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Vehicle Emissions and Impacts of Taxes and Incentives in the Evolution of Past Emissions

Report to EEA

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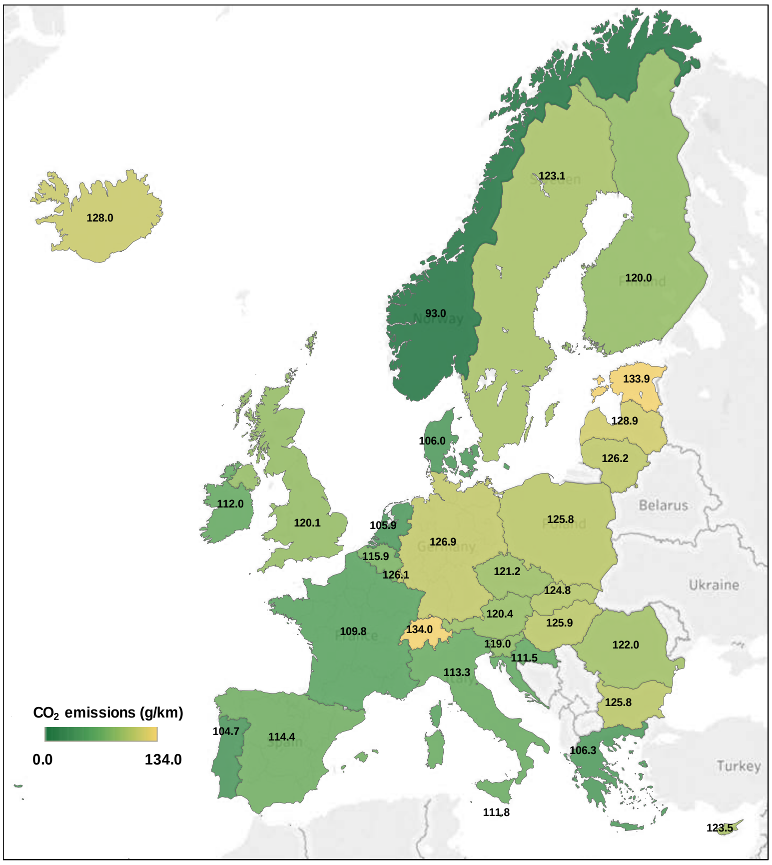
Executive Summary

Introduction

Reducing greenhouse gas (GHG) emissions from the road transport sector is a key priority for the European Union (EU). Passenger cars are responsible for 44% of transport emissions, and are therefore an important target for emission reduction policies (EEA, 2017a). A key mechanism for reducing Greenhouse Gas (GHG) emissions from cars in the EU is Regulation (EC) No 443/2009. This placed an obligation on vehicle manufacturers to achieve an average Carbon Dioxide (CO_2) emission performance for the vehicles they produce, and at the EU level set a target of 130 g CO_2/km to be met by 2015 (which was achieved by a margin of 10 g CO_2/km), and a further target of 95 g CO_2/km to be met by 2021 (phased in from 2020). This mechanism can be considered as a supply side measure since it acts directly on the manufacturers. Complementing this Regulation is action at the national level, which impacts on consumers, retailers and fleet managers. This helps create the demand for lower carbon vehicles. This action typically involves financial mechanisms which often include vehicle tax.

Overall, in the EU, the average CO_2 emissions of new passenger cars has fallen steadily in recent years, from 170 g CO_2/km in 2001 to 118 g CO_2/km in 2016. However, underlying the EU-level trends there is substantial variation between countries, in terms of their average CO_2 emissions and the rate of reduction seen over time. Portugal had the lowest average CO_2 emissions of the EU-28 countries in 2016 of 105 g/km, compared to the highest value of 134 g/km in Estonia. Countries have also shown considerable differences in their rate of uptake of zero- and low-emission vehicles.



Average CO_2 emissions from new passenger cars for the EU-28 + Norway, Iceland and Switzerland in 2016 (g CO_2/km)

Objectives of the study
The analysis presented in this report considers the role that national level actions such as taxes and other financial incentives have had in driving reductions in average CO_2 emissions from new passenger cars in Europe.

It aims to synthesise understanding of how these measures affect the uptake of vehicles with lower CO_2 emissions, and to examine the extent to which differences in average CO_2 emissions (and trends over time) between countries may be attributable to differences in the taxation and incentives systems in place.

This study took two complementary approaches to addressing this goal:

1) In the first part of the study, an inventory of taxation systems across Europe was created, to understand differences between countries and over time in the incentives present;
2) In the second part of the study, in-depth case studies were carried out for seven individual countries, examining evidence of the impact of taxation and other incentives in specific countries.

Taxes and incentives considered include those based on the CO_2 emissions (or a proxy such as engine power) of vehicles, as well those specifically targeted at zero- and low-emission propulsion technologies (including fuel cell, electric and hybrid vehicles). The impact of fuel tax was also considered, but dealt with separately as this is present to some extent in all of the countries studied.

Inventory of taxes and incentives encouraging CO_2 emission reductions
The inventory of taxes and incentives consisted of two key aspects:

a) A comprehensive assessment of taxes and incentives available in 2016 across Europe. The geographical coverage includes the EU-28 plus Norway, Iceland, Switzerland and Liechtenstein; and
b) A time-series of key taxes and incentives over the reference years 2010 to 2016, for EU countries.

The inventory was compiled from a variety of publicly accessible sources, including vehicle tax guides published by the European Automobile Manufacturers Association (ACEA), and summaries of incentives produced by the European Alternative Fuels Observatory. The choice of years and approaches reflected data availability. It is important, therefore, to note that this work does not reflect the very latest incentives introduced in the countries. The outcomes of the analysis were framed around four categories: acquisition (upfront) incentives; recurring incentives; company incentives and infrastructure related incentives. The inventory recorded the presence or absence of different types of tax and incentive in each country and year. Due to the varied ways in which the rates of taxes and incentives are structured, it was not possible to quantify and compare the strength or monetary size of incentives between countries or over time.

The comprehensive assessment showed that all of the 32 countries considered offered at least one type of tax or incentive encouraging uptake of passenger cars with lower CO_2 emissions. Most countries tended to employ a range of different environmental taxes and incentives, acting at more than one point in the car ownership process. However, some countries such as Bulgaria, Poland, Estonia and the Czech Republic had relatively few incentives on the timescales that this project considered. Almost all countries (29) provided incentives encouraging uptake of efficient conventional internal combustion engine vehicles (ICEVs) and of zero- or low emission vehicle technology (BEVs, PHEVs, HEVs and FCEVs[1]).

[1] BEV = Battery electric vehicle; FCEV = Fuel cell electric vehicle; PHEV = Plug-in hybrid electric vehicle; HEV = Hybrid electric vehicle (not plug-in)

However, specific incentives for company cars (e.g. variable capital allowances and benefit-in-kind taxation) were only provided in about half of the countries and evidence of government support for electric charging infrastructure was only found for 11 countries.

Summary of the presence/absence and the number of taxes and incentives available by country to encourage purchase of cars with lower CO_2 emissions in 2016.

Country	CO_2 and proxy based incentives				Incentives for zero- and low-emission vehicles				
	Acquisition	Recurring	Company	Total number*	Acquisition	Recurring	Infrastructure	Company	Total number*
Austria	✓	✓	✓	3	✓	✓	✓	✓	8
Belgium	✓	✓	✓	4	✓	✓		✓	4
Bulgaria		✓		1		✓			1
Croatia	✓	✓		2			✓		1
Cyprus	✓	✓		2		✓			2
Czech Republic		✓		1		✓			1
Denmark	✓	✓	✓	3	✓	✓	✓		6
Estonia				0		✓			2
Finland	✓	✓		3	✓				1
France	✓	✓	✓	8	✓		✓	✓	5
Germany		✓		1	✓	✓		✓	5
Greece	✓	✓		3	✓	✓			4
Hungary	✓	✓	✓	4	✓	✓		✓	7
Iceland	✓	✓		2	✓	✓	✓		5
Ireland	✓	✓	✓	3	✓	✓	✓		6
Italy	✓	✓		2	✓	✓			3
Latvia	✓	✓	✓	3	✓	✓		✓	5
Liechtenstein		✓		1	✓	✓			2
Lithuania				0		✓			2
Luxembourg		✓		1		✓		✓	2
Malta	✓	✓		2	✓	✓			5
Netherlands	✓	✓	✓	3	✓	✓	✓	✓	6
Norway	✓			1	✓	✓	✓	✓	10
Poland	✓			1					0
Portugal	✓	✓		2	✓	✓		✓	6
Romania	✓	✓		2	✓	✓	✓		4
Slovakia	✓	✓		2		✓			2
Slovenia	✓	✓		2	✓	✓			2
Spain	✓	✓	✓	3		✓	✓	✓	8
Sweden		✓		1	✓	✓	✓	✓	7
Switzerland		✓		1	✓	✓			2
United Kingdom	✓	✓	✓	7	✓	✓	✓	✓	5
Total	23	28	10	30	22	28	12	13	31

*A higher number of incentives does not necessarily imply a higher monetary value of incentives.

