Czech-Austrian Winter and Summer School
Electric vs Gasoline Vehicles:
Costs, Fuel & Electricity Prices, Taxes

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1 Abstract

This work is focusing on a problem, which is a direct comparison between vehicles propelled by combustion engines (petrol, diesel) and electric vehicles.

The paper is trying to provide broad yet brief collation from different points of view (economical, environmental, technological). This topic is very relevant and needs to be discussed in society.

2 Introduction

Comparing electric vehicles to casual ones is quite a complex thing. The technologies, they are based on, are very different and each one has some positive and negative aspects. The biggest issue is the source of energy, which moves the vehicle forward and the technology of storing this energy inside the chassis of a vehicle. Although the idea of an electric vehicle can sound pretty green to some people, because electric energy somehow can appear cleaner than burning gasoline, the truth can be a little disappointing in some ways.
From the environmental point of view, it is necessary to bear in mind where the energy, which propels the car, comes form. It is widely known that combustion engines use petrol and diesel, which are specific fractions emerging from raw petroleum processing. The amount of produced pollution is roughly the same regardless of the location of use and the location where the fuel was produced.
Electric vehicles, on the other hand, are absolutely dependent on location and technology which was used to produce the „fuel“. There are few methods how to produce electricity and some of them are greener, than others. The final consumer (user of electric vehicle) is not able to arbitrate where the energy in his EV was sourced from. The car can be either charged from the hydro or wind power plant and be completely environmentally friendly or it can be charged using an electricity produced in an outdated coal power plant – in this situation the car is running on coal and being unecological.

Fig. 1: Environmentally clean yet slow way of EV charging - direct usage of photovoltaic system[5]

Another, not less important, factor is the environmental burden of the vehicle itself. As far as the environmental consequences of manufacturing a casual car

compared to an EV, the results are very similar. But the battery of an EV is absolutely toxic, complex and unecological to produce and recycle. Moreover it is important to have in mind not only the complexity of production and recyclation, but how toxic is the product itself – for example in a situation where the car wreck is abandoned somewhere in the nature. A few litters of motor oil in a combustion engine car means nothing beneficial for the environment, but it is nothing in comparison with poisonous substances in the EVs battery pack, which can taint ground waters and destroy soil fertility.

One of the important technological factors to consider is that storing some amount of energy in batteries is much more space and weight demanding than storing the same amount of energy in petrol, diesel or flammable gasses. So despite the electric motor being more efficient than combustion engine, the range of EV is very limited and in real world scenarios they will be much smaller than advertised. This, in combination with long recharge time (compared to classic refuelling), may be a problem as well.

3 Problem statement, approach

Humanity is just at a point where a huge number of people own a car. Automobiles contribute greatly to the deterioration of the air condition and, overall, contribute to the destruction of the environment. Now is the time to solve the problem of how cars will be powered in the near and distant future. For the moment, a comparison of a conventional internal combustion engine with an electric drive is offered.
There is not much information available in terms of direct comparison between combustion engine vehicles (diesel, petrol) and electric vehicles in a broader, yet brief comparison. So, it is a goal of this work to make one.

The content of the work will be concentrated on comparing gasoline and electric vehicles from the point of view of costs (efficiency, running costs, cost of ownership...). Further important subjects are gasoline and electricity prices and tax mechanics applied on regular vs electric vehicles.

4 Results

4.1 Costs point of view - efficiency, electricity prices, running costs

In the figures and the table from 2019 the Electric Auto has a higher cost of ownership as gasoline and diesel in both countries (Austria and the Czech Republic).

	Electric	Diesel	Petrol
Austria	854€	549€	567€
Czech Republic	847€	515€	461€

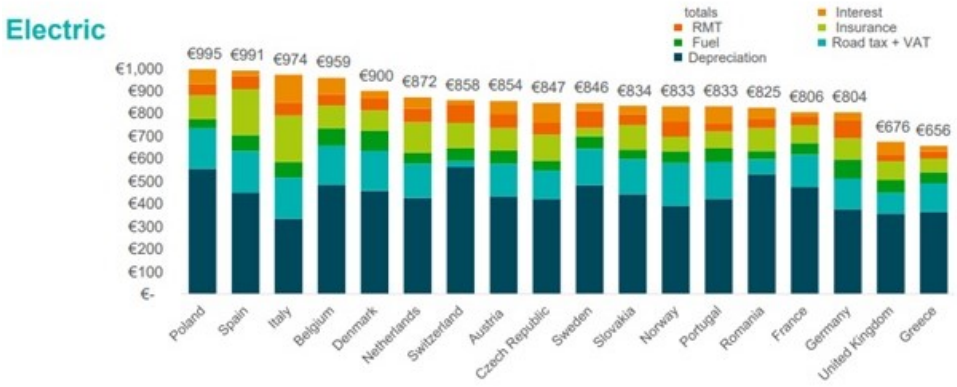

Fig. 2: Average monthly Total cost of ownership EV [6]

