

Taxation of electric vehicles in Europe: A methodology for comparison

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Summary

In Europe, a heterogeneous range of national vehicle taxation systems exists in parallel, so that a simple comparison of electric vehicle (xEV) tax advantages is not straightforward. In this contribution, various European vehicle taxation systems are examined and a methodology is introduced which allows a comprehensible comparison and overview by calculating CO₂ based taxation step curves. This methodology provides a powerful tool for benchmarking xEV technologies and analysing consumer acceptance of xEVs and enables furthermore the discussion about possible future taxation and incentive schemes.

Keywords: BEV (battery electric vehicle), PHEV (plug in hybrid electric vehicle), taxation, subsidy, consumers

1 Introduction

1.1 Total Cost of Ownership

The purchase decision of vehicle customers strongly depends on the total cost of ownership (TCO) (1) which comprise the loss of value, taxes, insurances, maintenance, interests and fuel costs (2) (3). Among these, the loss of value is typically the biggest cost component. Fig. 1 shows the TCO shares of a typical E-segment diesel vehicle of a business customer in the United Kingdom in 2016 over three years holding time. It can be seen that taxes hold the second largest share adding up to 25% in the shown example. Compared to this, fuel costs, maintenance, insurance and interest have minor shares.

Hence, the consumer acceptance of electric vehicles is strongly influenced by vehicle taxation (4) (5). Therefore, a comparison of battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) versus conventional vehicle taxation can help to understand consumer preferences. The comparison of the tax and incentive based cost advantages of a PHEV to a conventional vehicle (both E-segment) in Fig. 2 shows the large variance in Europe.

Vehicle taxation systems differ not only in their taxation levels but also in terms of their structural principles (6). Due to this wide range of calculation schemes, a direct comparison of tax levels is not expedient. In this contribution, six European vehicle taxation systems are examined (Germany, the Netherlands (NL), Italy, Norway, the United Kingdom (UK) and France) and a methodology is introduced that allows a comparison of different systems by looking at their CO₂ dependency in a range between 0 and 150 gCO₂/km in 1 gCO₂/km steps. Moreover, business and private customers are discussed separately (7) as yearly tax advantages of xEVs often derive from company car taxation. In addition, two different segments will be analysed (B- and E-segment). By applying this methodology, an outlook can be given for future vehicle taxation.

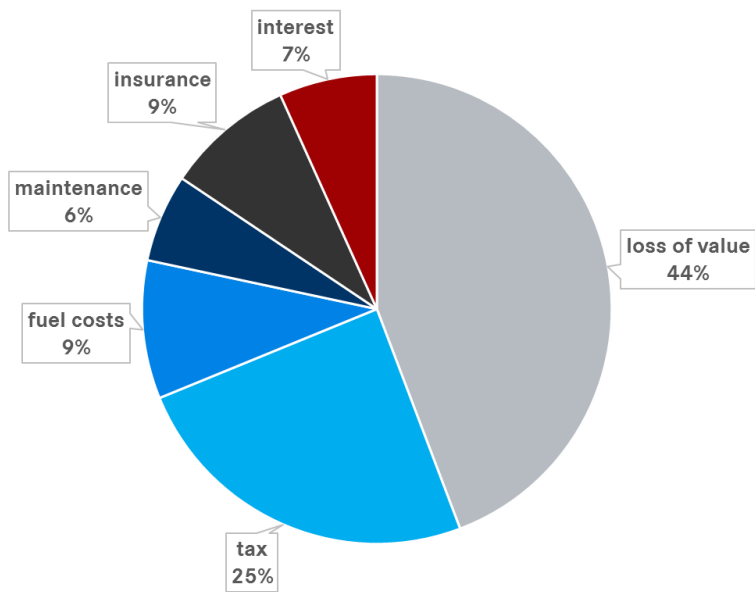


Fig. 1 Total cost of ownership shares of a typical E-segment diesel vehicle of a business customer in the United Kingdom in 2016 based on three years holding time.

