Successful policies to promote the dissemination of battery electric vehicles

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Overview

30% of the GHG-emissions in the EU regarding the transport sector, thereof 72% is road transport.[1] Electric vehicles produce between 75% and 90% fewer GHG-Emissions, than conventional vehicles. Battery electric vehicles (BEVs) and fuel cell vehicles (FCVs) have zero emissions at the point of use and could significantly contribute to the reduction of GHG-emissions in combination with electricity produced from renewable energy sources (RES).[2] Far-reaching arguments against switching to EVs are the high investment costs compared to conventional vehicles and technical limitations (e.g. limited driving range and charging infrastructure availability).[3]

This work analyses how policies affect the dissemination of BEVs in selected countries with remarkable market shares of BEVs. The core objective is to investigate how policies affect BEV economics compared to conventional car economics. On the one hand, the current economic state of BEVs in comparison to conventional cars is analysed, and on the other proper policies to overcome the major current barrier of high investment costs are identified. Regarding economics, a Total Cost of Ownership (TCO), including existing national policy instruments such as fuel, registration and ownership taxes as well as subsidies is calculated. The TCO is calculated for the major BEV markets China, California in the USA and the most important European countries (Austria, Germany, the Netherlands and Norway). For these countries, detailed economics analyses are conducted for two cases of cars, small and large ones. Regarding proper policies to overcome the major current barriers, measures in different dimensions (subsidies, standards, taxes and legal frameworks, see Figure 1) and applicable monetary and non-monetary incentives to promote BEVs (and reduce the number of ICEs) are discussed. Furthermore, fuel and electricity prices as well as the BEV-distribution in selected countries (China, Japan, the USA, United Kingdom and some European countries (Austria, France, Germany, Sweden and Norway) are examined. Moreover, amounts of subsidies, exemptions from taxes and non-monetary measures for BEVs for the selected countries are elaborated.

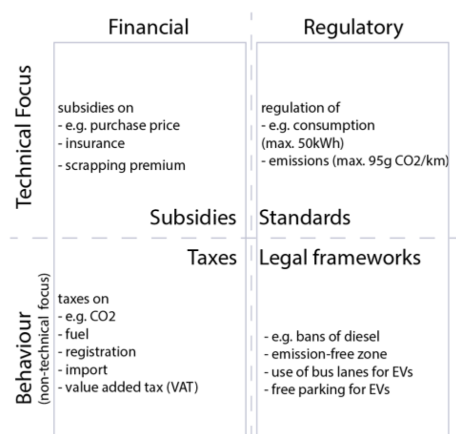

Figure 1 - The four major dimensions of energy policies with a special focus on transport

Methods

$$TCO = C_{Cap} + C_{O\&M} + C_E \text{ [€/year]}$$

$$C_{Cap} = (IC_0 - \tau_{sub}) * \alpha \text{ [€/year]}$$

$$C_E = p_f * vkm * FI \text{ [€/year]}$$

$$\alpha = \frac{z * (1+z)^n}{(1+z)^n - 1}$$

$$p_f = p_{net} + \tau_{VAT} + \tau_{CO2} + \tau_{Excise} \text{ [€/kWh]}$$

C_{Cap} costs of capital for the vehicle including purchase subsidies;
$C_{O\&M}$ costs of operating and maintenance;
C_E costs of energy, either fuel or electricity;
IC_0 initial investment costs (including subsidies τ_{sub});
α capital recovery factor (CRF);
pf fuel or electricity price;
vkm km driven per year;
FI fuel intensity;
τ_{VAT} Value-added tax (VAT);
τ_{CO2} CO_2 based tax;
τ_{Excise} excise tax on fuels;