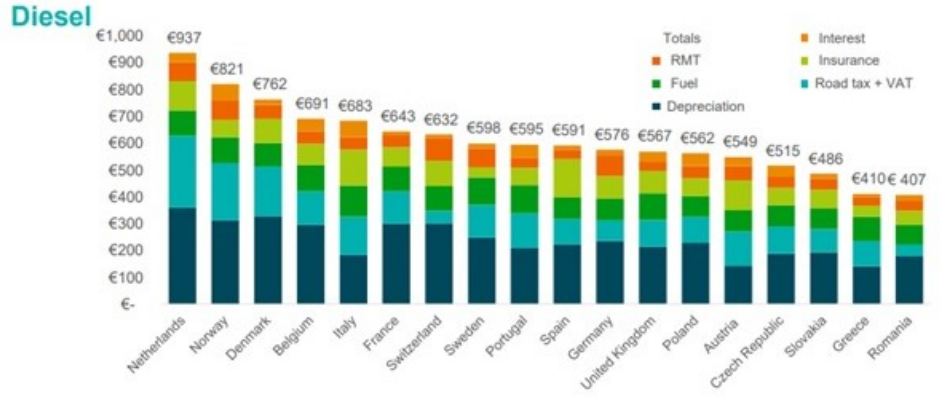

Fig. 3: Average monthly Total cost of ownership Diesel [6]

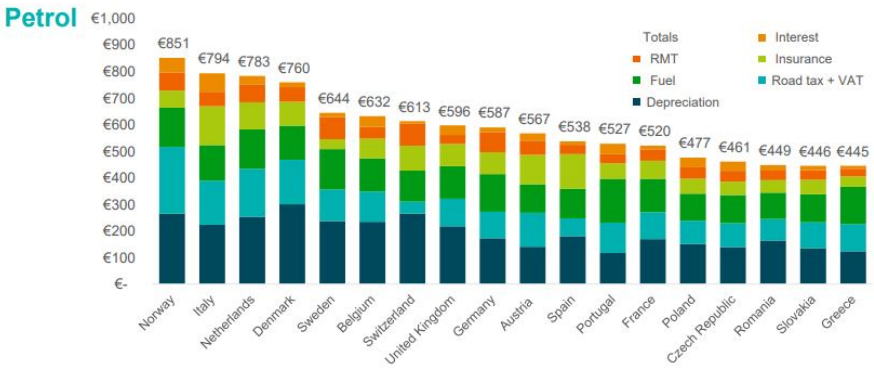

Fig. 4: Average monthly Total cost of ownership Petrol [6]

Based on Figure 5, if you compare the total cost of ownership of electricity and gasoline in percent and in detail, the Electric Auto has a higher cost depreciation as a gasoline car, which is because of the higher investment costs, when buying a EV. The average of road tax and VAT, as well as maintanence, repair and insurance costs, are a little bit higher at the gasoline cars. But the main differences are the fuel costs. They are much lower for the EV than for the conventional cars. So the obvious way, to force customers to buy an EV is to give a funding to reduce investment costs.

Fig. 5: The TCO compare EV and Diesel [6]

Comparing Energy Costs per Mile for Electric and Gasoline-fueled Vehicles:

The fuel cost of driving an electric vehicle depends on the cost of electricity per kWh and the energy efficiency of the vehicle. In figure 6, the fuel for an electric vehicle with an energy efficiency of 3 miles per kWh costs about 3.3 cents per mile when electricity costs 10 cents per kwh.[7]

