



ECONOMICS OF E-MOBILITY: COSTS, FUELS AND ELECTRICITY PRICES, TAXES AND LEGISLATION

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1. Introduction

Today one of the important topic in the world is how to optimize fuel consumption and also prevent greenhouse gas emissions. Because of the irreparable damages, the governments decided to find a solution. Under the Kyoto Protocol, the European Union (EU) committed to reduce greenhouse gas (GHG) emissions by 8% between the 2008 to 2012 period, compared to the 1990 level. In March 2007 the EU committed itself to a 20-30% reduction of GHG emissions overall by 2020.

Electric Vehicles can help increase energy Security, improve fuel economy, Lower fuel costs and reduce CO2 emissions and reduce oil dependence cost and increase Energy Sustainability and noise pollution coming from transport, thus the topic e-mobility is increasingly present in media and public in the World.

Nowadays, it is supposed that electric vehicles (EVs) can perform an important role in a shift to more sustainable mobility. But we can also find many opinions that E-mobility perpetuates a car-dominated society with inadequate environmental benefits. With using both points of view we can summarize that the E-mobility could contribute to sustainable mobility, but its impact depends on market developing. (BMVIT, 2010)

There are obviously some benefits connected with EVs but also some risks. For the economic point of view, the main risk are low running cost which can lead to rebound effects, because the money you save by using the EVs you can spend for anything else what may destroy the environment.

This paper will analyze the situation of electric vehicles in Austria and Czech Republic, with an emphasis on a sales, prices, benefits and costs. There will be an comparison of these two states which both have different ways of "environmental behavior". Some conclusions and possible advices will occur because of this comparison.

The main aim of this Seminar Paper is to find out if the political background and support may have the significant impact on EVs sales.

2. Abstract

This seminar paper focuses on very actual and discussed topic of E-Mobility and compares the situation in Austria and Czech Republic. It tries to answer the question if the political (especially financial) support could lead to an increase of EVs usage. Based on important variables like electricity prices versus fuel prices and taxes, there is a comparison of EVs sales in Austria and Czech Republic, where you can find a significant difference (Austria has approx. 10 times more EVs). Because of the finding that there is a strong support of alternative types of cars in Austria, and none of those in CZ, it can be said that political support could strongly influence the decisions of consumers to prefer EVs than conventional cars and through that it can help to protect the environment.

3. Paper

3.1. MOTIVATION

E-Mobility is one of the discussed topics in the field of energy and transport. Electric vehicles can increase the energy security, improve fuel economy, lower fuel costs and reduce emissions and oil dependence cost and increase energy sustainability. That is the reason why the E-mobility topic is increasingly presented in media and public for all over the world. The electricity is supposed to be an effective and ecological energy source, and there is still lot of opportunities for its utilization in the transport. E-mobility is in generous considered to be an alternative to fossil fuels in transportation.

The European Union occupies approx. quarter of global sales of electric vehicles. The largest national market is represented by the USA and Japan. We can see the wide variation in sales between European countries, because Norway and the Netherlands achieve over 5 % sales, compared to less than 1 % in other states. (Transport and Environment, 2013)

We can say that the EVs situation is much more advanced in Austria than Czech Republic. This seminar paper will also focus on finding some possible correlation between political framework, legislation and financial support for EVs and its sales.

3.2. PROBLEM STATEMENT

This thesis will focus on finding and describing the significant differences between the situation in the field of E-Mobility in Czech Republic and Austria. As it was mentioned above, the situation in Austria is supposed to be considered much more advanced than in Czech Republic. Seminar paper presents basic variables which are connected with the E-Mobility topic, such as costs, fuels and electricity prices, taxes and political and legislative framework and that there will be a comparison of both presented results. Based on these gained comparisons we can find a possible correlation between political (financial) or

legislative support and EVs sales. If there is a significant relationship we can assume that the government support can have the important impact on sales and it is a good way how to motivate people to protect the environment. But this can have more solutions except the political framework, people in Austria can be more "environmentally educated", there could be also strongly different "environmental behavior" than in Czech Republic.