The analysis of taxes and incentives over time showed that overall, there was relatively little change in the number of countries employing taxes on acquisition or ownership graded by CO_2 or a proxy (such as engine power) during the period 2010-2016. However, there was a rise in the number of countries using CO_2 or a proxy as the basis for company car taxation, from 5 in 2010 to 10 in 2016. In contrast, the number of countries offering incentives for BEVs, FCEVs, and PHEVs increased considerably over the same period. Overall, this suggests that incentives have become broader and more comprehensive over time.

Although the presence or absence of CO_2 (or proxy) based taxes and incentives was relatively stable, the boundaries between tax bands and the monetary value of incentives have shifted over this period in many countries. For example, in the Netherlands the threshold CO_2 emission value for exemption of petrol cars from registration tax moved progressively downwards over the period, from 110 g CO_2/km in

2010 to 50 g CO_2/km in 2016. However, as mentioned above it was not possible to quantify overall changes in tax band boundaries or incentive size across Europe.

In-depth national case studies

The seven country case studies were purposefully chosen to explore different approaches used for taxation and incentives, and countries having seen differing trends in average CO_2 emissions or uptake of low-emission vehicle types. The countries considered were the Netherlands, Greece, Norway, Germany, Poland, France and Ireland. The case studies drew heavily upon the academic literature available, including studies using econometric models, consumer surveys and other types of analysis to quantify the impact of vehicle taxation and incentives in individual countries. Additionally, context was also provided by information on taxation and trends in vehicle purchasing behaviour, using the same sources as the inventory compilation described above.

The following key conclusions were made based on the case studies.

i) Where there were sufficiently large and targeted taxes and incentives in place, consumer adoption of lower CO_2 emitting vehicles followed.

- In the Netherlands, average CO_2 emissions have fallen more rapidly than the average for the EU since 2007. Since 2008, purchasing a CO_2 efficient car has been encouraged through registration tax and annual circulation tax structure, combined with favourable taxation of company cars. Since 2010, the tax system has also favoured electric and plug-in hybrid vehicles, and the Netherlands now has the highest share of these vehicles in new car sales in the EU. It is suggested that 15-20% of the reduction in emission rates between 2005-2012 are due to CO_2 based taxation.
- Norway has highest proportion of full-electric cars (BEVs) in Europe. This reflects an active, long term policy of relevant incentives, covering vehicle acquisition, ownership, charging infrastructure, as well as exemptions from toll and ferry charges. These benefits have ensured that the cost of BEVs and PHEVs is comparable to a similar ICEV. As a result of the high share of BEVs and PHEVs in new car sales, Norway also had the lowest average CO_2 emissions from new cars in Europe in 2016, at 93 g CO_2/km.
- France has seen a steady fall in average new car CO_2 emissions since 2001, remaining below the EU average. The decline accelerated in 2008, alongside introduction of a bonus-malus scheme penalising purchase of high-emission vehicles and rewarding lower-emission vehicles. From 2007 to 2009, the average emissions dropped by 8.7 g CO_2/km, 90 % of which can be attributed to tax reform.
- In Ireland, registration tax and annual circulation tax have been based on CO_2 emissions since 2008. Before then, average emissions of new cars sold in Ireland were well above the European average, but since introduction of the taxes, emissions have dropped much more quickly than the average European emissions. This rapid reduction was achieved by rapid dieselisation, due to the generally lower CO_2 emissions of diesel cars.

ii) In contrast, where there were more limited taxes and incentives in place, the rate of emissions reductions was lower.

- Average new car CO_2 emissions in Germany were above the EU average in 2016. There are several possible reasons for this, including the high average mass and power of the German car fleet, low rates of annual circulation tax, and the high share of company cars in the fleet (66% in 2015). Company car drivers tend to be less sensitive to increases in fuel prices, making it more difficult to influence behaviour through fuel tax.

- Poland has seen a slower reduction in CO_2 emissions from new cars than the EU as a whole, moving from well below the average in 2004 to 8 g/km above the average in 2016. No taxes in Poland are based on CO_2 emissions explicitly, and although the registration tax is based on engine capacity, the categorisation is crude so does not give additional incentives for the best CO_2 performing car models. Moreover, the tax is based on the value of the vehicle, and because a high proportion of cars in Poland are registered second-hand, this encourages import of older, less CO_2 efficient cars from other EU countries.

iii) The case studies also highlight the importance of country context. In Greece, CO_2 emissions from new cars were the fourth lowest in the EU in 2016, at 106 g CO_2/km, having been above the average until 2010. It would be difficult to attribute these changes due to CO_2-based tax incentives, as the registration tax had no CO_2 component until 2017 and the annual circulation tax is low. However, the economic crisis had a large impact on Greece, and a luxury tax was introduced affecting large, heavy cars. In 2016 new cars in Greece had the lowest mass, engine capacity and power in Europe (after Malta). It is suggested the decrease in emissions between 2009 and 2016 reflects the increased dieselisation and the impacts of the severe economic crisis on Greece, which has resulted in a reduction in demand for cars, especially larger (more expensive and higher emitting) ones. While, in Poland, the rise in car ownership can linked to the large political and associated socio-economic changes which have occurred over the past thirty years. The ready availability of car models from Western Europe has facilitated this rise.

iv) Finally, the case studies also illustrate the wider, often unintended, impacts of vehicle taxation. One such unintended impact is the potential for additional vehicle mileage and associated impacts on CO_2 emissions if less costly vehicles result in increased vehicle ownership (“rebound effects”). For example, in the Netherlands, it is estimated that tax reductions for small, low-emissions cars caused an annual extra sale of some 25,000 to 30,000 cars. In France following the introduction of the bonus-malus system in 2008, sales of new vehicles increased by 3.5 %, resulting in a revenue deficit of EUR 225 million. A second unintended impact is the potential for air quality impacts of increased dieselisation, if vehicles are encouraged on the basis of CO_2 emissions alone, without additional consideration of other emissions. In Ireland, this kind of situation caused a shift in diesel car share from 27% of new cars in 2007, to 70% in 2016. A final potential impact is that incentives for low CO_2 emission cars could encourage people to change their cars more often. Consideration of the full life cycle impact of these vehicles is therefore important, including in the context of the location of vehicle use.

Conclusions

The aims of this study were to document the taxes and incentives in place across Europe designed to encourage reductions in average CO_2 emissions from new cars, and to synthesise understanding of the impact of these measures on car purchasing and usage behaviour.

The inventories have shown that most European countries employ some kind of vehicle tax or incentive based on CO_2 emissions, a proxy such as engine size, or low-emission propulsion type (such as electric or hybrid vehicles), but the number and focus of the incentives varies among countries. The number of countries using such taxes and rose between 2010 and 2016, largely due to introduction of more incentives for plug-in vehicles, and additional green company car taxes.

The case studies provide evidence that taxes and incentives – if sufficiently large and targeted – can have a strong impact on the composition of new car sales, although other factors such as improving technology and reducing economic hardship can also be important. Careful design of policy is required to avoid rebound effects and unintended adverse impacts such as increased emissions of other pollutants.

Glossary

Abbreviation	Definition
ACEA	European Automobile Manufacturers Association
AFV(s)	Alternatively fuelled vehicles
BEV(s)	Battery electric vehicle(s)
CO_2	Carbon dioxide
E85	A mixture of 85% ethanol and 15% petrol (gasoline)
EAFO	European Alternative Fuels Observatory
EEA	European Environment Agency
EU	European Union
FCEV(s)	Fuel-cell electric vehicle(s)
Feebate	Combination of a fee as a disincentive to purchase some vehicles, and a rebate as an incentive to purchase other vehicles
GHG	Greenhouse gas
HEV(s)	Hybrid electric vehicle(s)
ICEV(s)	Internal Combustion Engine Vehicle(s)
I-CVUE	Incentives for Cleaner Vehicles in Urban Europe
LPG	Liquefied petroleum gas
NEDC	New European Driving Cycle emissions test procedure
NG/biomethane	A mixture of natural gas and methane originating from biomass
PEV(s)	Plug-in electric vehicle(s)
PHEV(s)	Plug-in hybrid electric vehicle(s)
TCO	Total cost of ownership
WLTP	World Harmonized Light Vehicle Test Procedure

1 Introduction

Reducing greenhouse gas (GHG) emissions from the road transport sector is a key priority for the European Union (EU). Transport as a whole including aviation but excluding international shipping, represents around a quarter of EU GHG emissions and is the only major sector where emissions are still rising (EEA, 2017a). In 2015, 73% of the GHG emissions from transport came from the road transport sector, and 44% from passenger cars alone (EEA, 2017a).

A key mechanism for reducing GHG emissions from cars the EU is Regulation (EC) No 443/2009. This places an obligation on vehicle manufacturers to achieve an average Carbon Dioxide (CO_2) emission performance for the vehicles they produce, and sets an EU-level target of 130g CO_2/km to be met by 2015 and a further target of 95g CO_2/km to be met by 2021 (phased in from 2020). Correspondingly, Member States are required to record and collate information for each new passenger car registered in their territory and to report this information to the European Commission by 28 February of each year. Data are submitted to the Central Data Repository, managed by the EEA.

