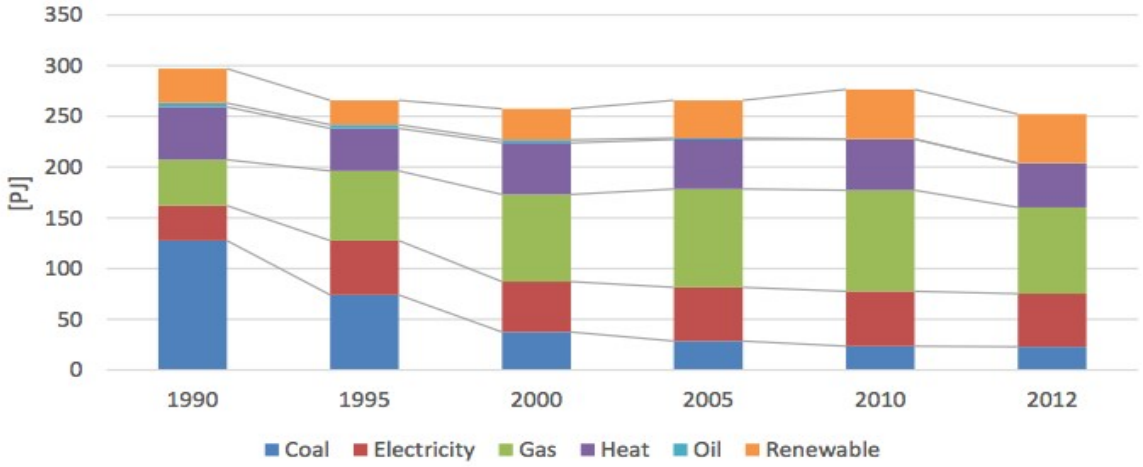
All these variations may or may not be predicted and cannot be controlled. Energy saving in household should be initiated at the beginning of the chain i.e. from the encompassing designer, energy specialist, construction companies, subcontractors, the client's structural and technical supervisors should all emphasize on quality of the work (Trade, 2014). A research by personal consulting shows that, 60 percent of energy can be saved in residential building. (Network, 2015) The most efficient ways to save energy in household is providing a better insulation for dwellings during construction. A study from State Housing Fund shows that 45 percent of panel dwellings don't have retrofitted at all and 20 percent of dwellings had been partially retrofitted. It also demonstrated that, the cost of completing the retrofitting process is about 23 billion Euros. That is by renovating the leaks in the roofs and facades, replacing windows and pipes, new elevators of non-panel residential housing (Nico Nieboer, 2012).

Between 2000 and 2012, the energy efficiency index of households in Czech Republic shows a drop of 23.2%. The decrease in energy consumption within 2000-2012 is higher than EU-28 average of 18.7%. This decline in energy consumption is as a result from improving building status, better energy saving appliances and as a result of high-energy prices (Odyssee, 2015).

Due to the high cost of using full energy potentials during construction, the Government of Czech Republic initiates several programs to subsidise energy efficiency. One of the most important programs is the new green saving program 2014-2020 which can support measures on houses, where subsidies from structural funds are not allowed (Council, 2015). The program focuses on

direct subsidising of both deep and partial thermal renovation and highly efficient and renewable energy source installation in existing single-family and multi-apartment buildings. New energy performance houses using a high share of renewable source are supported Seminars and education are given by the ministry of environment focused on energy saving and renewables source of energy in the houses to all those interested in energy conservation, insulation or changing the type of heating in their houses. The aim of the program is to improve the environment by reducing greenhouse emissions through energy efficiency in buildings, and supports residential development with low energy performance and finally the efficient use of energy (Council, 2015). Almost one 1 billion Euro was issued between 2009-2013 for support of energy saving and almost 80 million Euros was issued in 2014. A budget of 80 million euros was made for household and companies in 2015.

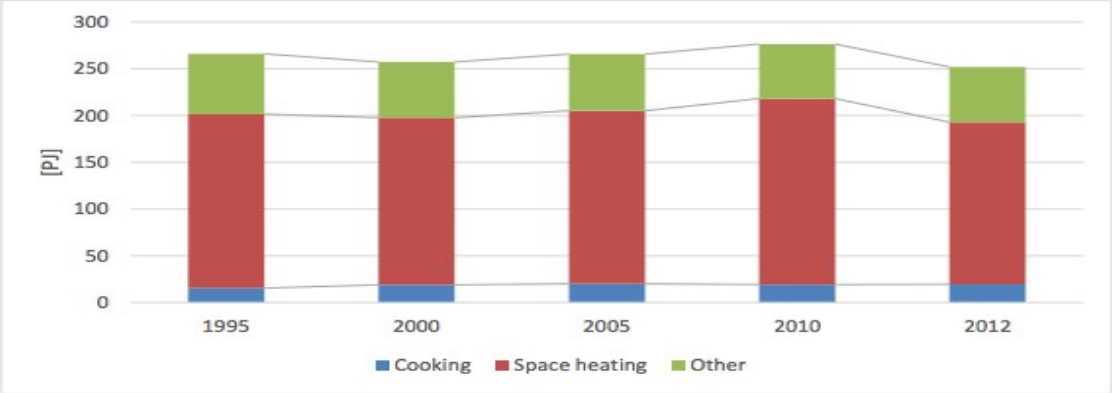
Figure 19: Final energy consumption of residential sector by energy carriers in Czech Republic