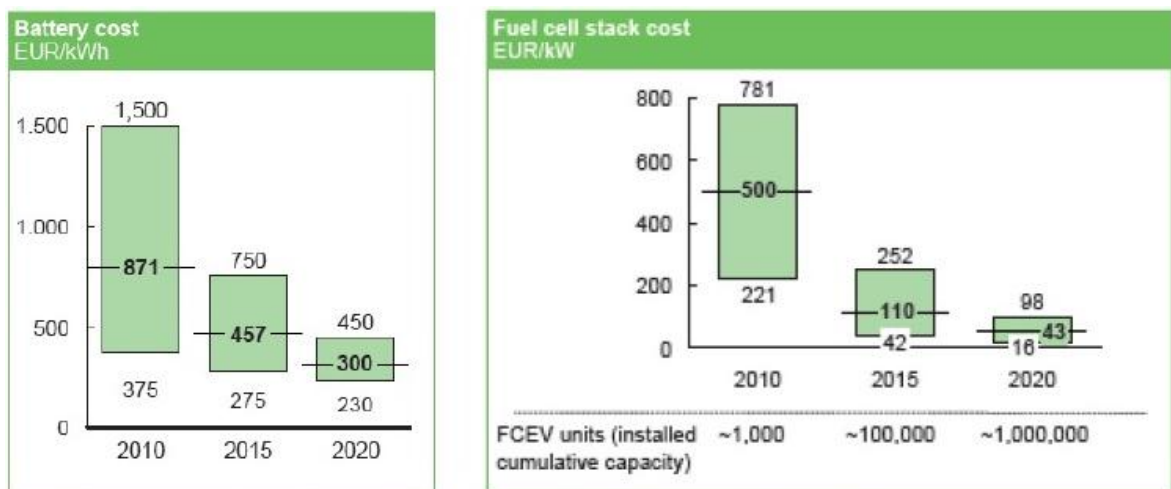
3.3. APPROACH

For filling the main goals of this seminar paper, there will be an analysis of a current situation in the field of E-Mobility in both states. Variables which are going to be discussed are as follows: costs, electricity and fuel prices, taxes and legislation. Then there will be a comparison based on the gained information. It's necessary to say that there are more types of transport which uses the electric power than personal cars (e.g. electrobicycles), but this seminar paper will focus especially on cars for personal usage.

3.3.1 INVESTMENT COSTS

Battery is the most effective component in the analysis of the EVs investment costs. We evaluated the results of data analysis performed by Mckinsey & Company. Here are some remarks on the development costs, According to Figure 1 the battery costs are expected to decrease gradually. e.g. the average battery costs in year 2010 was 871 EUR/kWh and is predicted to be 300 EUR/kWh in 2020. The same decrease pattern is also valid for fuel cell stack cost. This is probably the main reason why there are just a few electric vehicles in the Czech Republic, EVs are more expensive than fuel cars and people prefer lower investment costs in the beginning of the process than low costs during using the car. But it is said that there are for example batteries with a lifetime of 2000 cycles. If we count with a 250 km for one charging, we can assume the battery lifetime last for 500 000 km. (www.elektromobil.vseznamu.cz, 2010)