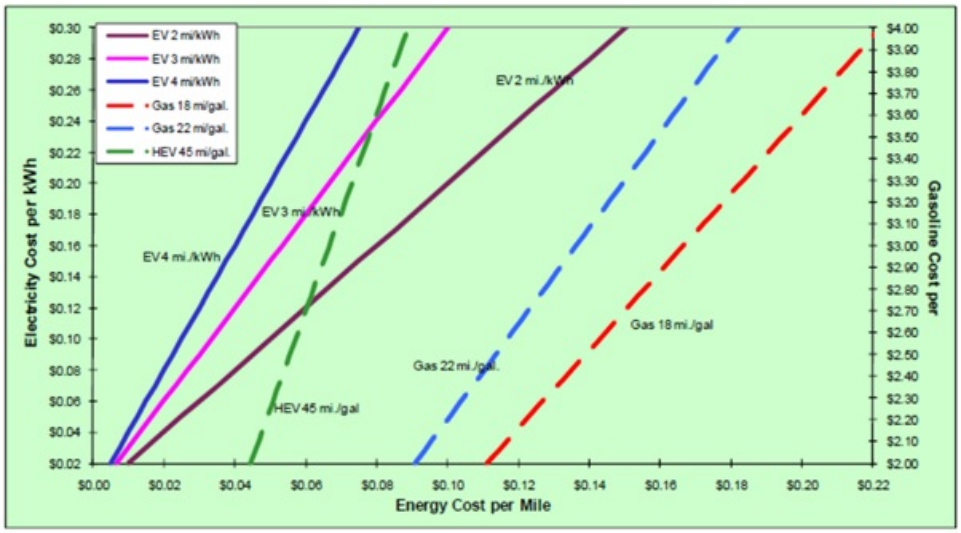

Fig. 6: Compare of Energy Cost per Mile [7]

The national average cost for electricity in the Austria is between 14 and more than 23 cents and in the Czech republic is about 18 cents per kWh, while the average residential rate is about 11.7 cents per kWh. Historically, some electricity providers have charging rates for electric vehicles that vary based on usage, day, and season. In the past, these rates have ranged from 3 cents to as high as 50 cents per kWh.[7]

4.2 Technological point of view - pros and cons of both technologies, limitations

Currently the main limitation at Electric Cars is extensive charging time and Scarcity of charging points, that make the tendency towards Electric Auto to stagnate.
In its 2018 progress report, the National Platform for Electric Mobility (NPE) assumes a charging infrastructure requirement for the years 2020 to 2025, expressed in relation to the number of vehicles from 1:14 to 1:16.5 for normal charging in the public sector. Taking into account the vehicle ramp-up forecast by the NPE, there is a requirement in absolute numbers from 45,000 to 71,000 AC charging points and from 4,200 to 7,100 DC charging points by 2020. In the following five years, the build-up from 130,000 to 190,000 AC Charging points as well as 13,000 to 19,000 DC charging points is required in the public area. This results in an investment requirement of 2 billion to 3 billion euros, which according to the NPE is associated with a funding requirement of 800 million to 1.2 billion euros [NPE18, p.53ff.].[9]

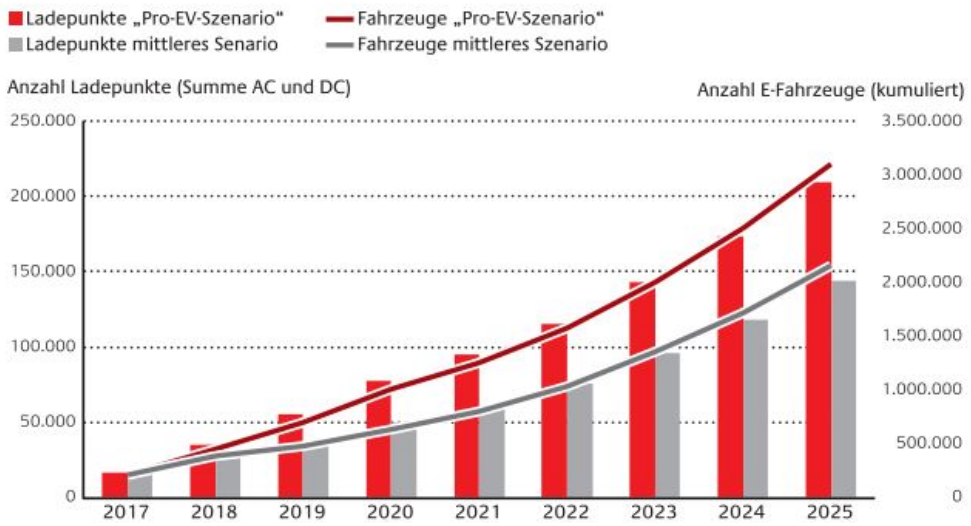

Fig. 7: by 2025 there will be a need of 145 thousand charging points in the public area and from 2.4 to 3.5 million charging points in the private area.[8]

As we already know, a scarce reserve of oil is already available. According to the U.S. Energy Information Administration's International Energy Statistics in 2014, proven oil reserves were 1656 billion barrels[3]. It can be a clear reason why after 2045 the use of a gasoline auto is reduced because it will become a expensive product due to shortage.