Source: Odyssee, 2015

The structure of energy carriers used in residential sector is changing as shown in Fig 15. Coal consumption decreases and it remains almost constant after 2010. The stagnation is caused by presence of locations, where individual coal boilers are still the most affordable heating technology. The usage of Gas replaces coal and its share in final consumption of residential sector increased. However, its use is limited due to the high price of Gas and there are quite a lot of places without connection to the transmission pipelines. The electricity consumption in household does not change as a result of the expensive price of electricity. Heat use in household decreases as a result of good insulation used in collective houses. Mostly, the household fed from Gas-based CHPs experience increasing heat prices and tend to disconnect from district heating and switch to local boilers. The use of wood in family housing rises

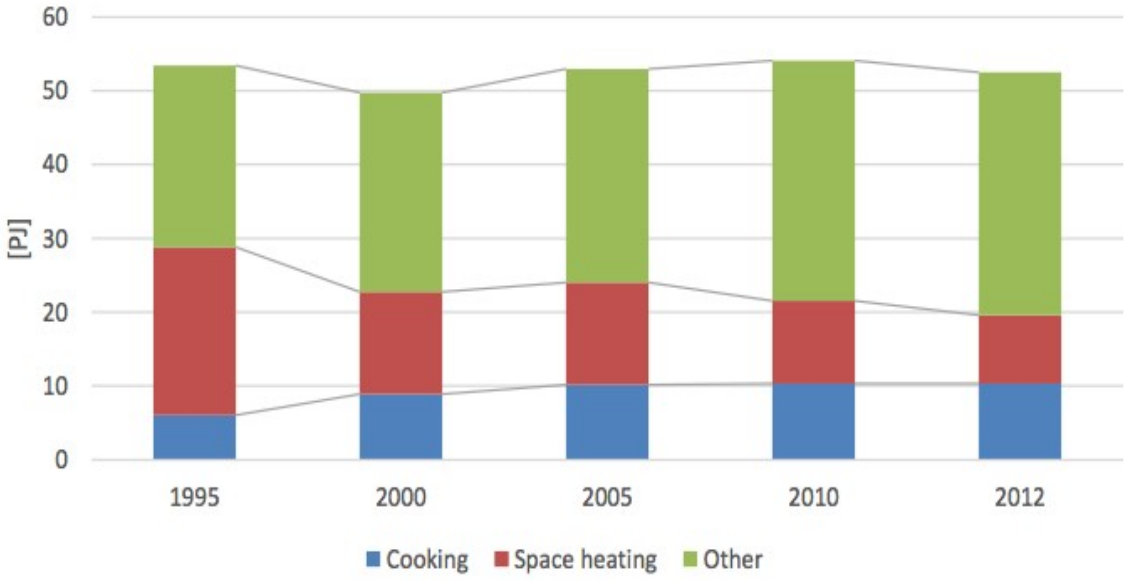
Figure 20: Final energy consumption of residential sector by energy use in Czech Republic



Source: Odyssee, 2015

Structure of energy consumption by type of use did not change in the period 2000-2012

Figure 21: Final electricity consumption of residential sector by electricity use in Czech Republic



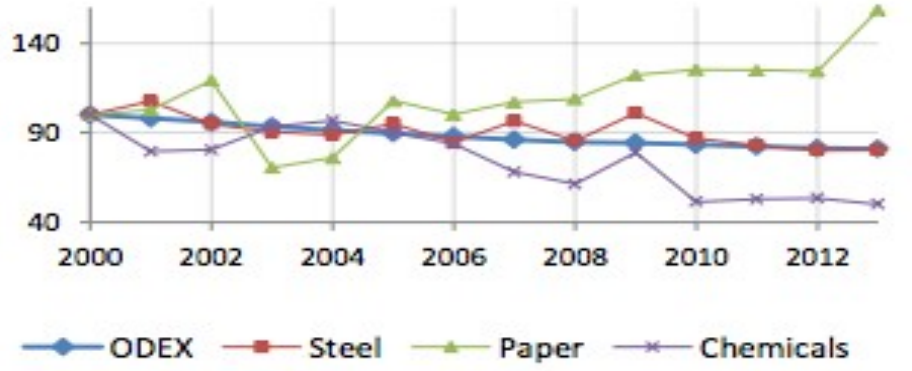
Source: Odyssee, 2015

The usage of electricity is changing as show in Figure 17. The use of space heating is decreasing as a consequence of high electricity prices. The use of electricity for cooking increased and from 2005 became stable. Consumption of appliances growths – rising number of appliances overshadows the energy efficiency improvement of electric appliances.