Complementing the Regulation, Member States individually, have GHG emission reduction commitments through EU legislation and International obligations. Reducing GHG emissions from the car fleet in their territories will clearly need to form part of the process for meeting those commitments. The obligations placed on vehicle manufacturers directly through Regulation 443/2009, and the general obligation to ensure free movement of goods within the EU, mean that individual Member States cannot set their own CO_2 emission standards for cars sold in their territory. Nor would such standards necessarily incentivise consumers to purchase lower emission alternatives. As a result, all Member States operate some form of financial mechanism to help shift the car fleet towards lower emission vehicles, in particular, through the taxation system.

Financial mechanisms can therefore be key at the Member State level and can be directed at a number of points in the car purchase and running chain. At the start of the chain, consumers (car buyers) can be offered up front subsidies on the cost of new vehicles. While reductions later in the chain affect the running costs of lower emission vehicles, e.g. through reductions in circulation tax or subsidised electricity for charging electric or plug in hybrid vehicles.

Sitting between the manufacturers and the consumer are vehicle retailers, albeit these often tied to specific manufacturers through franchise operations. Certain incentives (e.g. subsidised pricing, scrappage schemes) are delivered via retailers, although the incentive still effectively acts upon the consumer.

A further key sector to address is the company car market. Incentives in this sector can act on consumers (the individual user), e.g. changes to personal taxation based on the CO_2 emission performance of a company vehicle, or on fleet managers to reduce emissions overall from their fleet.

Overall, this provides two parallel systems, one acting directly on the manufacturers (supply side) and the other on consumers, retailers and fleet managers (demand side). It is clearly not a simple matter to disentangle the impact of one from the other and, in fact, they are both necessary for the success of the policy overall. Member States would not be able to incentivise lower emission vehicles if those vehicles were not available on the supply side, and without incentives on the vehicle demand side, patterns of consumption could simply shift towards vehicles at the more polluting end of the supply offering, if these vehicles are more desirable or cheaper.

This report focuses on vehicle demand side measures: examining the taxation strategies used by Member States to reduce new car fleet CO_2 emissions and assesses their relative success. This is in line with the European Environment Agency's project remit. The report is therefore framed around two key, related, objectives:

- The development of an inventory of the vehicle taxation and incentive systems in the European context (Subtask 1)

- Presenting a series of in-depth case studies of key relevant countries, to better understand the impacts that different tax and incentive approaches have had on CO_2 emissions of the new passenger car fleet (Subtask 2)

Correspondingly the report is structured as follows:

- Chapter 2 sets the scene by examining recent trends in CO_2 emissions across the new car fleet in Europe. Differences between countries and different vehicle fuelling options are considered.
- Chapter 3 presents an inventory the vehicle taxation systems in place across Europe. The chapter first briefly describes the background to and the scope of the taxes and incentives considered, then summarises the findings, focusing on how countries differ and the trends observed over time. The findings are broadly framed around taxes at the acquisition stage (up front); taxes through the lifetime cost of the vehicle (circulation taxes); and company car tax. These findings are provided at the overview EU level and for the individual countries.
- Chapter 4 builds on the outcomes of the vehicle taxes analysis, considering in detail seven different countries with varying histories of vehicle taxation and differing trends in CO_2 emissions over time. The seven case studies purposefully reflect the range of approaches and the geographic and socio-demographic nature of countries in Europe. Outcomes of the different approaches are detailed with reference to impacts and lessons learnt.
- Chapter 5 offers conclusions and recommendations for further work.

2 Recent trends in passenger car purchases

This chapter presents recent trends in average CO_2 emissions from new passenger cars and in the composition of the new car vehicle fleet. It therefore provides context to the analysis of taxation policies and their impacts which is presented in the following chapters.

Trends are presented for the EU as a whole and for individual countries, considering the variation currently seen across Europe and trends over time. The trends are not disaggregated, therefore the patterns reflect the impact of supply side measures (e.g. EU regulatory) as well as demand side (e.g. consumer focused) measures i.e. in terms of taxes and incentives which take place at the country level.

When interpreting the trends described below, it is important to note that analysis throughout this report:

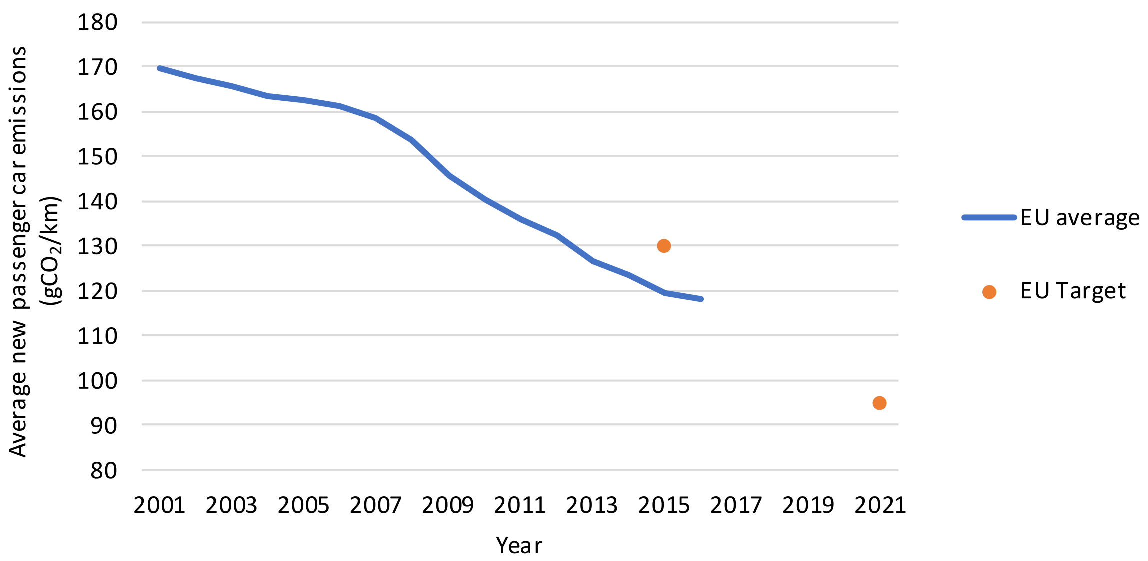
1) In terms of CO_2 emissions considers only new cars (i.e. newly produced). It therefore does not evaluate emissions from the existing fleet.

2) Assumes CO_2 emissions associated with the New European Driving Cycle (NEDC) cycle rather than typical "on the road" emissions. In line with the NEDC, tank to wheel rather than life cycle emissions are therefore considered.

3) Considers the EU-28 Member States along with Norway, Iceland, Switzerland and Liechtenstein where data was available.

2.1 Overall trends and performance in CO_2 emissions

Between 2001 and 2016, the average CO_2 emissions performance of new cars in the EU fell by around 30 %, from 170 g CO_2/km to 118 g CO_2/km (Figure 2-1).

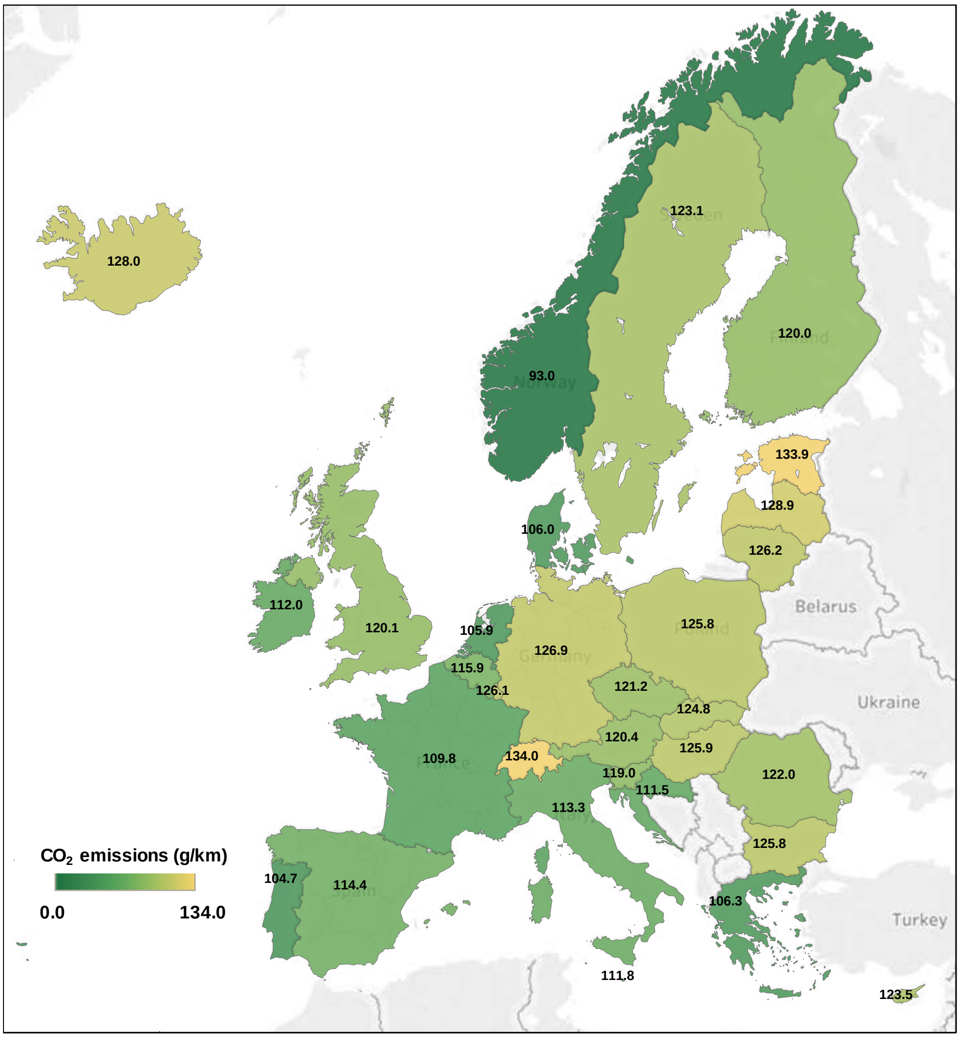


Source: EEA (2017b)

Figure 2-1. Average CO_2 emissions from new cars sold in the EU, 2001-2016, compared with the 2015 and 2021 targets. The geographical scope of the data changes over time from EU-15 to EU-25, EU-27 and EU-28.