Figure 2 - TCO method for conventional cars and BEVs

The aim of the TCO calculation is to identify the difference between ICEs and BEVs costs, considering the capital costs C_{Cap}, operating and maintenance costs $C_{O\&M}$, and electricity/fuel costs C_E (see Figure 2). The TCO is calculated for two vehicles, a BEV and a comparable conventional vehicle for all selected countries. Our method of approach is based on the following principles: (i) For the calculation, 12,500 kilometres per year, a depreciation period of eight years and an interest rate of 5% were assumed. (ii) The capital costs per year depend on the initial investment costs IC_0 (including subsidies τ_{sub}) and the capital recovery factor (CRF) α. (iii) The costs of energy C_E depend on the fuel price or the electricity price p_f, the km driven per year *vkm,* and the fuel intensity *FI*. The fuel price p_f is the sum of the net price p_{net}, the Value-added tax τ_{VAT}, CO_2 based tax τ_{CO2} and an excise tax on fuels τ_{Excise}. We apply this method to calculate TCO for two specific cases (small and large cars), where we compare the TCO for selected countries with some relevance of BEVs.

Results

Figure 2 shows the TCO results for Case 1, comparing a VW Golf with an E-Golf. Norway as an exemplary case is shown in Figure 3. The major results are: (i) The lowest prices for the ICE are in the USA, the highest in Norway and the Netherlands. The lowest costs for BEVs are in the USA and China. The highest costs can be found in Norway, Germany and the USA. The high costs of conventional cars in Norway and the Netherlands are mainly due to high fossil fuel prices and registration taxes. In contrast, fuel prices in the USA (California) and China are very low. (ii) The Netherlands shows that high costs for a BEV can be compensated through high registration taxes combined with subsidies and high gasoline prices. (iii) China shows that an average level of subsidies, low registration taxes in combination with low electricity prices seem to have a higher impact than high subsidies in combination with low taxes. (iv) The example of Norway shows that monetary measures, combined with high registration taxes on ICEs, significantly impact disseminating BEVs. (v) Subsidies significantly impact TCO. (vi) A change in the interest rate parameter has a stronger effect on the annual costs than a change in the depreciation time.

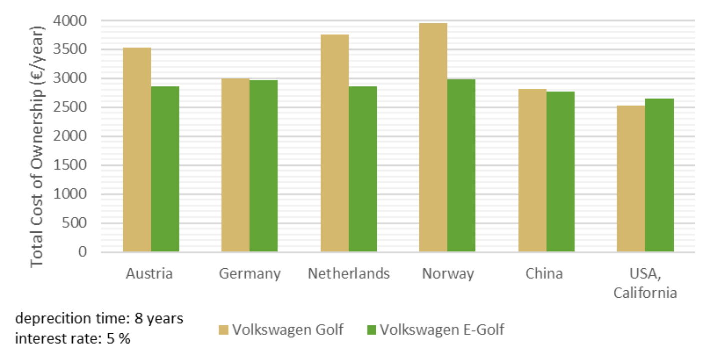

Figure 2 - TCO (Case 1) - VW Golf vs E-Golf

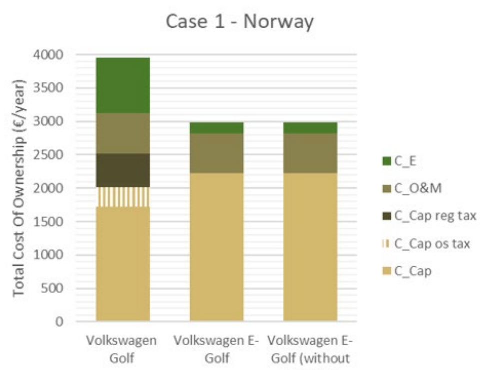

Figure 3 - Composition of the TCO, Norway

Conclusions

The following recommendations for policymakers to push the dissemination of BEVs forward are identified:

(i) Pushing the purchases of BEVs by providing remarkable purchase subsidies at least for the next years to reduce the investment costs over time due to technological learning effects;

(ii) Implementation of high registration taxes to push up the prices of ICEs even more;

(iii) Legislative measures as the introduction of emission-free transport zones and free parking for BEVs would be helpful to disseminate BEVs, especially in urban areas;

(iv) Introducing CO_2 taxes would support the economic performance of BEVs indirectly by increasing the prices of petrol and diesel;

References

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