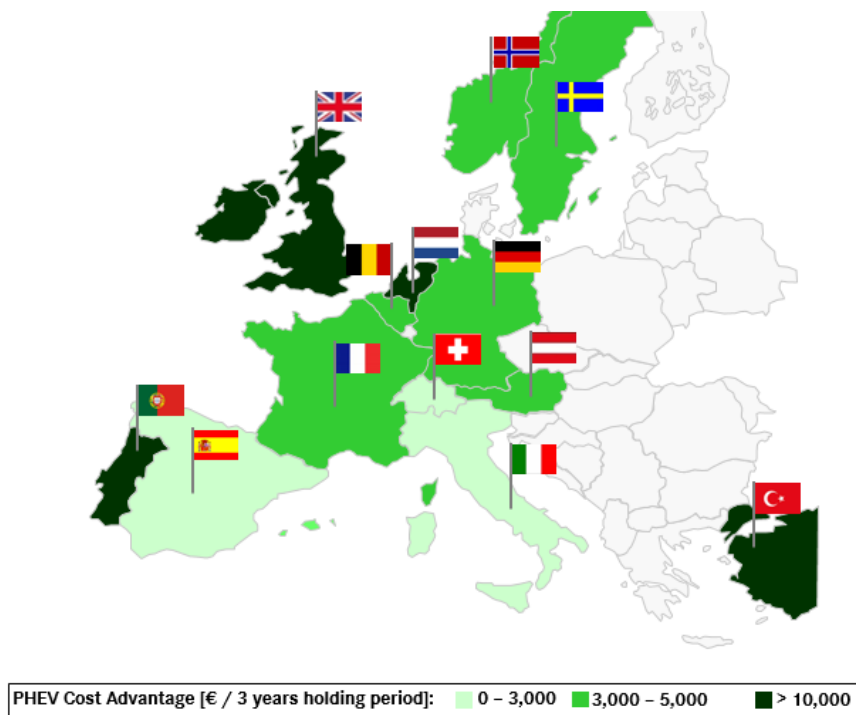


Fig. 2 Tax and incentive based cost advantage of a PHEV compared to a conventional vehicle in (E-segment).

1.2 Vehicle Taxation in Europe

In Europe, a heterogeneous range of national vehicle taxation systems exists in parallel, varying both through taxation components in place (purchase subsidies and registration taxes at point of sale, yearly ownership taxes, company car taxes) and through the parameters determining the tax burden (CO₂, engine power, engine displacement, electrical driving range, vehicle weight, vehicle list price, fuel type). In Fig. 3, an overview is shown of relevant thresholds regarding technical requirements and price limits for being entitled to xEV subsidies and tax advantages. Subsequently, the vehicle taxation of six examined European countries (Germany, NL, Italy, Norway, UK and France) will be described more detailed.

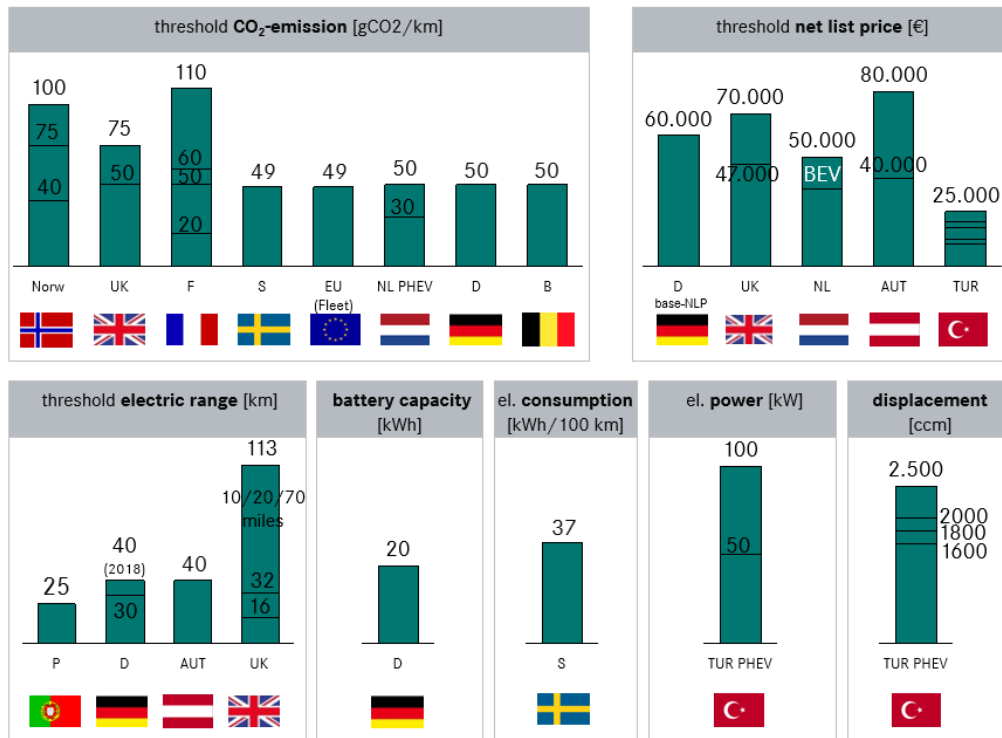


Fig. 3 Overview of thresholds for eligibility of xEV subsidies, tax advantages and super-credits in EU-fleet (April 2017).