Fig. 1: Development of Battery costs for batteries and fuel cell stacks



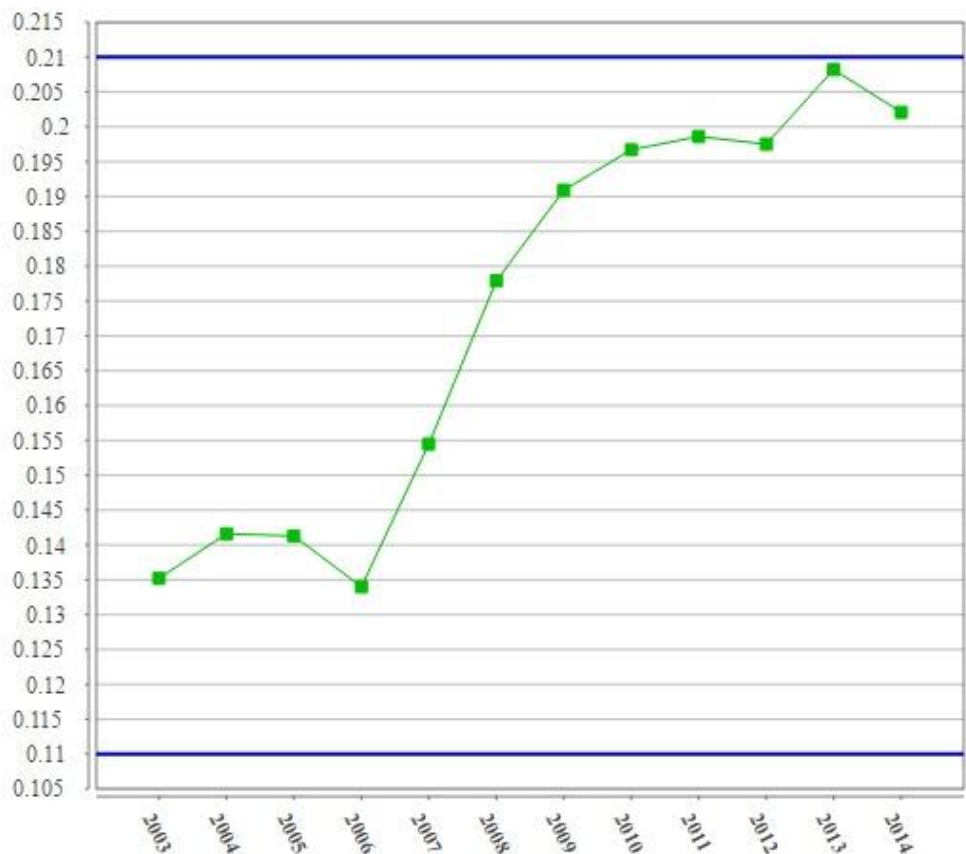
Data Source: Mckinsey & Company, 2011

It's necessary to mention the fact that there are many advantages by using EVs in comparison to fuel cars. One of them is for example the engine of the car. EVs are supposed to have engine with less components and that is the reason why it is said to be easier and there is lower probability of engine failure. The second advantage is that it's not necessary to change oil, coolant and filter. There is no transmission in new EVs and problems which can be connected with it. And the last but not least, the motor is not exposed to high pressures and temperatures, that means higher durability of the electric motor the classical combustion engine. (www.elektromobil.vseznamu.cz, 2010)

