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Analysis of alternative policy instruments to promote electric vehicles in Austria

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ABSTRACT

The large amount of CO_2 emissions and of fossil fuel consumption caused by the transportation sector makes the sector central for attaining the EU energy and climate policy targets. Consequently, new propulsion systems are developed in the automotive industry, which currently have cost disadvantages compared to conventional internal combustion engines (ICE). The article provides a review on support measures for electric vehicles (EV), which have been currently implemented within the European Union. In a case study analysis for Austria, we analyze different policy instruments including a CO_2 tax aiming to support the introduction of electric vehicles in Austria. We have calculated and compared total costs of ownership (TCO), which includes all costs associated with the ownership of an automobile including costs of purchasing, operating and maintaining, charges and taxes as well as costs of recycling and disposal. A survey on main specifications of electric vehicles has been conducted among the main automobile manufacturers and importers in Austria. Based on this survey, TCO have been calculated dynamically from 2011 to 2020 for a business as usual (BAU) scenario considering currently implemented taxes and subsidies for ICE and electric vehicle systems. Three alternative policy support measures have been assessed to promote EV until 2015. Results show that EV will be cost-competitive with ICE by the year 2012/2013 if projected production volumes and thus economies of scale are reached. Further, we conclude that an up-front price support seems to be favorable over taxation systems.

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1. Introduction

Currently, 98% of the transportation sector in the EU depends on fossil fuels. The sector is responsible for approximately 21% of the greenhouse gas (GHG) emissions, with more than half of the emissions produced by passenger cars [1]. The EU Directive (2009/33/EC) on the promotion of clean and energy efficient road transport vehicles has been released to foster a broad market penetration of environmentally friendly vehicles in order to decarbonize the transportation sector and to reduce oil dependency.

Several new propulsion systems such as plug-in hybrids, range extenders as well as electric vehicles (EV) have emerged and entered the market or are ready to enter the market in the near future [2]. However, the cost disadvantages of the newly emerging propulsion systems as well as their limited driving range have to be overcome in order to achieve a shift in the transportation sector. Due to the limited energy density of batteries, EV have currently a limited driving range of approximately 160 km. A dense charging network would be required to overcome the limited driving range barrier. However, economic viability and a successful introduction of alternative propulsion systems will mainly depend on economic aspects such as relative average costs in comparison to internal combustion engines (ICE).

Therefore, the gap between the total cost of ownership (TCO) of alternative transportation systems and of ICE should be temporarily closed by appropriate policy interventions to promote environmentally friendly vehicles. Current research regarding the economic viability of electric vehicles has mainly focused on life-cycle cost analysis [3–5]. Thiel et al. [3]compared the well-to-wheel CO_2 emissions, costs and CO_2 abatement costs of passenger light duty vehicles including gasoline vehicles, diesel vehicles, diesel hybrid vehicles, plug-in hybrid, and battery electric vehicles. A static comparison has been conducted for the years 2010, 2020 and 2030 under a new energy policy scenario for Europe. They conclude that electric vehicles can clearly contribute to a decarbonization of the transportation system if renewable electricity is used. According to [3], adequate policy instruments are necessary to overcome the current cost disadvantages of electric vehicles to attain appropriate payback periods.

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Ogden et al. [4] conducted an analysis of the societal lifecycle cost of transportation including the purchase price, fuel costs, externality costs of securing oil supply and damage costs for emissions of air pollutants and greenhouse gases which are calculated over the full fuel cycle.

Thomas [5] developed a dynamic computer simulation model that compares the societal benefits of replacing conventional gasoline cars with vehicles that are partially electrified, including hybrid electric vehicles. He concludes that electric vehicles in combination with hybrids, plug-in hybrids and biofuels will be necessary to achieve an 80% reduction in greenhouse gas emissions below 1990 levels by simultaneously cutting dependence on imported oil and eliminating nearly all controllable urban air pollution from the light duty vehicle fleet. However, to increase market shares, market barriers have to be overcome. Therefore, the consumer perspective and thus the choice of cost-effective policy instruments should be the focus of further research.