1.2.1 Germany

The registration tax is a fixed amount of €24.30. The annual vehicle tax is dependent on both the displacement (Diesel: €9.50 / Gasoline: €2 for every 100 ccm and part thereof) and CO₂ (€2 for every gram above 95 gCO₂/km). The company car tax is commonly calculated as 1% of the gross list price times the personal income tax rate. As calculation basis for company car taxation of BEV and PHEV, the gross list price is reduced by €500 per kWh storage capacity of the battery with a cap at 20 kWh (€10,000) for vehicles bought before December 31st, 2013. After 2013, this amount is reduced by €50 every year (i.e. -450 €/kWh in 2014, -400 €/kWh in 2015 etc.).

Purchase subsidies were introduced in June 2016 (€ 4,000 for BEV and € 3,000 for PHEV with less than 50 gCO₂/km) and not exceeding € 60.000 net list price of the base model).

1.2.2 The Netherlands

The registration tax is called BPM and is determined by the car's CO₂ emissions. The BPM is not charged for BEV. In addition, there is a separate BPM rating scheme for PHEV. Diesel vehicles are charged extra if exceeding 65 gCO₂/km. The annual road tax depends on the vehicle's weight and fuel type (vehicles with less than 50 gCO₂/km pay half tariff, vehicles with 0 gCO₂/km are entirely exempted). The company car taxation is implemented by adding a percentage of the vehicle's consumer price to the personal salary. In case of 0 gCO₂/km, the percentage is 4% if the list price is not exceeding €50.000. For all other vehicles, 22% are applied.

1.2.3 Italy

In Italy, vehicle taxation is only depending on engine power. Nevertheless, there are local differences as each province can increase the nationwide base rate by up to 30%. Electric vehicles are exempted from paying vehicle taxes for five years from the date of the first registration. Afterwards, they must pay a charge equal to a quarter of the amount of their corresponding gasoline vehicles.

1.2.4 Norway

The registration tax depends on the vehicle's weight (about €405 up to 1,200 kg, about €620 from 1,200 kg). Norway is charging an import tax which takes into account the vehicle's weight, CO₂-emissions and NO_x-emissions. The vehicle weight of PHEV is reduced by 26% for the calculation of the import tax. Other hybrids get a weight advantage of 10%. Until 2016, the engine power was also part of the calculation scheme. The annual tax is about €313 apart from two exemptions: BEV pay only about €50 and diesel vehicles without a particle filter pay €365. Furthermore, BEVs are exempted from the 25% value added tax.

1.2.5 The United Kingdom

The registration tax is a fixed amount of €64. A new yearly vehicle excise duty scheme was introduced on April 1st, 2017. First year rates are strongly depending on CO₂, whereby only 0 gCO₂/km is free of charge. 2nd year onwards, tax rates depend on the vehicle price. The company car tax rate is CO₂-dependent with a lower rate in the range between 0 and 50 gCO₂/km. For diesel, a surcharge of 3% is applied.

There are three categories of purchase subsidies (in addition, a maximum list price of €69,800 applies for eligibility of category 2 & 3):

- Category 1 = €5,230 (CO₂ emissions less than 50g/km, zero emission range of at least 70 miles)
- Category 2 = €2,910 (CO₂ emissions less than 50g/km, zero emission range between 10 and 69 miles)
- Category 3 = €2,910 (CO₂ emissions between 50 and 75 g/km, , zero emission range of at least 20 miles)

1.2.6 France

The registration tax is depending on both the horse power and CO₂-emission ("Malus Ecologique"). The yearly vehicle tax applies only to vehicles above 190 gCO₂/km. The company car tax is CO₂-dependent as well.

Vehicles below 20 gCO₂/km get a subsidy of €6,000 with a cap at 27% of the acquisition price. Between 21 and 60 gCO₂/km, the subsidy is €1,000 (max. 20% of the acquisition price). An additional subsidy applies if a diesel vehicle (registered before January 2007) is replaced with a new BEV or PHEV. This scrapping subsidy amounts €4,000 when purchasing a vehicle below 20 gCO₂/km and €2,500 for vehicles between 21 and 60 gCO₂/km. Scrapping subsidies are not considered in the CO₂ step curves as the requirement of holding a 10 years old diesel vehicle is fulfilled only by a minor part of the stock.