This chart shows that, based on test results prior to sale, the new car fleet across the EU met the 2015 target of 130 g CO_2/km by a margin of around 10 g CO_2/km which, in the context of such targets is relatively comfortable. It also shows that, again according to test results, the downward trend is continuing at a steady rate. However, a further 19.5 % reduction in CO_2 emissions will be required to comply with the 2021 target of 95 g CO_2/km (30 % below the 2015 target). Extrapolating the current trend, compliance with the 2021 target will be marginal at best. The indication therefore is that the uptake of low emission vehicles will need to accelerate in order for the target to be met.

Observing how these overall trends are reflected in individual Member States provides some indication of the strength of incentives (to move towards lower emission vehicles) offered by each Member State. However, some caution is required. The policies at EU and Member State level act on the sale of new vehicles rather than the existing fleet. The strength of new vehicle sales and thus the rate of turnover of the fleet, will depend on strength of the economy in the Member State as well as “cultural” attitudes towards car purchasing and the base taxation applied to all vehicles (i.e. not differentiated by CO_2 emission performance). Figure 2-2 and Figure 2-3 show how CO_2 emissions from the car fleet vary between Member States and the trends in such differences.

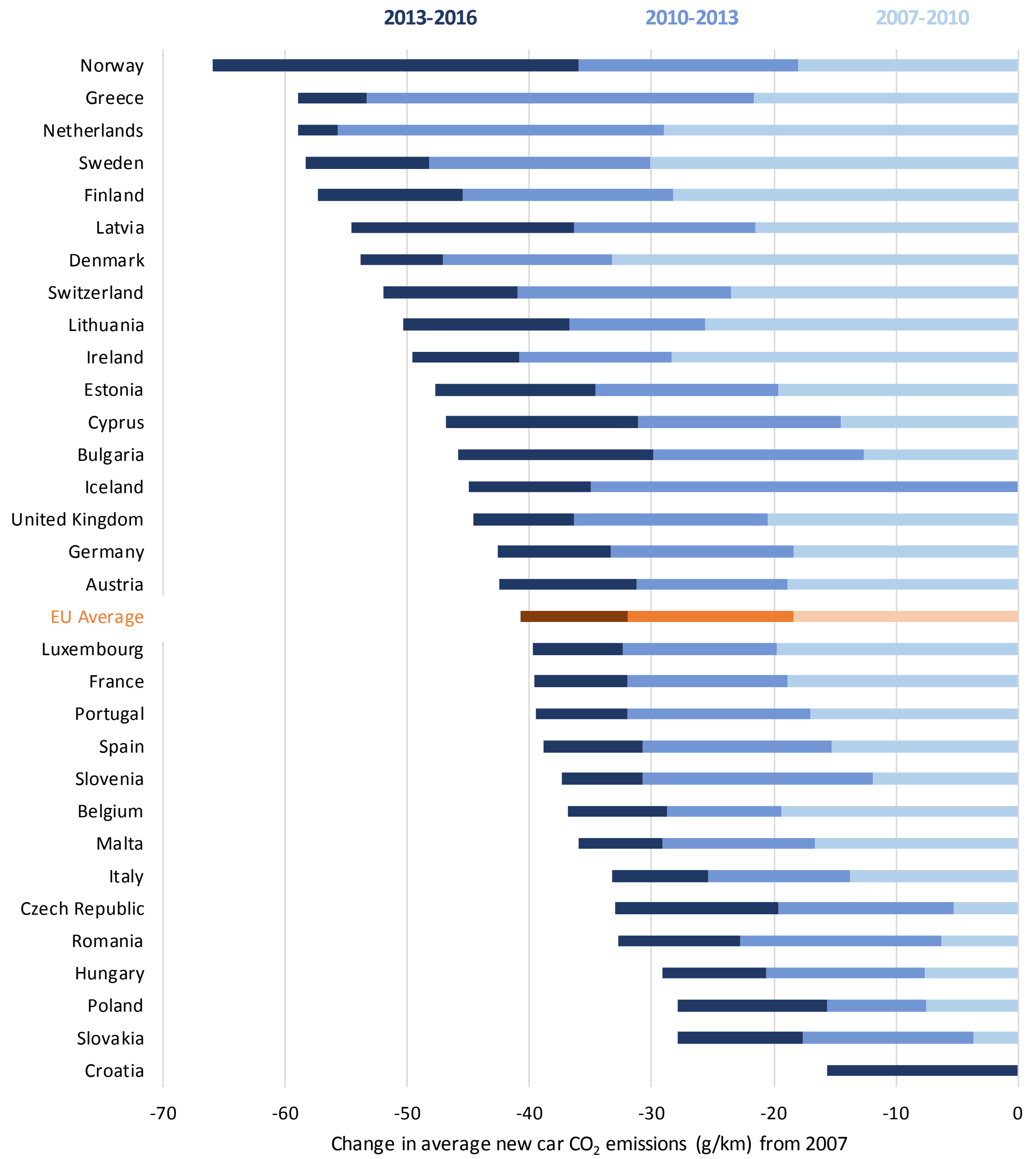


Source: EU-28 – EEA (2017b); Norway – OFV (2017); Switzerland - SFOE (2017); Iceland – RSV (2017).

Figure 2-2. Average CO_2 emissions from new passenger cars for EU-28 countries plus Norway, Iceland and Switzerland in 2016.

CO_2 emissions figures are rounded to the nearest 1 decimal place.

Figure 2-2 shows clear differences across Europe in average CO_2 emissions performance of new cars in 2016, with the lowest emissions in Norway (which is not an EU Member State), followed by Portugal, Greece, Denmark and the Netherlands. The highest average CO_2 emissions are in Switzerland and Estonia.



Source: EU – EEA (2017b); Norway – OFV (2017) and NAF (2017); Switzerland - SFOE (2017) and Alberini and Bareit (2016); Iceland – RSV (2017). Croatia has only reported data to the EEA since 2013.

Figure 2-3. Change in average CO_2 emissions from new passenger cars in the EU plus Norway, Iceland and Switzerland, by country, from 2007-2010, 2010-2013 and 2013-2016.

Average CO_2 emissions from new cars has fallen in all European countries since 2007, but the size of the reduction, as well as the timing of when the most significant changes occurred, has varied between countries (Figure 2-3). Norway has seen the largest absolute reduction since 2007, followed by Greece and the Netherlands. The smallest reductions occurred in Poland and Slovakia. For the EU as a whole, the rate of change in the average CO_2 emissions from new vehicles was highest between 2007 and 2010, falling in the 2010-2013 period and again between 2013 and 2016.

Taking the Scandinavian group of countries as an example, the rate of change in Sweden, Finland and Denmark follow the average pattern for the EU, i.e. the rate of change is highest in the earlier period and lower in the later period. This is not the case for Norway, where the rate of change was consistent in the first two periods (and lower than for Sweden) but much higher in the 2013-2016 period. This indicates that changes in purchasing behaviour occurred in Norway which were not replicated in the neighbouring countries.

Taking another example, the Netherlands has seen the third largest reduction in average CO_2 emissions over the whole period (2007 – 2016). However, in the period 2013-2016 the Netherlands showed the smallest reduction of any EU country, which suggests a change in policy or other factors influencing car purchase behaviour occurred during the period.

Likely drivers of differing trends in average new car CO_2 emissions in a selection of countries (including the Netherlands and Norway) are explored in the case studies presented in Chapter 4.