On the other hand, the renewable resource sources are being developed and the price and availability of the electricity is leading to more electric auto use.

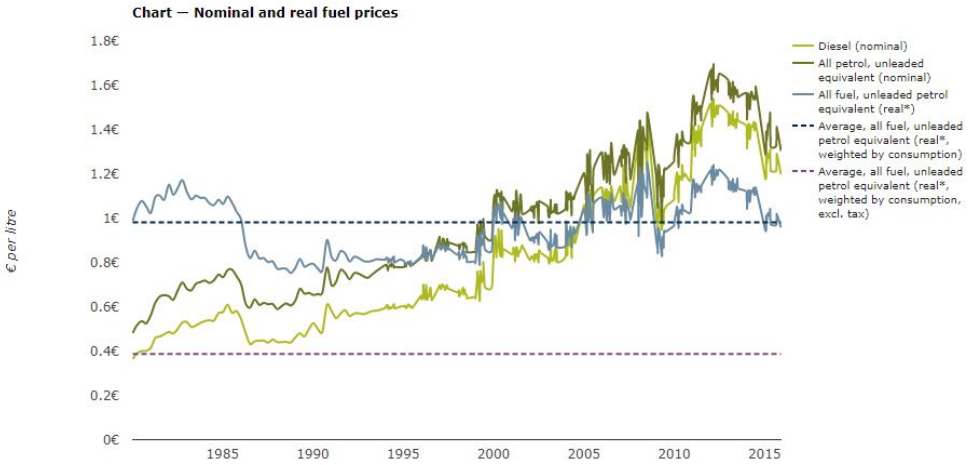

Fig. 8: Fuel prices [10]

4.3 Environmental point of view

In recent years, attempts have been made to model global warming and the CO2 effects on the basis of various scenarios.
In particular attention was also paid to petrol vehicles and their CO2 emissions. On the other hand, due to their zero emissions, the resources for renewable energies are particularly regarded as future electricity sources and they are matched with climate protection policy. This is where electric cars come into consideration with their low CO2 emissions amount.
The following data (Fig. 9 and 10) have be modeled from IAMC 1.5°C Scenario Explorer with MESSAGEix-GLOBIOM || Low Energy Demand 1.0 Senario.

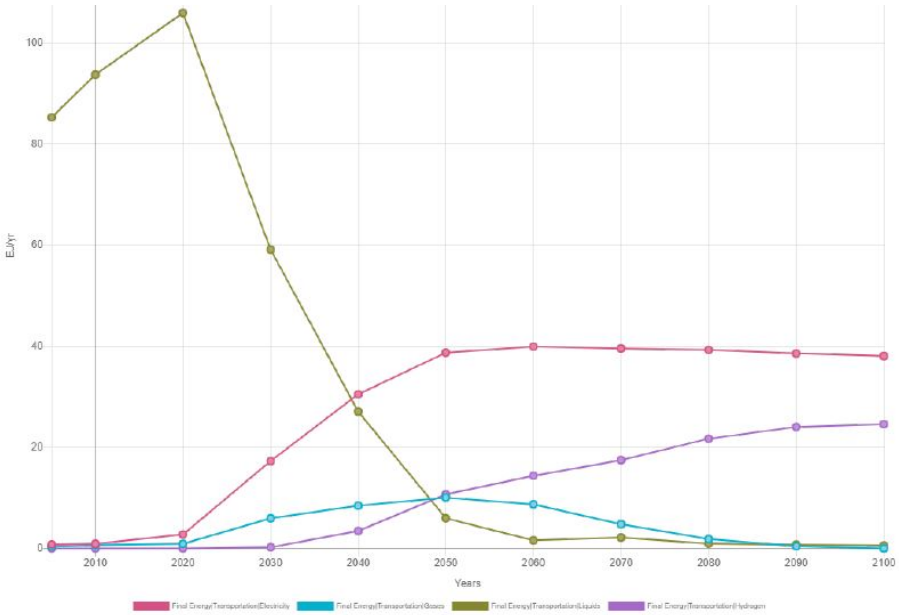

Fig. 9: modeling of electric and gasoline auto use until 2100[12]

Also as a result of the climate protection policies, CO2 taxes will be increased to reduce CO2 emissions, this means the tax costs for gasoline cars will be increased annually.