1.3 Additional xEV benefits

Fuel cost savings are an additional xEV benefit (8) caused partly by lower excise duties on electricity. Excise duties are included in the fuel costs and will not be taken into account in the CO₂ step curves.

Road charges are not taken into account, even though xEVs might be exempted from certain charges in some local region today (e.g. London, Oslo). Additionally, xEVs might profit from free parking in city areas or free use of ferries (Norway) (5) (9) or bus lane access (7). As these advantages are limited to locally restricted areas, they are not taken into account as we want to describe the common situation in the countries considered.

Some countries grant subsidies for installing wallboxes for home charging (e.g. Austria €200 or the UK £500). Such grants are not considered in the step curve calculation as they are purely focused on explicit vehicle taxation schemes.

Looking at China, xEVs have an additional non-monetary advantage as they can get a license plate much easier compared to conventional vehicles that wait for several years to obtain a license plate (9).

2 Methodology for a comparison of vehicle taxation schemes

The comparison of national vehicle taxation systems is achieved by looking at hypothetical CO₂ based taxation curves between 0 to 200 gCO₂/km in 1 gCO₂/km-steps. The vehicle characteristics are derived from actual vehicles such as a typical E-segment vehicle in Fig. 4. For comparison reasons, all vehicles are supposed to be equal in price, weight and engine power. 0 gCO₂/km represents a BEV. In the range between 1 and 50 gCO₂/km, a PHEV is depicted with both an electric and a combustion engine. From 51 to 110 gCO₂/km a hybrid vehicle is implied. The range between 111 and 150 gCO₂/km represents a conventional vehicle.

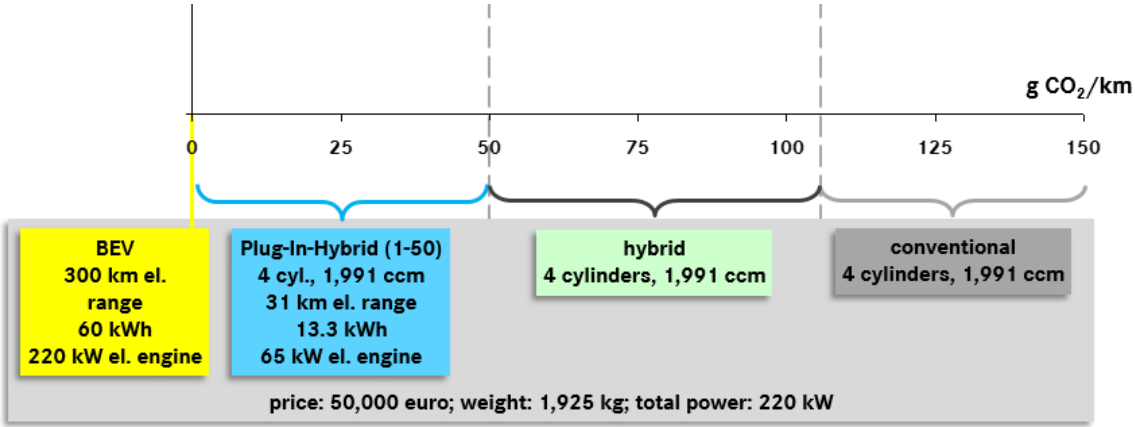


Fig. 4 Vehicle characteristics of a typical E-segment vehicle.

In Fig. 5, vehicle characteristics of a typical B-segment car (small cars) are shown. PHEVs are not offered in this segment due to the fact that size and price do not allow an installation of two drive-trains. As a consequence, these cars are either electric or conventional.

In this paper, we focus on CO₂ step curves of gasoline vehicles as PHEVs are nowadays largely fueled by gasoline. Nevertheless, the methodology of CO₂ step curves can be applied similarly to diesel vehicles.

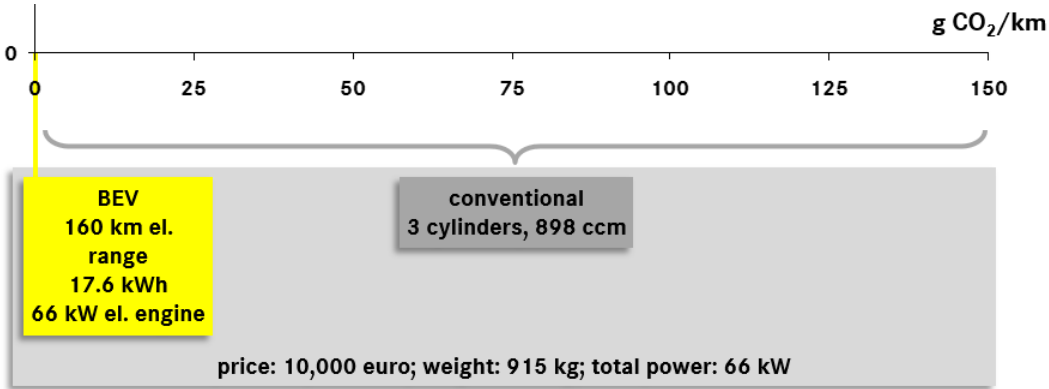


Fig. 5 Vehicle characteristics of a typical B-segment vehicle.