2.2 Trends in fleet composition and emission performance

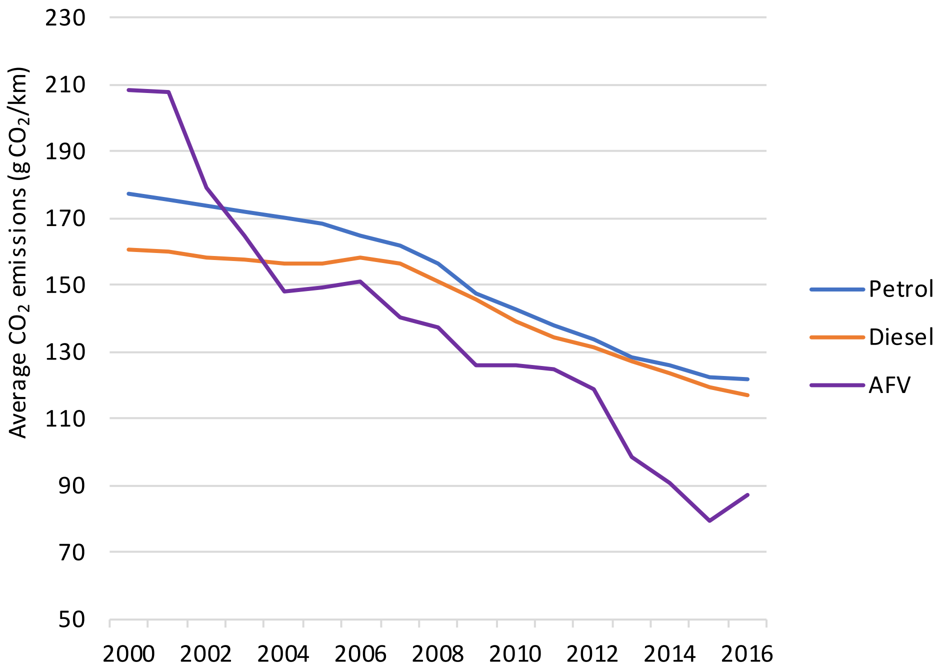
The composition of the car fleet across the EU, and thus the CO_2 emissions performance, has changed over time, partly because of the CO_2 emission reduction policies being pursued by the EU and Member States individually and partly as a result of wider consumption trends. In broad terms, cars in the EU have tended to become larger and heavier over time (ICCT, 2017) thus are inclined to act in the opposite direction to policies aimed at reducing CO_2 emissions. However, this is not a simple pattern: a larger, heavier car need not produce higher CO_2 emissions if its drive train is more efficient or if it uses non-conventional power, e.g. plug in hybrid (PHEV) or full electric (BEV or FCEV) and if this power is obtained through lower carbon electricity. It is also worth noting that conventionally fuelled cars (Internal Combustion Engine Vehicles – ICEVs) have improved fuel efficiency over time. However, there is likely to be a limit to how low emissions from ICEVs can go – ultimately a fuel has to be burned in order to produce power and thus CO_2 will be emitted. Nor is it currently possible to produce biofuels for use in ICEVs which are truly carbon neutral and sustainable. However, it is also true to say that the limit has not yet been reached and that further efficiency gains from ICEVs are likely to be possible.

Figure 2-4 and Figure 2-5 below illustrate this change over time. Figure 2-5 shows the fleet composition for new petrol, diesel and alternatively fuelled vehicles (AFVs) across the study area. AFVs comprise fully electric vehicles, plug-in and non-plug-in hybrids, and vehicles burning LPG, NG/biomethane and E85 (85% ethanol – 15% petrol mixture). Two things are immediately apparent from this chart: firstly, that the uptake of diesel fuelled cars has been very strong until recently, making up 50% of the new car fleet at one point; and secondly that AFVs make up only a very small proportion of the new car fleet. This means that efficiency gains in ICEVs are responsible for the majority of the reduction in CO_2 emissions from new cars.

This is borne out by Figure 2-4, which shows a reduction in average CO_2 emissions from new petrol, diesel and AFVs between 2000 and 2016, with stronger performance in ICEVs since 2006. Emission reductions in petrol and diesel cars track each other closely, especially since 2006, with diesels performing slightly better, at least on the basis of test results. AFVs improve more quickly over the period this could reflect the smaller sample size than for ICEVs (as illustrated in Figure 2-5) but could also be due to increasing availability of electric vehicles which will offer lower CO_2 emissions (tank to wheel) compared with other alternative fuelled vehicles. What is clear is that switching to AFVs will produce a faster reduction in CO_2 emissions than simply relying on efficiency gains in ICEVs, assuming that these continue at the current rate.

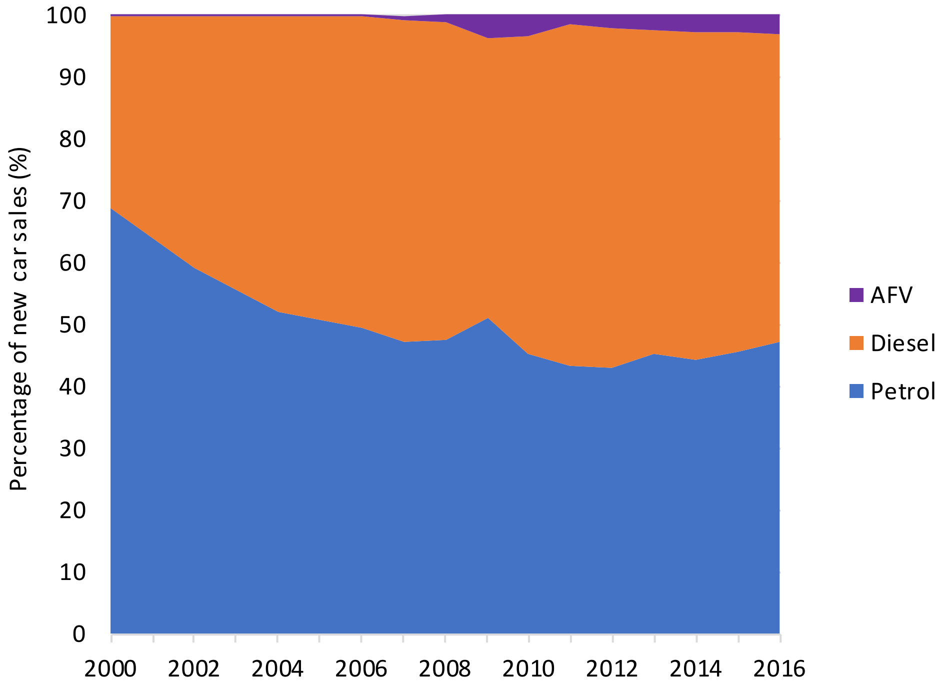
The rapid decrease in average CO_2 emissions from AFVs partly reflects a change in the type of AFVs purchased over time, with an increasing share of plug-in fully electric and hybrid vehicles. Sales of AFVs can be seen in Figure 2-5 from 2006 onwards, but Figure 2-6 shows that, until 2010, sales of BEV and PHEVs were negligible, with the early AFV uptake likely to consist of alternatively fuelled ICEVs, e.g. LPG or CNG fuelled vehicles. Although market share for PHEVs and BEVs combined in 2016 was low at 1.1%, sales of both types of vehicle are growing strongly.

Once again, the picture is not consistent across the study area. Figure 2-7 shows the variation in BEV and PHEV market share in 2016. While the broad patterns are similar to Figure 2-2, there are some clear differences. Norway shows both the lowest average CO_2 emissions for new cars (Figure 2-2) and the highest uptake rate for PHEVs and BEVs. However, while Greece is one of the stronger performers in terms of average CO_2 emissions, it has one of the lowest uptake rates for PHEV and BEVs. This illustrates that, for some countries, reducing CO_2 emissions is more strongly tied to efficiency gains in ICEVs which may not be sufficient to maintain improvements over the long term. While such countries could avoid "early adopter" penalties as the PHEV and BEV technologies mature, roll out of charging infrastructure may need to be implemented at a faster pace should ICEV improvements slow down.



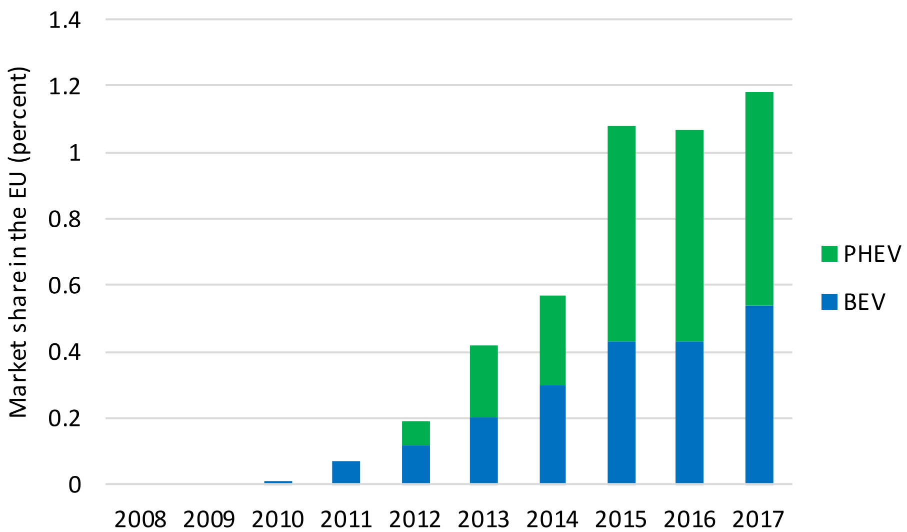
Source: EEA (2017b)

Figure 2-4. Average CO_2 emissions from new passenger cars in the EU, 2000-2016, by fuel type. The geographical scope of the data changes over time from EU-15 to EU-25, EU-27 and EU-28.