3.4. ELECTRICITY PRICES

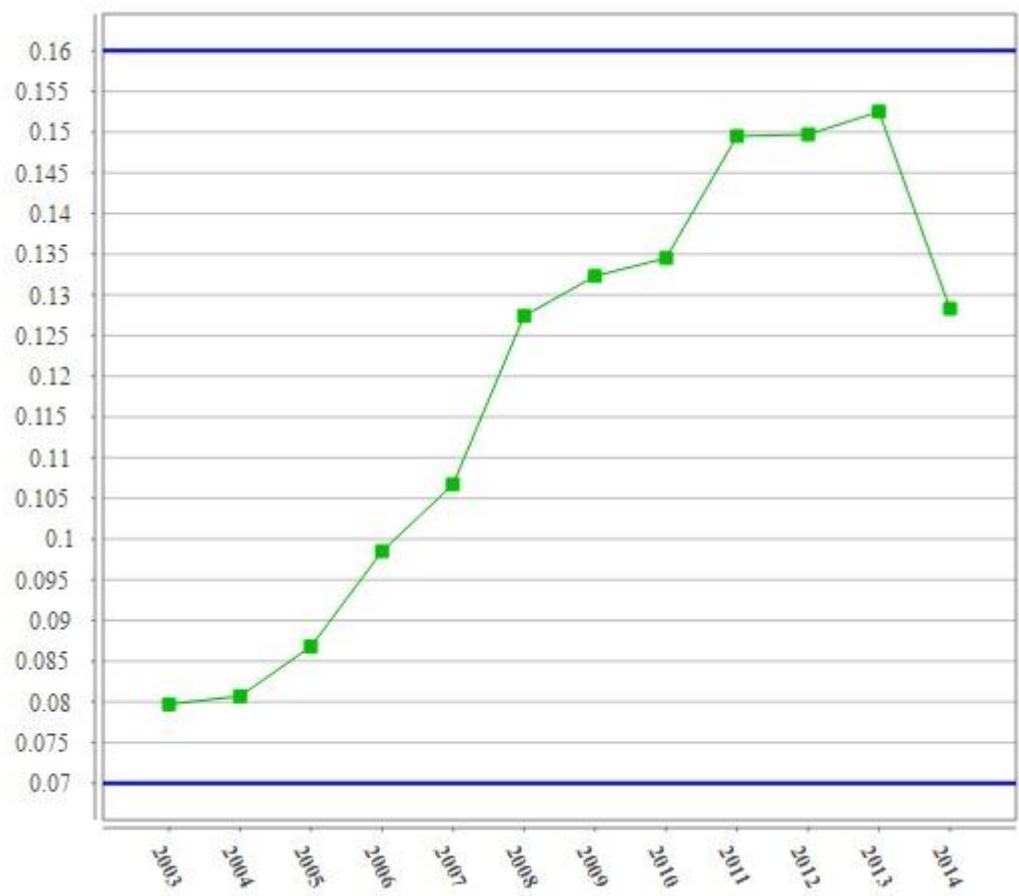
Electricity customers experienced the largest price increases, beyond taxes, fees, and other charges, there are two main components of electricity bills: the generation component, which reflects the costs of generating the electricity, and the delivery portion, which reflects the costs of transmitting and distributing that electricity. As it can be seen from two graphs above, the electricity prices in EUR per kWh are higher in Austria. There is a significant difference for every of these years, for example in 2014 the Austria counted the prices around 0,2 EUR per kWh, but the Czech Republic "just" 0,13. This could probably lead to higher usage of electricity (and also EVs of course) in Czech Republic because there is also a significant skip between 2013 and 2014 (0,155 to 0,13), but in fact, it didn't.