The resulting taxation curves (Fig. 6, Fig. 7, Fig. 8) are solely depending on CO₂ emissions. Since the characteristic lines comprise all taxation and incentive components in three years holding time, both one-time taxation (registration tax and grants) and yearly tax (annual tax and company car tax) items are included.

3 Results

Fig. 6 shows CO₂ based taxation step curves of a business customer vehicle based on a typical E-segment vehicle for the past three years in Norway, UK, Italy, NL, Germany and France. Fig. 7 shows the same for a private customer vehicle. Fig. 8 depicts the CO₂ based taxation of a B-segment vehicle for a private customer. The graphs allow the following conclusions:

- Some countries like the UK, NL, Norway and France use to adapt vehicle taxation on a yearly basis, whereas Germany and Italy keep their taxation schemes for several years.
- Beside France, there is a difference in taxation from 0 to 1 gCO₂/km-vehicles for private and business customers. This step indicates the tax and incentive advantage between BEV and PHEV. Norway reduced this step in 2016 and nearly eliminated it in 2017, whereas NL shows a vice versa development. This demonstrates the heterogenous fiscal classification of electrified vehicles.
- Business customers of PHEVs (range from 1 to 50 gCO₂/km) benefit from severe tax advantages compared to conventional vehicles (>50 gCO₂/km) in Norway and UK and from moderate advantages in France, NL and Germany in 2017. That's because the taxation level of business customer vehicles above 100 gCO₂/km in Norway and the UK is severely higher than in Italy, Germany and France.
- In UK and France, the tax difference between a conventional vehicle and a BEV or PHEV is much higher for a business customer than for a private customer due to the CO₂-dependent taxation of the benefit in kind for the private use of company cars in these countries. In Norway, the situation is vice versa and Norwegian private customers additionally profit from a value added tax exemption.
- The UK and France have stepwise changes in taxation with increasing CO₂ values. Contrary to that, Norway, NL and Germany have continuous correlations between vehicle CO₂ emissions and taxation levels, meaning each additional gram of CO₂ is charged. The steps at 50 and 110 gCO₂/km in Norway are caused by the weight reduction advantage of PHEV and hybrids. Italy has no dependency on CO₂ at all.
- The taxation level of a B-segment vehicle is much lower than of a E-segment vehicle due to the lower price (UK), the less engine power (Italy), the lower weight (Norway, NL) and the less displacement (Germany, France). In Norway, NL, UK, France and Germany, the B-segment-BEV advantages for private customers compared to a conventional vehicle are on similar levels (€1.500 to €2.000). In Italy, the advantage is much smaller.