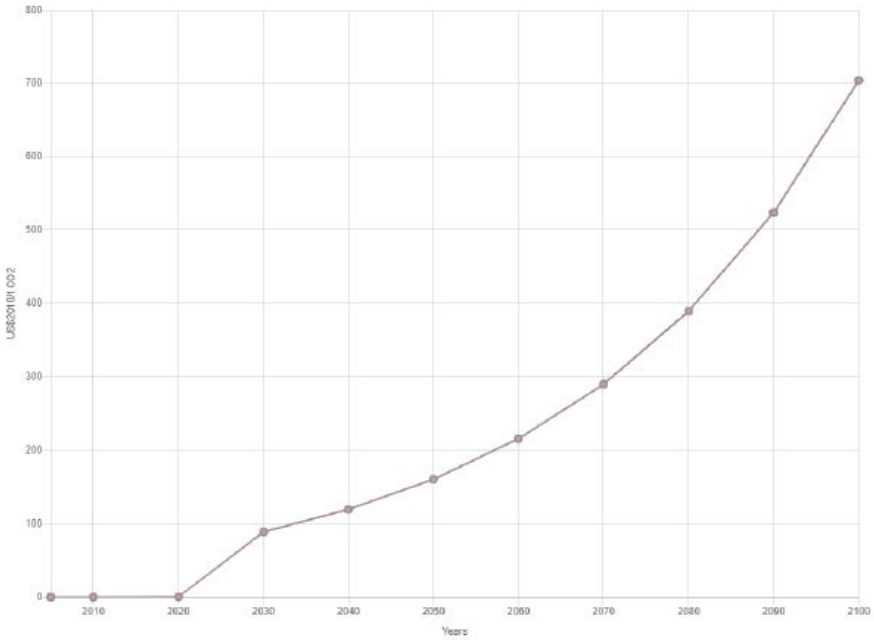

Fig. 10: Co2 Price model 2000-2100[12]

4.4 Taxation of Electric Vehicles in Europa, Austria, Czech Republic

According to ACEA (European Automobile Manufacturers' Association) in European Countries for the tax system four aspects (acquisition, tax benefits, Company Cars, incentives) are taken into account. For buying electric vehicles in the 28 member states of the European Union, depending on which country you want to buy it in, different factors have to be considered.

• Today, stimuli for electrically-chargeable cars are available in 24 out of the 28 EU states.

• However, just 12 EU member states offer bonus payments or premiums to buyers.

• Most countries only grant tax reductions or exemptions for electric cars.[2]

Tax EU				
COUNTRY	ACQUISITION	TAX BENEFITS OWNERSHIP	COMPANY CARS	INCENTIVES
AUSTRIA	VAT deduction and exemption from tax for zero-emission cars (eg. BEVs and FCEVs).	Exemption for zero-emission cars	Exemption for zero-emission cars.	Incentive scheme (until end of 2020) •€3,000 for new BEVs and FCEVs •€1,500 for PHEVs and EREVs
CZECH REPUBLIC	Exemption from registration charges for BEVs and FCEVs emitting 50g CO2/km or less (upon request of a special number plate)	Exemption for alternatively powered vehicles (ie electric,hybrids, CNG, LPG and E85).	-	-