Fig. 2: Electricity prices in Austria (EUR per kWh) during 2003 - 2014



Data source: Eurostat, 2015

Fig. 3: Electricity prices in Czech Republic (EUR per kWh) during 2003 - 2014

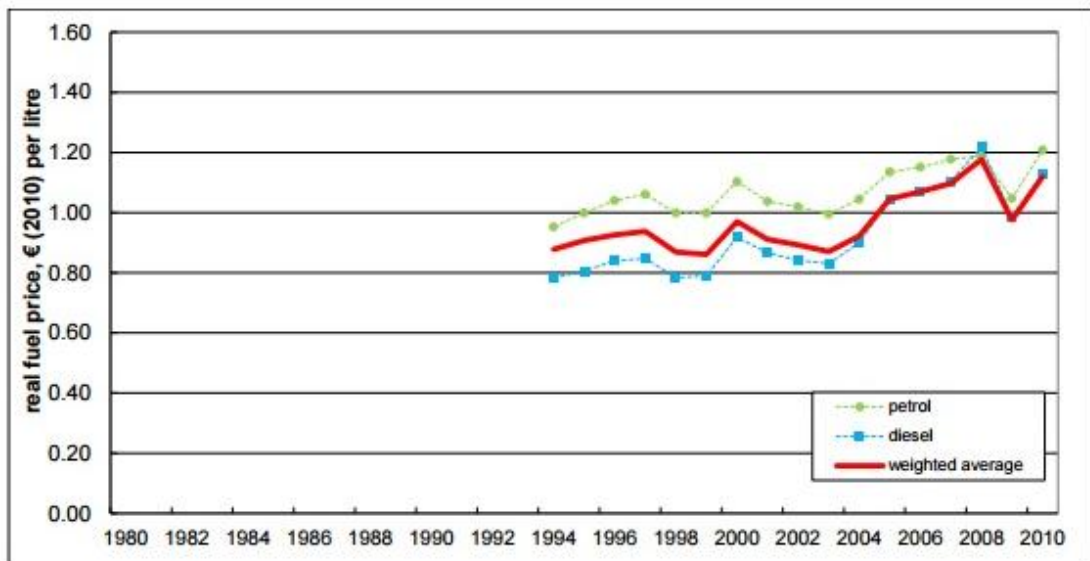


Data source: Eurostat, 2015

3.5. FUEL PRICES

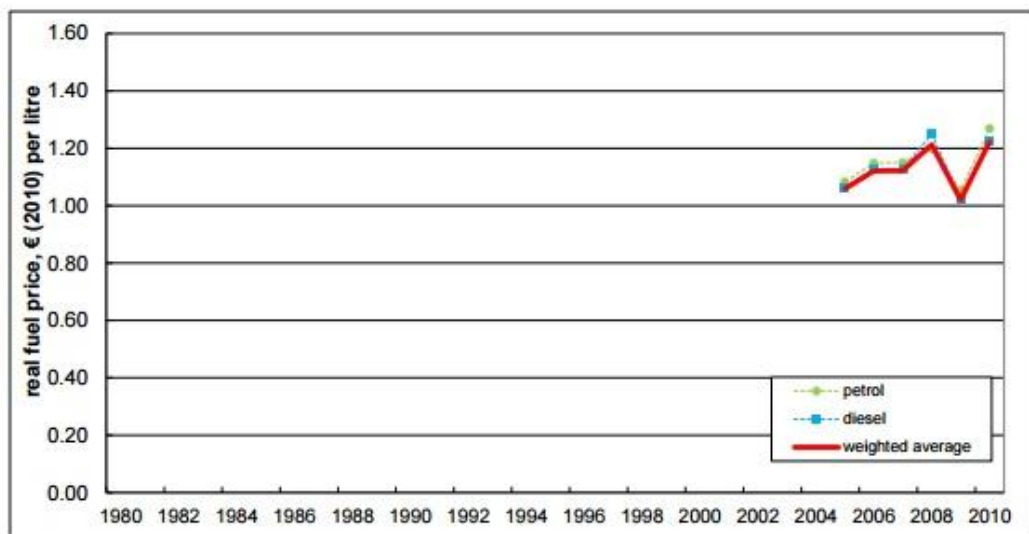
It has been a continuous increase in the price of vehicle fuels according to the diagram (Fig. 4) in the time frame 1994-2010 in Austria due to the increase of fossil fuel prices and significant increase in fuel taxes. We can see from the comparison of both of graphs that there are very similar prices in Austria and Czech Republic (Fig. 5), that is the second reason for us to think that there could be more EVs sales in CZ in case of cheaper electricity and expensive fuel prices.

Fig. 4: Fuel prices of petrol and diesel in Austria during 1994 - 2010



Source: www.transportenvironment.org, 2013

Fig. 5: Fuel prices of petrol and diesel in Czech Republic during 2004 - 2010 (after entering EU)



Source: www.transportenvironment.org, 2013

3.6. COMPARISON OF THE COSTS OF FUELS AND ELECTRICITY

The average electric vehicle is supposed to consume approximately 12 - 15 kWh per 100 km. If we leave out the purchase price, low costs of operation and maintenance are the reason why lots of people choose this type of car instead of the "standard" one. Because the estimated battery efficiency is supposed to be 80,5 %, for charging we need 14,9 kWh. Electricity prices (used as an example from the PRE Czech company) are as follows: night tariff costs 0.07 EUR, day tariff 0.16 EUR.