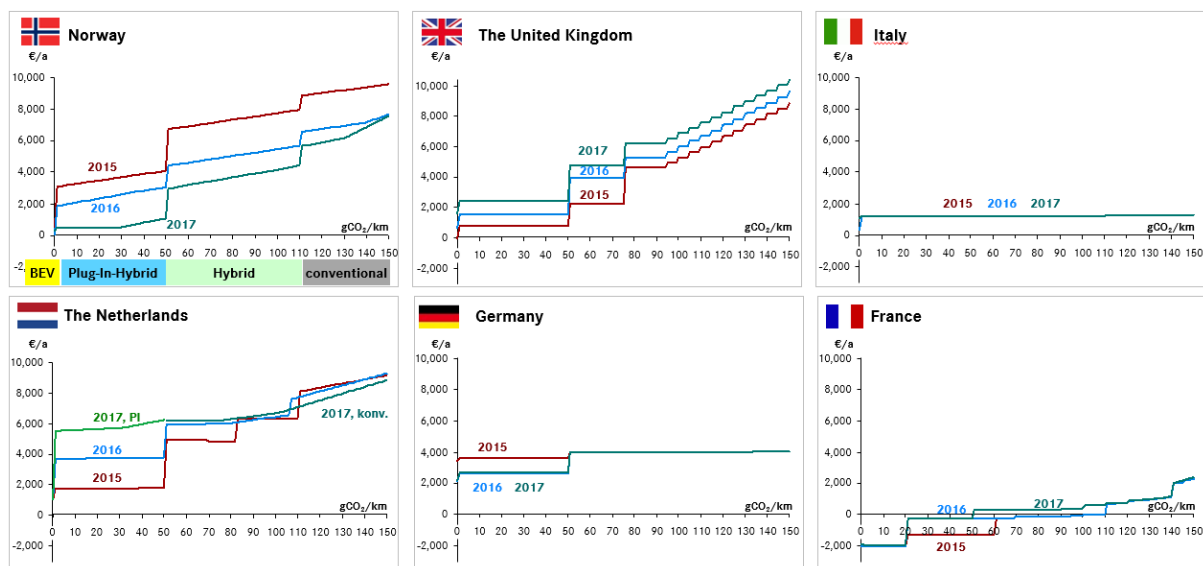


Fig. 6 CO₂ based step curves of vehicle taxation of **business** customers based on a typical **E-segment** gasoline vehicle in three years holding time, including one-time and yearly taxation/incentives in 2015, 2016 and 2017.

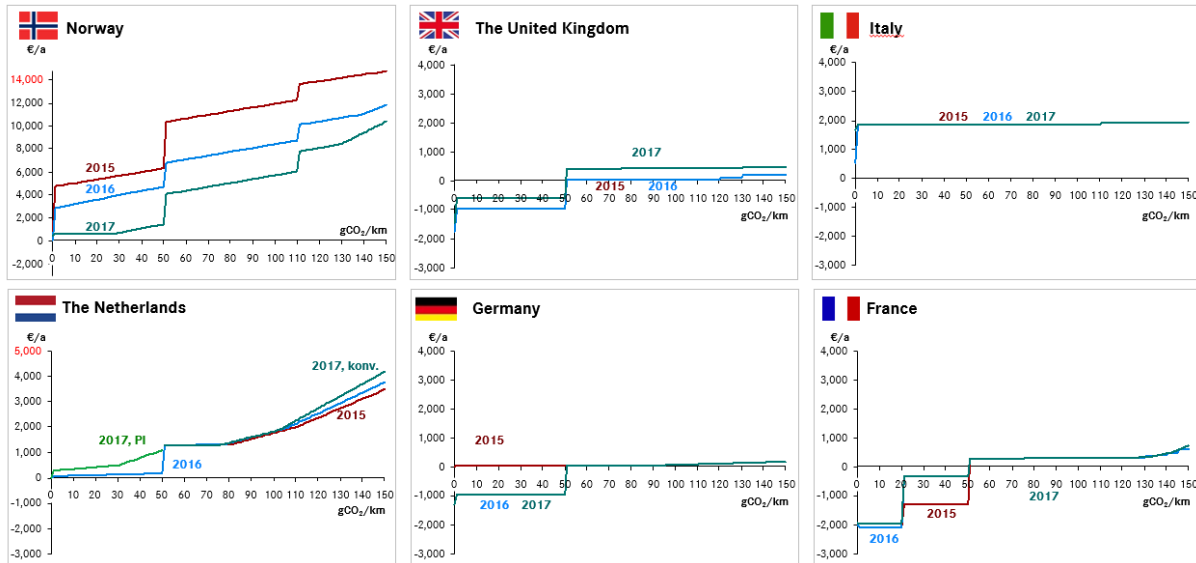


Fig. 7 CO₂ based step curves of vehicle taxation of *private* customers based on a typical *E-segment* gasoline vehicle in three years holding time, including one-time and yearly taxation/incentives in 2015, 2016 and 2017.