Source: EEA (2017b)

Figure 2-5. Percentage of new passenger car sales in the EU, 2000-2016, by fuel type



Source: EAFO (2017)

Figure 2-6. Share of battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs) in new car sales in the EU, 2008 – 2017

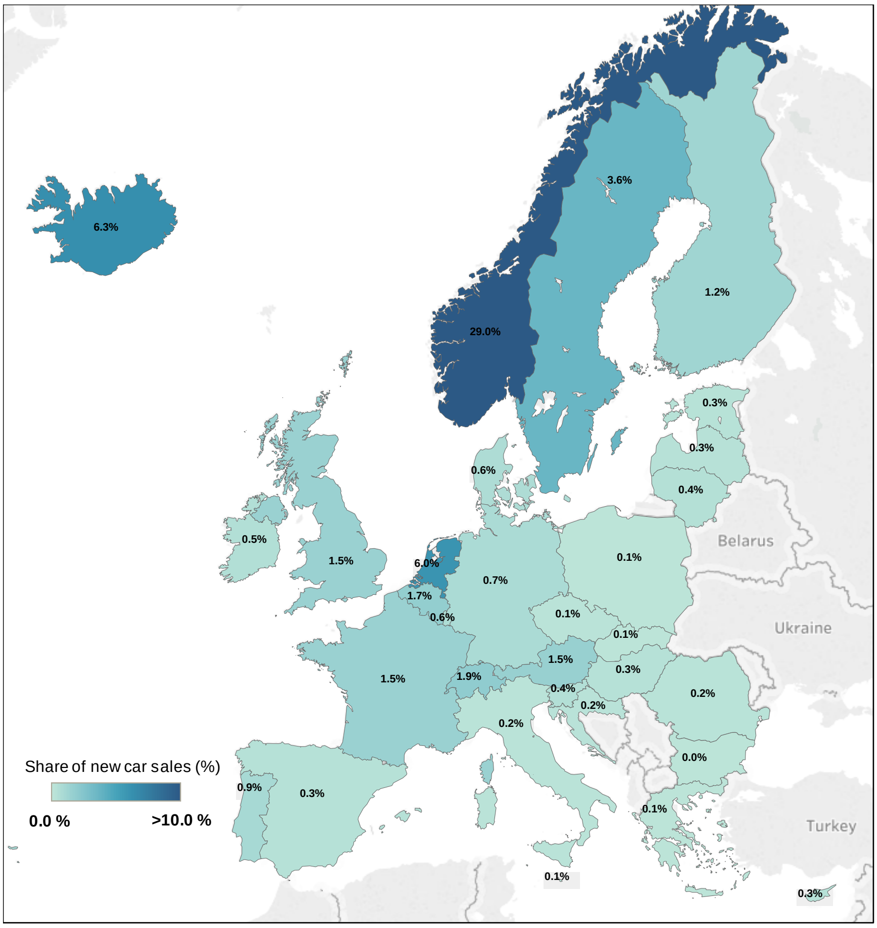


Figure 2-7. Percentage share of BEVs and PHEVs (combined) in new car sales in the EU and Norway, Iceland and Switzerland, by country in 2016.
Percentages are rounded to 1 decimal place, so a value of 0.0% means <0.05%.

2.3 Summary

This chapter has provided an overview of progress made so far in achieving lower carbon emission vehicle targets. It is clear that while the EU targets for 2015 have been achieved, the targets for 2021 are more challenging. Furthermore, the recent proposal for post-2020 CO_2 targets (EC, 2017c) recommends a further 30% reduction from the 2021 targets by 2030. It is likely that adoption of zero-emission and ultra-low emission vehicles will need to play a significant role in achieving these targets. The following chapters provide an opportunity to consider the role of vehicle taxation and incentives in facilitating the changes required, and to understand the drivers of the differences in country-level CO_2 emissions illustrated above.

3 Inventory of vehicle taxation systems in Europe

3.1 Overview

Taxes on passenger car purchase, ownership, fuel, and road usage have historically been used to offset the negative externalities of motoring (such as congestion, air pollution, road casualties and road wear) on society, and have also provided tax revenue for governments.

Since the introduction of mandatory CO_2 emissions targets for new passenger cars at the European level (Regulation (EC) 443/2009), taxes and financial incentives have been employed by some European countries to influence passenger car purchasing and usage behaviour, with the goal of reducing CO_2 emissions. However, individual countries do not have targets for CO_2 emissions from passenger cars, so there is considerable variation between European countries in the existence and design of taxation and incentive policies to achieve this aim.

Taxation and incentive programmes can differ in several aspects which may affect their effectiveness in reducing average CO_2 emissions, including the number and monetary value of incentives on offer, their placement in the vehicle life cycle (one-off incentives on acquisition versus recurring incentives), the type of owner they target (private individuals versus companies), and the type of vehicles they favour (efficient ICEVs, hybrids, electric vehicles).

Systematic comparisons between countries, and over time, of the relevant taxes and incentives in place across Europe can help us to understand the patterns in CO_2 emissions performance and uptake of zero- or low-emission vehicles presented in Chapter 2. Prior to this study, there was no single inventory of taxes and incentives in Europe which was both comprehensive in coverage and presented information in a way which enables such comparisons. For example, information on incentives to purchase and own electric or hybrid vehicles is not always included in descriptions of vehicle taxes and incentives applicable in a country. Furthermore, much of the information that is available is not presented in an easily digestible way.

This chapter presents a summary of a systematic inventory of the relevant taxes and incentives created as part of this work. By recording information in a comparable way across countries and over time, this inventory highlights the main similarities and differences between countries, and the timing of the introduction, removal or modification of important policies.

The remainder of this overview briefly covers the approach taken to the development of the inventory, before the findings are presented in section 3.2. A more detailed description of and rationale for the methodology used is presented in Appendix A.

3.1.1 Categorisation of taxes and incentives

Following a brief review of available data and of other key literature on the topic (EAFO, 2017; Jordal-Jørgensen et al., 2017; Hardman et al., 2017; Kok, 2015), a categorisation of relevant taxes and incentives was created, reflecting the overall scope of the study and the key attributes of interest. The categories chosen are listed in the table below.

Table 3-1. List of types of tax and incentive included in the inventory

Category	Description
Acquisition incentives	Up-front costs and incentives are effective in influencing purchasing decisions (Hardman et al., 2017). This category comprises differentiated purchase, import or registration taxes, purchase subsidies, bonus/malus schemes (also known as 'feebates'; either a subsidy or a surcharge may apply depending on the vehicle), or scrappage-for-replacement schemes (offering a bonus to exchange an old car for a particular kind of new car). These are hereafter referred to as "acquisition incentives" throughout this report.
Recurring incentives	Recurring costs may represent a large share of the total cost of car ownership. This category includes: a) Financial incentives such as differentiated annual circulation taxes, road tolls, congestion or low emission zone charges for different vehicle types, free parking and subsidised electricity (for plug-in vehicles). b) Non-financial incentives such as preferential lane use, access or parking for particular types of vehicle.
Company incentives	Most commonly, this category comprises benefit-in-kind taxation of employees using a company car privately, and the deductibility of car-related costs from company profits – both of which can be graded by CO_2 emissions of propulsion type.
Infrastructure	The perceived utility of alternatively fuelled vehicles is affected by the availability of the required infrastructure. This category includes, for example, government funding for the installation of refuelling and charging facilities for low emissions vehicles.

The list of taxes and incentives presented above was further subdivided to create separate categories for incentives graded by CO_2 emissions which encourage efficient ICEVs, and those incentivising uptake of low- or zero-emission vehicles with a particular propulsion type such as battery-electric (BEV), fuel cell electric (FCEV), plug-in hybrid (PHEV) and hybrid electric (HEV) vehicles.

The full breakdown of tax and incentive categories used in the compilation of the inventory is provided in Appendix B – an excel file containing the categorised and coded information on taxes and incentives by country.

3.1.2 Inventory compilation

Following the definition of tax and incentive categories, available sources of information (e.g. ACEA, 2010a – 2017a; EAFO, 2017) were systematically reviewed for each country individually, cross-checking across different sources, to establish a consistent picture of taxes and incentives.

A quantitative measure of the size or strength of each incentive could not be recorded in a consistent manner, due to the varied ways in which countries calculate tax rates and the wide variety of vehicles on the market. Therefore, the information on taxes and incentives was coded in the inventory in a purely qualitative way, indicating presence or absence of that tax or incentive for each year and country. The coding used was:

i) "**Yes – National**" – tax or incentive is applicable throughout the whole country for that year.

ii) **"Yes – Local"** – tax or incentive is applicable in some parts of the country for that year.

iii) **"Proxy"** – tax or incentive is based on a variable correlated with CO_2 emissions, but not on CO_2 emissions *per se.*

Additionally, where the tax or incentive encouraged uptake of battery-electric vehicles (BEVs), fuel-cell electric vehicles (FCEVs), plug-in hybrid vehicles (PHEVs) or hybrid electric vehicles (HEV; not plug-in), all applicable vehicle types were listed.