Based on these assumptions, the estimated price for 100 km for an average electric vehicle is supposed to be:

Night tariff: $14.9 * 0.07 = 1.043$ EUR/per 100 km

Day tariff: $14.9 * 0.16 = 2.384$ EUR/per 100 km

This calculation depends on the type of battery because the efficiency may change.

For the classic type of car the estimated average consumption of fuel is 8 liters per 100 km. If we count with current price of gasoline in Czech Republic, we use 32 CZK/liter (1.16 EUR/liter). Then the amount for driving 100 km is:

$8 * 32 = 256$ CZK

$8 * 1.16 = 9.28$ EUR

If we want to compare the electric vehicles costs with a diesel car, we assume that it consume 5 liters per 100 km. Average price of diesel in Czech republic nowadays is 31 CZK (1.13 EUR), so the calculation will be:

$5 * 31 = 155$ CZK

$5 * 1.13 = 5.65$ EUR

So it is clear from the calculation above that the costs of diesel car are approx. 2.4 times higher than EVs (using the day tariff) and 5.4 times higher in the night tariff. Using the gasoline car as an example for comparison it is obvious that costs of this classic type of car are 3.9 times higher for night day tariff and 8.9 times for the day tariff.

It's necessary to mention the fact that these are just a really basic calculations how to measure the costs of classic and electric cars but it is obvious that the operation costs are lower by using electric vehicle. (www.elektromobil.vseznamu.cz, 2010)

Electricity prices (used as an example from the Wien Energie Company) are as follows: night tariff costs 0.13 EUR, day tariff 0.17 EUR.

Based on these assumptions, the estimated price for 100 km for an average electric vehicle is supposed to be:

Night tariff: $14.9 * 0.13 = 1.937$ EUR/per 100 km

Day tariff: $14.9 * 0.17 = 2.533$ EUR/per 100 km

If we count with current price of gasoline in Austria, we use 1.29 EUR/liter. Then the amount for driving 100 km is:

$8 * 1.29 = 10.3$ EUR

If we compare the EVs costs with a diesel car in Austria, we count with an average price of 1.17 EUR, so the calculation will be:

$$5 * 1.17 = 5.85 \text{ EUR}$$

So it is clear from the calculation above that the costs of diesel car are approx. 2.3 times higher than EVs (using the day tariff) and 3 times higher in the night tariff. Using the gasoline car as an example for comparison it is obvious that costs of this classic type of car are 5.3 times higher for night day tariff and 4 times for the day tariff.

3.7. POLITICAL FRAMEWORK IN AUSTRIA AND CZECH REPUBLIC

Electric mobility in Austria has been steadily gaining in importance over the last few years. Greenhouse gas (GHG) emissions reduction continues as a national priority with specific reduction targets for the transport sector.

In 2010, the Austrian Energy Strategy was adopted to help implement the EU 20-20-20 targets and a target of 250,000 electric vehicles by 2020. In Austria financial incentives and purchase tax credits are offered for new cars with alternative propulsion systems: e.g. Electric vehicles are exempted from the purchase tax and the annual motor vehicle tax, resulting in about 4,000 EUR savings over five years. Fleet owners receive a funding if they change from conventional to electric vehicles. The rates of financial support are staggered according to the type of vehicle introduced, the level of CO₂ reduction achieved and the amount of renewable energy used: Up to 4,000 EUR are granted for purchasing EVs, if powered with renewable energy, otherwise only 2,000 EUR. (Austrian Energy Agency 2013)