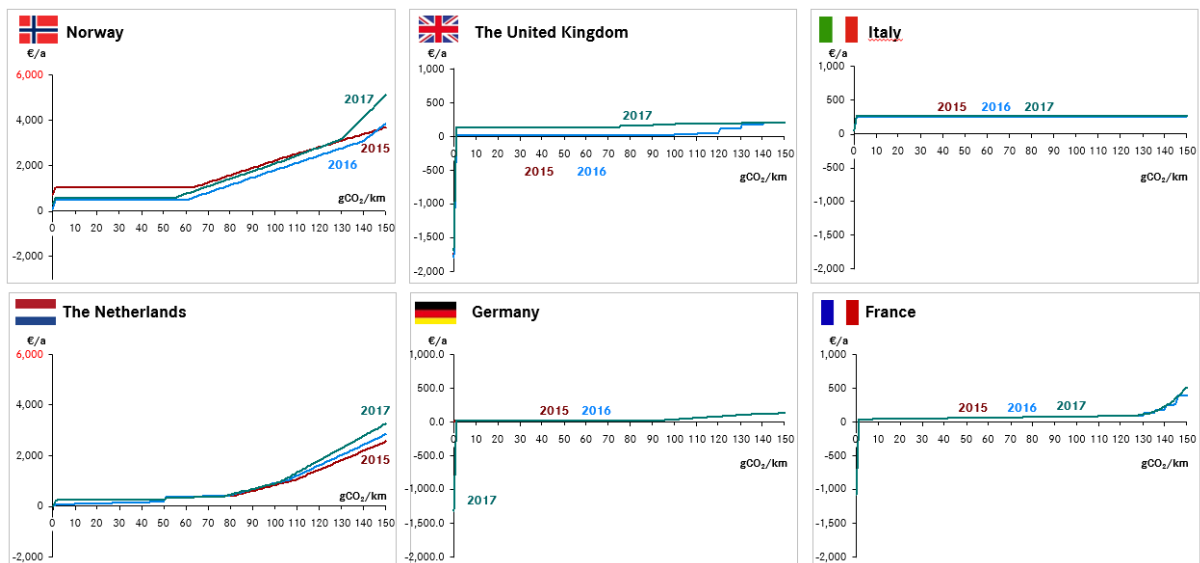


Fig. 8 CO₂ based step curves of vehicle taxation of *private* customers based on a typical *B-segment* gasoline vehicle in three years holding time, including one-time and yearly taxation/incentives in 2015, 2016 and 2017.

4 Outlook

In this section, the benefit of analysing CO₂ step curves is demonstrated on the one hand by analysing retrospective the bonus / malus system in France and on the other hand by discussing the announced development of vehicle taxation in UK and NL. As the UK, NL and France used to adapt their taxation schemes nearly every year, we focus on them in this section.

4.1 France

As described in section 1.2.6, France has installed a bonus / malus system at the point of vehicle registration in which the bonus is a purchase subsidy for vehicles with low CO₂ emissions and the malus is a fee for

vehicles with high CO₂ emissions. In Fig. 9, the respective bonus / malus scheme is shown from 2010 onwards. It can be seen that it was adjusted regularly with the following trends (marked in **Fehler! Verweisquelle konnte nicht gefunden werden.** with numbered arrows):

1. Decreasing bonus level.
2. Increasing malus level.
3. The starting point of the malus is shifted to lower CO₂ values.
4. CO₂ limits for subsidies are lowered.

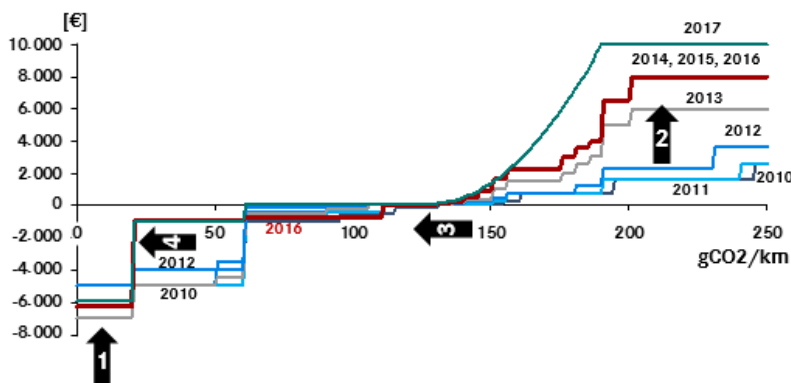


Fig. 9 Bonus / Malus scheme in France from 2010 to 2017

In 2017, the malus steps are eliminated respectively reduced to an increment of 1 gCO₂/km. In principle, every gram CO₂-emission has the same impact on the environment. From this point of view, there is no reason to have steps in vehicle taxation at certain CO₂ levels. Steps are more or less randomly chosen and hence lead to an unfair situation between vehicles, which differ only in 1 gCO₂/km. From a customer's point of view, continuous CO₂-dependency is fairer and follows the guidelines on financial incentives for clean and energy efficient vehicles (10).

4.2 The United Kingdom and the Netherlands

The UK and the Netherlands are two countries which announced at least parts of the future vehicle taxation until 2020 already.