10.2.2 Industries

The energy efficiency index of Industry shows an improvement of 19.1% between the period of 2000 and 2012. Mainly, real technical energy savings and high impacts of activity and value of products urge the improvement of energy efficiency. These two factors of improvement almost compensate each other. The energy intensity of manufacturing industry was 2.3 percent higher than the EU28 average structure. Operational programme Enterprise and Innovation for competitiveness are the main instrument used to promote energy efficiency in industries.

Figure 22: Main Energy Efficiency Indicators in Industry in Czech Republic (100=2000)



Source: Odyssee-Mure, 2015

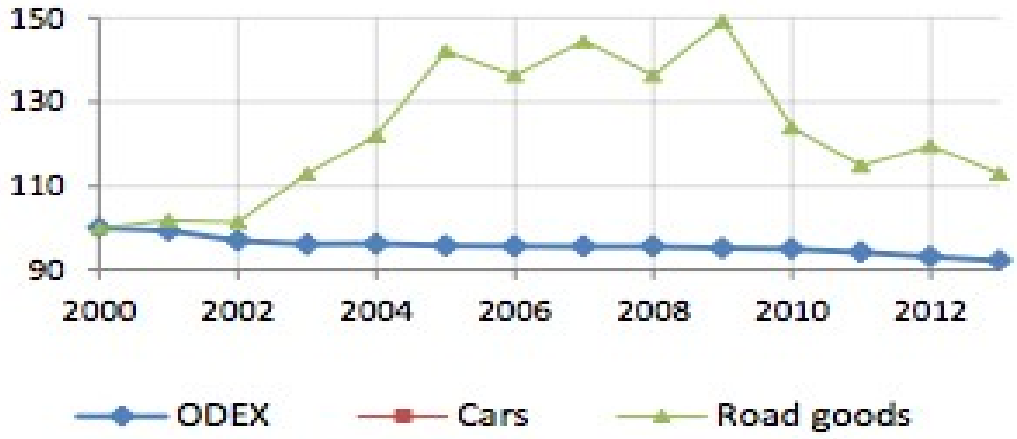
10.2.3 Transportation

The variation of energy consumption in transport changes under the influence of

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

The energy efficiency index of transport sector in Czech Republic improves by 6.8 percent in 2012 as compared to year 2000. It decreases slowly within 2000-2012 only by 7.8%. The improvement of EU28 reached 13% at the same period. The improved rate of energy efficiency is influence by increase of road transport instead of public transport modes and also lower capacity utilisation in road transport. Importation of old used cars from the Western Europe plays a negative role as well (Odyssee-Mure, 2015). There is no special programme designed to promote energy efficiency in transport sector. However, the required energy savings will be reached by reduction in CO2 emission and also by energy intensity of passenger vehicles placed on the market and the operational program transport (primarily oriented at improvement of transport infrastructure.) The transport policy set a goal where the share stock of road transport that is not driven by petroleum products should increase from 0.03% in 2011 to 3% in 2020. Also the share of petrol, diesel and kerosene in total energy consumption in transport sector should reduce from 93% in 2011 to 85% in 2020. Moreover the total volume of freight transport carried by rail and water for shipments of more than 300 km should increase from 41% in 2011 to 50% in 2020 (Trade, 2014).

Figure 23: Main energy Efficiency Indicators in transport in Czech Republic (100=2000)



Source: Odyssee-Mure, 2015

11 CONCLUSION

The EU targets for 2020 and 2030 are to reduce the final energy consumption by 20% in the year 2020 and by at least 27% in 2030 as mentioned in chapter 6. The alternative and the obligatory scheme are the two main energy efficiency scheme implemented by the EU commission as quoted in chapter 7. Czech Republic uses to use the alternative scheme and Austria makes use of both the alternative and the obligatory scheme. As the state of the art (chapter 8) of both countries shows is the final energy consumption of Czech Republic (1,000 PJ) by 100 PJ lower than in Austria (1,100 PJ). The final energy saving target for 2020 is for Czech Republic 191 PJ and for Austria 200 PJ respectively. For the implementation of efficient energy saving measures (chapter 9) Czech Republic implements a set of policy measures in accordance to Article 7 of EED;2012/27/EU which can be seen in Table 13. In Austria the bottom-up method is used as described in chapter 9.1. Chapter 10 describes how the above mentioned targets are reached in a cost efficient way in both countries.

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