The aim of the article is to analyze different policy instruments by comparing total cost of ownership (TCO) of EV and ICE in Austria. TCO are calculated dynamically from 2011 to 2020 for a business as usual (BAU) scenario considering currently implemented taxes and subsidies for ICE and EV. In contrast to lifecycle cost analysis of alternative propulsion systems, our analysis focuses mainly on the total cost of ownership and places the consumer perspective in the center of the analysis, because with the exemption of early adopters consumers are usually not willing to accept the current cost differential between ICE and EV. Surveys conducted among Californian households found that e.g. the present value of fuel savings is rarely considered in the purchase decision of a new vehicle [6]. If consumers consider fuel economy when purchasing a vehicle, surveys conducted by [7] and [8] indicate that consumers expect vehicle efficiency improvements to pay for themselves in the first three years or less. As indicated by the surveys and argued by [9] main barriers toward a transition to an alternative transportation system are not technical ones but socio-economic ones. Therefore the political framework can have considerable impact on the vehicle characteristics and fuel efficiency [10] as well as on the driving distance by affecting the cost of transport and as such influencing consumer behavior and spreading efficient propulsion technologies [11].

The article is structured as follows. Section 2 provides an overview of the support schemes currently launched in the EU-15. Section 3 gives an overview of currently implemented taxes on transportation in Austria. Section 4 presents the data and methodology. An analysis on different policy support instruments to equalize the TCO of EV and ICE in Austria is shown in Section 5. Section 6 presents a sensitivity analysis on the main model parameters and Section 7 concludes.

2. Implemented support schemes for EV in the EU-15

Many EU member states have introduced national targets for the EV driving stock, the expansion of charging infrastructure, or production targets of electric vehicles [12]. Most EU member states overcome the cost disadvantage of alternative vehicles by introducing policy instruments such as an up-front price support in order to increase the affordability of electric vehicles by reducing the marginal capital cost, which is considered as one of the key barriers for consumers [13]. Within the EU-15, passenger cars have mainly been the target of a tax reform that takes into account the CO_2 emissions of vehicles. Policy instruments that are currently implemented in order to stimulate the up-take of alternative propulsion systems consist of [13]:

- Registration or purchase taxes

Registration or purchase taxes are an up-front cost and can have a strong impact on directing buying decisions to low carbon vehicles, if costs are differentiated with regard to the specific CO_2 emissions of the vehicles. In France, a bonus/malus system has been introduced whereby vehicles above certain CO_2 emission thresholds have to pay a malus and vehicles under the threshold receive a bonus. Such a system may increase the acceptability of policy makers as well as of consumers, because it can be designed in a revenue neutral manner [13].

The EU proposal for a Council Directive [14] with the aim of decarbonizing the transportation sector suggests implementing reforms in the vehicle registration taxes and annual circulation taxes. It is stated that fiscal measures provide a strong incentive value, for example, by encouraging the rapid renewal of the car fleet and influencing consumer's behavior toward more fuel-efficient passenger cars.

- Circulation or motor taxes

The circulation tax usually tied to the engine power, cylinder capacity or fuel consumption is a monthly or annual paid tax. According to [13], circulation or motor taxes have a limited effect on the purchase decision as they are annual or monthly charges, implying that consumers place much more attention to the up-front purchase price than to annual or monthly charges. Although they are considered to be politically acceptable, their impact to promote EV is rather low as the cost range of such measures is limited [14].

- Fuel taxes

Fuel taxes are considered to be an effective regulatory instrument to (i) limit energy consumption in road transport [15,16] (ii) incentivize consumers to buy more energy efficient cars, and (iii) change driving patterns.

Table 1 provides an overview of the currently implemented support measures [13,15–17].

3. Status quo: policy instruments implemented for passenger cars in Austria

Currently there are three main taxation instruments influencing the cost of passenger car transport in Austria [14]: a purchase tax which is basically an up-front fuel consumption tax called Normverbrauchsabgabe (NoVA), an engine related vehicle tax (motorbezogene Versicherungssteuer), and a fuel tax.

The fuel consumption tax has to be paid upon first registration of the car in the country. The tax is levied as a percentage of the purchase price and is calculated based on the fuel consumption of the car. A bonus/malus system is implemented with respect to the CO_2 emission of a car. Cars with a CO_2 emission above the threshold of 160 g/km have to additionally pay 25 EUR/g. EV receive currently a bonus of EUR 500. Additionally, the consumer has to pay 20% VAT on the total purchase price including the fuel consumption tax.

The engine related tax, also called circulation tax, is paid according to the insurance payment, monthly, semi-annual or annual. The amount of the engine related tax depends on the engine power of the car. Additionally, the consumer has to pay 11% insurance tax on the engine related tax. EV are currently exempt from the engine related tax in Austria.

The fuel tax called Mineralölsteuer (MöST) amounts for gasoline vehicles to 0.447 EUR/l and for diesel to 0.347 EUR/l. Currently, biofuels and compressed natural gas are exempt from fuel taxes.

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