The UK is planning a yearly increase of BIK rates until 2019 (see Fig. 10). From 2020 onwards, it is under discussion to introduce a dependency of the company car taxation to the electric driving range of PHEVs (1-50 gCO₂/km) (11). A long-range PHEV with more than 120 miles in zero-CO₂-emission-mode is treated equally to a BEV. This follows the assumption that a PHEV with more than 120 miles can be considered to drive predominantly electrically and should be promoted like a BEV. Such long-range PHEV will help to convince a larger share of the population to drive an electric vehicle as they help to overcome driving range limitations in areas with limited (public) charging infrastructure and to manage the one or two long distance vacation trips per year. In Fig. 10, we roughly illustrate the discussed dependency of electric driving range by translating the electric driving range in gCO₂/km. We assume that 130 miles correspond to less than 3 gCO₂/km, 70 miles correspond to 9 gCO₂/km, 40 miles correspond to 19 gCO₂/km and 30 miles correspond to 27 gCO₂/km.

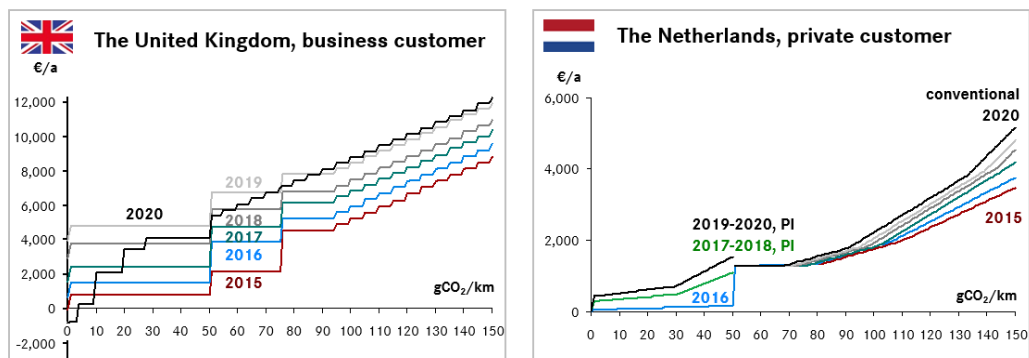


Fig. 10 CO₂ based step curves of vehicle taxation of business customers in the UK and private customers in the Netherlands from 2017 to 2020. The CO₂ step curves for the UK in 2020 are illustrating the ongoing discussion on introducing a dependency of electric driving range for PHEVs.

In the Netherlands, there was and is an increase in vehicle taxation every year until 2020, see Fig. 1 Fig. 10. The separate PHEV registration tax rates (introduced in 2017) will be increased in 2019 (see range of 1 to 50 gCO₂/km). Table 1 shows the CO₂ vehicle emissions by which a private customer has the same tax burden over the years. In 2020, a vehicle has to emit 100 gCO₂/km in order to have the same tax burden (€2,224 each year over 3 years holding period) like a 116.4 gCO₂/km-vehicle in 2015. Hence, a technical improvement of 2.5 to 3.5 % has to be achieved every year to maintain the identical tax level. In terms of CIP-percentage (continuous improvement process), this value is ambitious but still technically reasonable. Looking at a business customer in the UK, the mean CIP-percentage would be about 7.5% to have the same tax burden like in the previous year. This is far beyond a technical reasonable CIP. As a consequence, a part of the company car users will choose an xEV due to the fiscal attractiveness. Nevertheless, an additional consequence is that the number of company car users decreased over the past last years (12) as xEVs are not yet suitable for all customers (dependency on charging infrastructure, limited variety of xEV models, missing confidence in new technology). The customers escaped from the steering effect of company car taxation as the yearly tightening was not acceptable for them.

private customer in Netherlands							
year	-	2015	2016	2017	2018	2019	2020
vehicle emission	in gCO ₂ /km	116.4	112.5	109.5	106.0	130.5	100.0
delta vs. previous year	in %		3.3	2.6	3.2	2.4	3.4
business customer in UK							
year	-	2015	2016	2017	2018	2019	2020
vehicle emission	in gCO ₂ /km	140	130	120	110	95	90
delta vs. previous year	in %		7.1	7.7	8.3	13.6	5.3

Table 1 CO₂-values for having the same tax burden every year in absolute values (gCO₂/km) and relatively to previous year (%) for business customers in the UK and private customers in the Netherlands.

5 Conclusion

In this contribution, a methodology is introduced which gives a comprehensible overview of the heterogeneous and complex vehicle taxation landscape. By calculating CO₂ based taxation step curves, the influence of CO₂ on vehicle taxation in different European countries is demonstrated and compared for private and business customers as well as for different vehicle segments (full-size cars in E-segment and small cars in B-segment). This methodology enables the discussion about the development of taxation and incentive schemes and provides a powerful tool for benchmarking xEV technologies in a comprehensive European comparison.

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