Fuel duty was not included in the inventory because this tax is applied in all countries. The difference in fuel duty rates between countries is considered separately in section 3.5.

See section A.3 for details on the methodology used to code taxes and incentives.

3.1.3 Scope of inventory

The inventory compilation was approached in two separate ways, because of limitations in the coverage and consistency of historical data on taxes and incentives, in comparison to information about those available in 2016.

Two inventories were created, differing in focus and scope:

A. An inventory containing comprehensive information on taxes and incentives available in 2016;

B. An inventory containing a time-series of key taxes and incentives over time.

The differences in scope are summarised in the table below, with differences highlighted in orange.

Table 3-2. Scope of the two parts of the inventory, in terms of geography, time period and range of incentives considered.

Inventory	Geographic scope	Temporal scope	Range of incentives covered
A: 2016 snapshot of taxes and incentives	EU-28 + Norway, Switzerland, Iceland and Liechtenstein	2016	-Taxes and incentives on vehicle acquisition -Taxes on ownership -Company car taxes -Other recurring incentives (e.g. parking and toll exemptions) -Infrastructure incentives
B: Evolution of taxes and incentives over time	EU-28 Member States	2010 – 2016 (and partial 2017)	-Taxes and incentives on acquisition (purchase subsidies and grants may be missing in some cases) -Taxes on ownership -Company car taxes

The latest year for which data is presented is 2016, because some changes in taxation occurring during 2017 were not yet in place at the time that the ACEA tax guide 2017 (ACEA, 2017a) was published. This allows fair comparisons to be made between countries.

3.2 Inventory of relevant passenger car taxes and incentives in Europe, 2016

In 2016, there was considerable variation between European countries in the number and types of tax or incentive in place to encourage uptake of low CO_2 emission cars or to influence car usage.

This subsection summarises the presence or absence of a range of taxes and incentives by country in 2016. This has been chosen as the reference year to ensure comparability among countries, information on taxes and incentives in 2017 is not yet consistently available for all countries.

An overview of all taxes and incentives available to encourage lower CO_2 emissions is provided first, followed by more detailed descriptions of the taxes and incentives in place. The more detailed descriptions discuss separately incentives based on CO_2 emissions (or a proxy), and those encouraging the uptake of zero- or low-emission vehicles, i.e. battery electric (BEVs), fuel cell electric (FCEVs), plug-in hybrid (PHEVs) and hybrid electric vehicles (HEVs).

Further details of each tax or incentive can be found in Appendix B and by consulting the source references.

3.2.1 Overview of findings

In 2016, all of the 32 countries considered in this review (EU-28 plus Norway, Iceland, Switzerland and Liechtenstein) offered at least one type of tax or incentive encouraging uptake of passenger cars with lower CO_2 emissions.

Overall, most countries tended to employ a range of different environmental taxes and incentives. The majority of countries offered incentives acting at more than one point in the car ownership process, with 26 countries offering both acquisition and recurring incentives.

Likewise, almost all countries (29) provided incentives encouraging uptake of both efficient conventional internal combustion engine vehicles (ICEVs) and of zero- or low emission vehicle technology (BEVs, PHEVs, HEVs and FCEVs). However, specific incentives for companies (e.g. variable capital allowances and benefit-in-kind taxation) were only provided in about half of the countries and evidence of government support for electric charging infrastructure was only found for 11 countries.

Although most countries offered a range of different incentives, the focus of these varied considerably among countries. For instance, France had a large number of different taxes and incentives based on CO_2 emissions, including a purchase bonus/malus (subsidy/surcharge), registration tax (Carte Grise), annual malus and company car tax. In contrast, Norway had only one CO_2 based tax (the import tax), but a large array of incentives for electric vehicles. These included exemptions from import and annual circulation taxes, high levels of investment in public charging infrastructure, and nationwide exemption from tolls and ferry charges. Some countries had relatively few taxes and incentives, for example Poland, Estonia, Czech Republic and Luxembourg. Nonetheless, because this analysis did not take the size of each incentive into account, a small number of incentives does not necessarily imply that their overall effect is less than in countries with a larger number.

Taxes and other policies acting as disincentives to uptake of lower CO_2 emission vehicles were not explicitly covered in this study, but it is worth noting that the taxation policy in some countries may favour ownership of older vehicles, which tend to have higher average CO_2 emissions than newer ones. For example, in countries including Bulgaria, Croatia and Hungary, annual circulation tax is reduced for older vehicles, to take into account depreciation. Elsewhere (for example Belgium and Greece), registration / acquisition tax on second hand cars is reduced progressively with car age. Nevertheless, these incentives favour existing vehicles, so their likely impact is to prolong vehicle lifetime (and thus slow the rate of fleet turnover), rather than affect the composition of new car sales.

Table 3-3. Overview of taxes and incentives available in 2016 to encourage reductions in passenger car CO_2 emissions, recurring and company-specific).

Country	CO_2 and proxy based incentives				Incentives for zero- and low-emission vehicles				
	Acquisition	Recurring	Company	Total number*	Acquisition	Recurring	Infrastructure	Company	Total number*
Austria	✓	✓	✓	3	✓	✓	✓	✓	8
Belgium	✓	✓	✓	4	✓	✓		✓	4
Bulgaria		✓		1		✓			1
Croatia	✓	✓		2			✓		1
Cyprus	✓	✓		2		✓			2
Czech Republic		✓		1		✓			1
Denmark	✓	✓	✓	3	✓	✓	✓		6
Estonia				0		✓			2
Finland	✓	✓		3	✓				1
France	✓	✓	✓	8	✓		✓	✓	5
Germany		✓		1	✓	✓		✓	5
Greece	✓	✓		3	✓	✓			4
Hungary	✓	✓	✓	4	✓	✓		✓	7
Iceland	✓	✓		2	✓	✓	✓		5
Ireland	✓	✓	✓	3	✓	✓	✓		6
Italy	✓	✓		2	✓	✓			3
Latvia	✓	✓	✓	3	✓	✓		✓	5
Liechtenstein		✓		1	✓	✓			2
Lithuania				0		✓			2
Luxembourg		✓		1		✓		✓	2
Malta	✓	✓		2	✓	✓			5
Netherlands	✓	✓	✓	3	✓	✓	✓	✓	6
Norway	✓			1	✓	✓	✓	✓	10
Poland	✓			1					0
Portugal	✓	✓		2	✓	✓		✓	6
Romania	✓	✓		2	✓	✓	✓		4
Slovakia	✓	✓		2		✓			2
Slovenia	✓	✓		2	✓	✓			2
Spain	✓	✓	✓	3		✓	✓	✓	8
Sweden		✓		1	✓	✓	✓	✓	7
Switzerland		✓		1	✓	✓			2
United Kingdom	✓	✓	✓	7	✓	✓	✓	✓	5
Total	23	28	10	30	22	28	12	13	31

Examining the acquisition incentives more closely, the majority of these comprised registration or other taxes payable upon purchase of the vehicle with differing rates depending on CO_2 emissions. CO_2 emission rate was often combined with other characteristics such as vehicle age, power or Euro standard for calculating tax rates. In four countries, registration tax was not based on CO_2 emissions *per se*, but on other variables correlated with CO_2 emissions: fuel consumption in Denmark, engine capacity in Greece and Hungary, and engine power in Slovakia.

Other incentives employed on acquisition were a bonus/malus system based on CO_2 emissions in France, property acquisition fee in Hungary, excise tax in Poland, and an import tax in Norway.

Considering recurring incentives, the most frequently used incentive was CO_2 (or proxy) graded annual circulation tax, occurring in 28 of the 32 countries. In contrast to the situation for acquisition incentives, only half of countries based annual circulation tax rates on CO_2 emissions *per se*, with 16 countries using other related vehicle characteristics such as weight, engine capacity or power.

Frequently, where annual circulation tax was based on type-approved CO_2 emissions, this only applied to newer vehicles for which this information was available, and older vehicles continue to be taxed according to weight, power or engine capacity.

Evidence of incentives such as free parking, preferential lane-use or reduced toll/charging zone rates based on CO_2 emissions was found for very few countries, namely Finland, France, Germany and the UK. Where these incentives were available, they applied to particular cities or regions only. For example, in the UK only London operates a congestion charging zone where low emission vehicles are exempt. However, there are two caveats to this; firstly, the research may not have found all examples of these types of incentive because there is no single repository of information; second it must be noted that such incentives were much more widely available for zero- or low-emission vehicles (see next section).

Company-specific taxes and incentives based on CO_2 emissions or a proxy were present in only 10 countries in 2016. Nonetheless, it must be remembered that most instruments such as purchase subsidies, registration tax and annual circulation tax are also applicable to companies. Consequently, company-specific taxes are usually additional, providing an extra incentive to fleet managers to purchase low emissions vehicles.