There is no such political help for electric vehicles in Czech Republic. There is rather an emphasis on large combustion plants and nowadays also on small combustion plants in households than cars. So nowadays there are no such subsidies and financial support for EVs like in Austria. But the situation may change in the future, because just a few days ago, Czech Ministry of Environment announced the new possible financial help in a new subsidy program for up to 200 000 CZK (approx. 7400 EUR) for buying the electric vehicle, but just for the villages in national parks. There lot of recommendations from the experts how to support the EVs sales. According to their opinion, the help couldn't be financial in the way of subsidies and so on, but for example free or discounted parking in cities, possibility to use fast lanes during rush hours. (Sikyta, 2012)

Table 1.: Fuel taxes in Austria and Czech Republic

Years	Fuel Overall Tax			
	Austria		Czech Republic	
	Petrol (€/Liter)	Diesel (€/Liter)	Petrol (€/Liter)	Diesel (€/Liter)
2004	0.58	0.44	0.46	0.37
2005	0.59	0.5	0.47	0.39
2006	0.6	0.5	0.46	0.38
2007	0.63	0.53	0.48	0.4
2008	0.69	0.59	0.47	0.39
2009	0.66	0.55	0.50	0.41
2010	0.68	0.57	0.51	0.42
2011	0.75	0.66	0.53	0.45
2012	0.77	0.67	0.52	0.44

Source: www.transportenvironment.org, 2013

It can be seen from the previous table that there are no such significant differences in the amount of fuel taxes between Austria and Czech Republic. We can see the gradual increase in both of states. It is obvious from the table that petrol is more taxed in Austria and Czech Republic.

3.8. POLITICAL FRAMEWORK IN EU

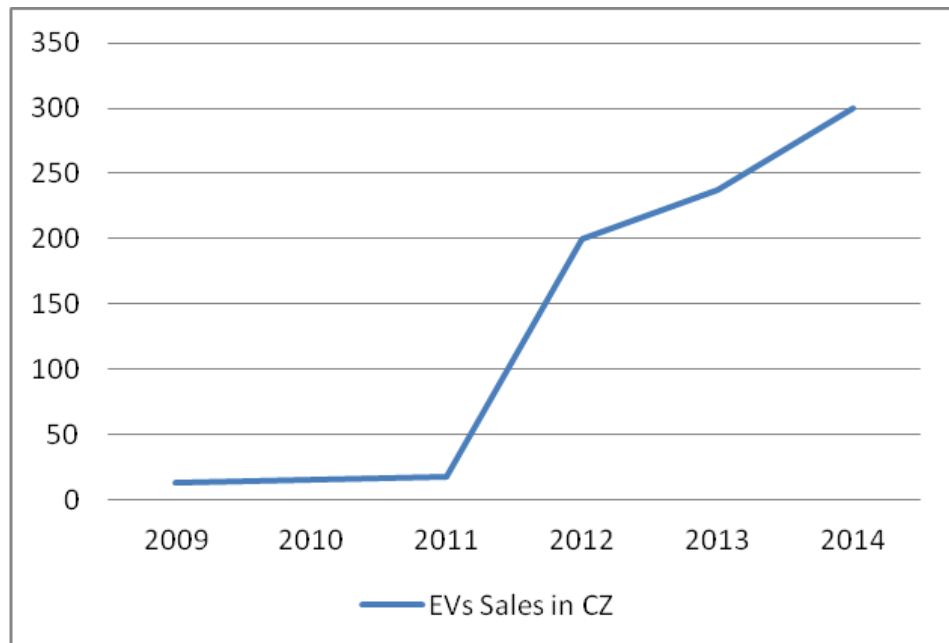
Motor vehicle fuels are taxed with different rates in EU countries basically the fuel tax is an effective regulatory instrument to influence consumers in terms of their choice of vehicle as well as its use. Since fuel cost is a function of vehicle efficiency, fuel price and the distance driven an increasing fuel price as a result of higher fuel taxes would induce consumers to either switch to cars with higher efficiency or to reduce their yearly driving distance.