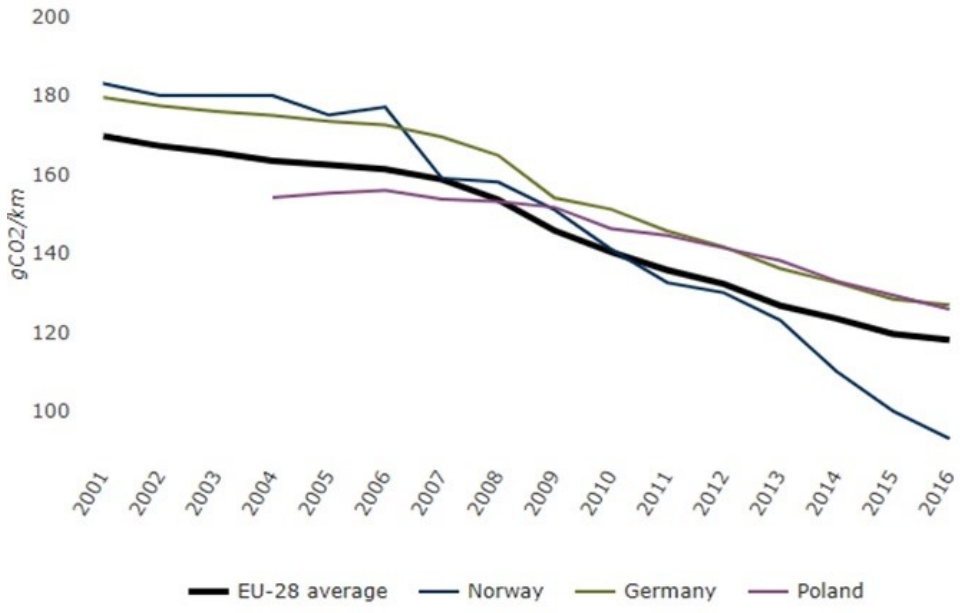

Fig. 11: Average CO2-emissions of new passenger cars sold in EU[4]

Reducing greenhouse gas (GHG) emissions from the transport sector is a key priority for the European Union (EU).
Average CO2 emissions of new passenger cars in the EU has fallen steadily in recent years, from 170 g CO2/km in 2001 to 118 g CO2/km in 2016, with an annual reduction rate of 2 %. A further 19.5 % reduction in average CO2 emissions will be required to comply with the 2021 target of 95 g CO2/km (27 % below the 2015 target).
Where there were appropriate levels of taxes and incentives in place, consumer adoption of lower CO2 emitting vehicles followed. This is seen in the case studies on electrification for Norway. In contrast, where there were more limited taxes and incentives in place, as was the case in Germany and Poland, adoption rates were lower.

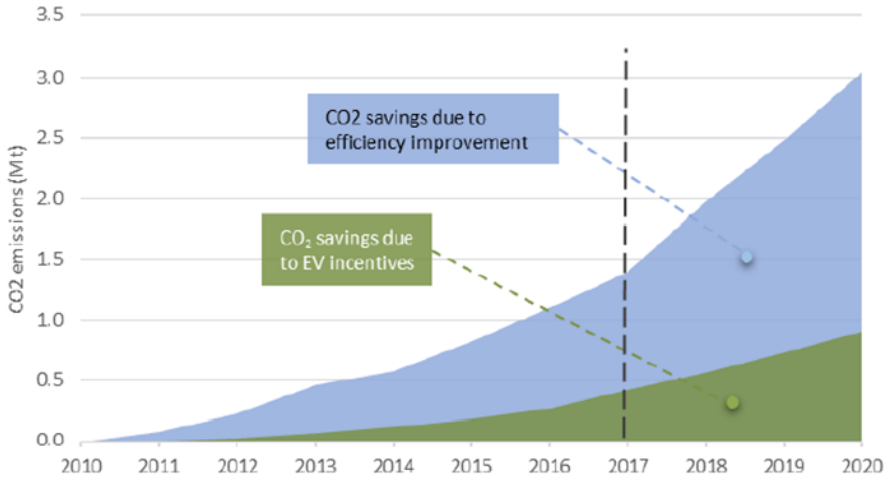

Fig. 12: Saving in CO2-emissions compared to the baseline scenario[11]

German automotive industry is considered one of the most competitive and innovative in the world while Germany has the largest sales volume of new cars across Europe. Nevertheless, considerable incentives for EV market appeared very slowly compared to other countries (such as France or the Netherlands) and were made available to consumers in July of 2016, when Germany approved an incentive and investment program to encourage switch to EVs.
Therefore, in Figure 12 it appears that with this particular slow rate of EVs uptake, CO2 savings due to the incentives given by the country will not exceed 1Mt by 2020 and savings due to the EU regulation will be about 2.1 Mt. Hence, the country can expect an overall 3% reduction in CO2 emissions due to its incentives for low-emitting vehicles and the European legislation that applied.[11]

5 Conclusion

It will no longer make sense to use a diesel or petrol vehicle, if it will be difficult to find fuel for these vehicles in the future. Every year, additional environmental costs of gasoline engines will lead to attempts to replace them with an electric car. Electric vehicles that get their electricity from renewable sources because of their zero cost will basically be more economical than the oil that is becoming scarcer and more expensive every year. It can be said, that if enough infrastructure is created for electric cars, they might be the most used products on the vehicle market in the future.
But it is a big question if there is a future for battery driven EVs. There is a possibility that the EV technology will be overrun by hydrogen projects or even

some kind of highly efficient combustion engine architecture (E.g. engine with counter-rotating pistons). The Future will show.

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