The EU 20-20-20 targets (binding targets to reduce greenhouse gas emissions and increase the share of renewable energy in gross final energy consumption, a non-binding target on energy efficiency) and to develop internal EU markets for electricity and natural gas. (OECD/IEA, 2014)

3.9. EVs SALES IN CZ AND AU

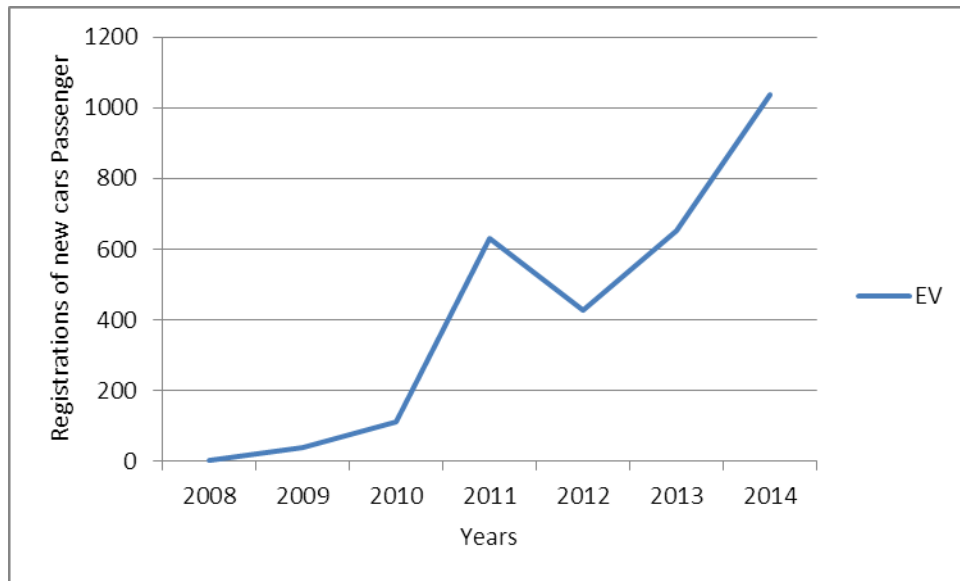
In this section the market of electric vehicle in Austria is considered. According to the Figure 9 at the beginning a small amount of cars sold. There are significant annual increases in demand of these vehicles in Austria. Based on the comparison of EVs sales in CZ (Fig. 8), it's obvious that there is an inconsiderable difference. There are like 3,5 times higher sales in Austria.

Fig. 8: EVs sales in Czech Republic during 2009 - 2014



Data source: Ministry of Transport, 2013

Fig. 9: EVs sales in Austria during 2008 - 2014



Data Source: Own Graphic database on Statistik.at, 2015

4. Conclusions

In general, European countries tend to tax petroleum fuels globally at the highest level. As it can be seen from the diagrams above, there are significant differences in the field of EVs sales in CZ and AT although the electricity is cheaper in Czech Republic. But there is a financial support missing in CZ and that is probably the reason why the EVs industry is called "in its infancy". According to some experts' opinion, there doesn't need to be a financial support for buying the electric vehicle from the government, it could be better to get some another incentives like discounted parking prices in cities, or permit to use the fast lane during rush hours. But nowadays there are none of those incentives taken into account in CZ. There are almost 10 times more electric vehicles in Austria and that is probably connected with the state financial support. But as it was mentioned in the beginning of this seminar paper, this fact could be also caused by strongly different ecological behavior, better ecological education and so on. But in fact, there was a hypothesis that political support could increase the EVs sales and through that to help to protect the environment more and from the information gained in this seminar paper, we can see the strong correlation between political support and amount of EVs in both of states. Political legislation could help decrease use of conventional cars and encourage to use electric and hybrid cars. But it could be also good to introduce some of non-financial incentives to convince consumers to buy the EV.

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