Table 3-4. Inventory of CO_2- and proxy-based taxes and incentives for passenger cars in Europe in 2016

Key: Nationwide | Regional | Proxy | Absent

Country	Acquisition incentives: Purchase subsidy	Acquisition incentives: Registration tax	Acquisition incentives: Other	Recurring incentives: Annual circulation tax	Recurring incentives: Parking	Recurring incentives: Tolls / charging zones	Recurring incentives: Lane use	Company incentives: Capital allowances	Company incentives: Benefit in kind taxation	Company incentives: Salary sacrifice
Austria	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Nationwide	Absent
Belgium	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Nationwide	Nationwide	Absent
Bulgaria	Absent	Absent	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Croatia	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Cyprus	Absent	Nationwide	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Czech Republic	Absent	Absent	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Denmark	Absent	Proxy	Absent	Proxy	Absent	Absent	Absent	Absent	Proxy	Absent
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Absent	Nationwide	Absent	Nationwide	Regional	Absent	Absent	Absent	Absent	Absent
France	Nationwide	Nationwide	Absent	Nationwide	Regional	Regional	Regional	Nationwide	Nationwide	Absent
Germany	Absent	Absent	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Greece	Absent	Proxy	Absent	Nationwide	Absent	Regional	Absent	Absent	Absent	Absent
Hungary	Absent	Proxy	Proxy	Proxy	Absent	Absent	Absent	Absent	Proxy	Absent
Iceland	Absent	Nationwide	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Ireland	Absent	Nationwide	Absent	Nationwide	Absent	Absent	Absent	Nationwide	Absent	Absent
Italy	Absent	Proxy	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Latvia	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Proxy	Absent
Liechtenstein	Absent	Absent	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Absent	Absent	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Malta	Absent	Nationwide	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Netherlands	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Nationwide	Absent
Norway	Absent	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Poland	Absent	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Absent	Nationwide	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Romania	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Slovakia	Absent	Proxy	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Slovenia	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
Spain	Absent	Nationwide	Absent	Proxy	Absent	Absent	Absent	Absent	Nationwide	Absent
Sweden	Absent	Absent	Absent	Nationwide	Absent	Absent	Absent	Absent	Absent	Absent
Switzerland	Absent	Absent	Absent	Proxy	Absent	Absent	Absent	Absent	Absent	Absent
United Kingdom	Absent	Nationwide	Absent	Nationwide	Regional	Regional	Absent	Nationwide	Nationwide	Nationwide
Total	1	21	3	28	3	3	1	4	9	1

3.2.2 Incentives for uptake of zero- and low-emission vehicles

As was the case for CO_2 (and proxy) based taxes and incentives, almost all of the countries studied (31 out of 32) implemented at least one measure in 2016 incentivising purchase or use of zero- or low-emission vehicles (BEVs, PHEVs, FCEVs and HEVs). No evidence of such incentives by 2017 was found in Poland from the sources studied. Table 3-5 contains a summary of these incentives by country.

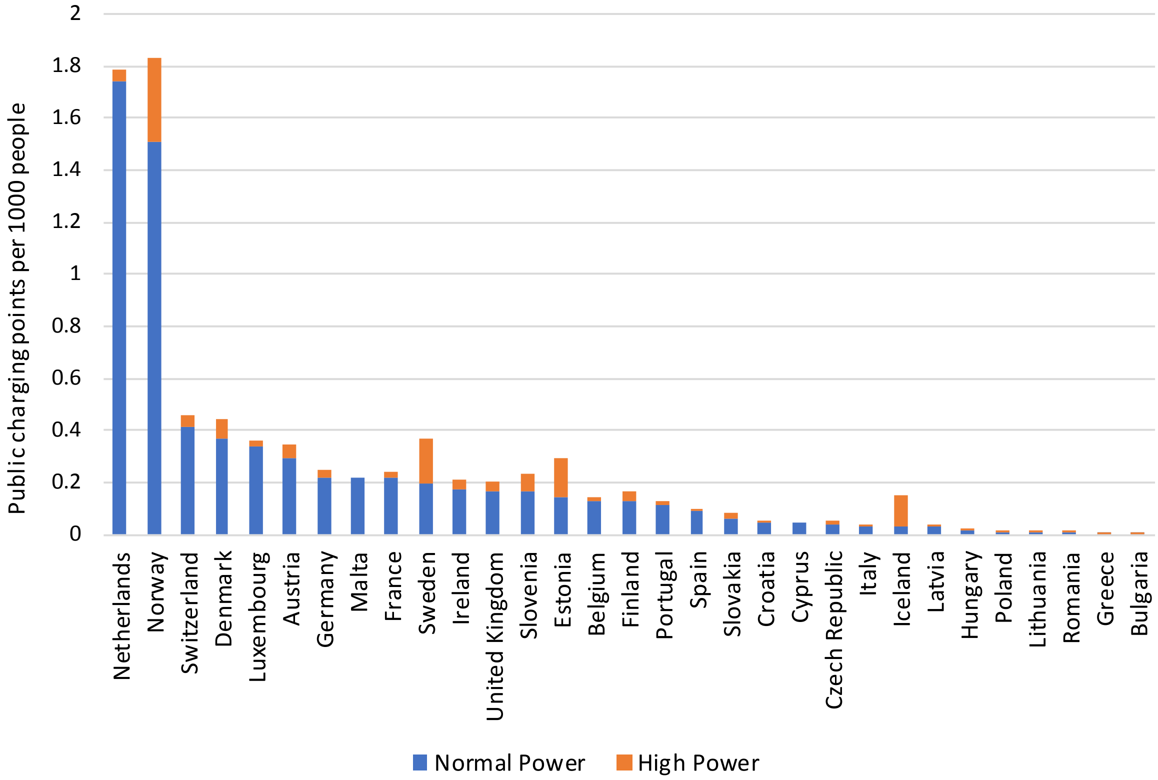
The availability and size of incentives varied between different types of vehicle (see Table 3-6), with fully electric vehicles benefitting from larger incentives and in more countries than plug-in hybrids (PHEVs), which in turn received more support than hybrid electric (not plug-in) vehicles (HEVs). For example, registration tax exemption or reductions were available for electric vehicles in 14 countries, for PHEVs in 10 countries, and for HEVs in 8 countries. To illustrate the differences in the size of incentives available, in France, purchasers of fully electric vehicles received a EUR 6300 bonus, compared to a EUR 1000 bonus for PHEVs and EUR 750 bonus for HEVs; in Ireland, fully electric vehicles qualify for EUR 5000 relief from registration tax, PHEVs receive a EUR 2500 discount, and HEVs a EUR 1500 discount. Unfortunately, the monetary size of incentive could not be easily summarised in the inventory (see section A.4 in Appendix A) and consistent comparisons between countries could therefore not be made.

Around two-thirds of countries (22) offered acquisition incentives for (BEVs, PHEVs, FCEVs and HEVs), and these were more varied than CO_2 based acquisition incentives. Fourteen countries offered reductions or exemptions from registration tax, but 15 countries offered purchase subsidies or premiums and 9 countries other kinds of acquisition incentive including scrappage schemes and VAT reductions. The effect of purchase subsidies and registration tax reductions on the vehicle purchase cost may be similar, but whereas registration tax grading may be revenue-neutral, purchase subsidies are often tied to a fixed total budget which must be renewed once exhausted. For instance, in Slovenia, EUR 2.5 million were pledged in total to support electric vehicle purchases from 2016.

The majority (28) of countries offered recurring incentives for zero- or low-emission vehicles in 2016, and in 23 countries this included specific exemptions or reductions in annual circulation tax; for electric vehicles in 23 countries, for PHEVs in 14 countries, and for HEVs in 10 countries. However, in contrast to CO_2-based incentives, many other types of recurring incentives – some non-financial - were additionally offered by countries for zero-and low-emission vehicles. Evidence was found for local provision of free parking in 18 countries, of exemptions or reduction in tolls or charging zone fees in 5 countries, and use of restricted lanes in 8 countries. How widespread these local benefits were across localities within countries was not always clear from the information available, but in some countries such as Norway, these benefits are available in all cities.

Company-specific car tax benefits for zero- and low-emission vehicles were available in 13 countries in 2016; slightly more than the number offering such incentives based on CO_2 emissions alone or a proxy.

A further type of incentive offered by governments to support uptake of plug-in vehicles are grants to support installation of public or private electric charging points. In order to successfully foster uptake of plug-in vehicles, sufficient charging infrastructure is required to give people the confidence that fully electric vehicles will reliably meet their travel needs and help reduce range anxiety. In 2016, there was evidence that support for installation of public charging points was available in 8 countries, and for home or workplace charging points in 9 countries. The extent of charging infrastructure differs considerably between countries, with the Netherlands and Norway currently having around 1.8 charging points per 1000 people, compared to 0.2 per 1000 people in the UK and less than 0.1 in almost half of European countries (see Figure 3-1).



Source: EAFO (2017)

Figure 3-1. Availability of public vehicle charging infrastructure in Europe in 2017, by country

Little evidence was found of government support for hydrogen fuelling infrastructure in 2016. In Flanders, a so called “ecology premium” was available covering some of the cost of companies installing hydrogen fuelling infrastructure (ACEA, 2017a), but no reliable information for other countries was found. In 2017, the UK pledged GBP 23 million for investment in FCEV development and hydrogen refuelling infrastructure.

Table 3-5. Inventory of taxes and incentives encouraging uptake of zero and low-emission vehicles in Europe in 2016.

Key Nationwide | Regional | Absent

	Acquisition incentives					Recurring incentives					Infrastructure		Company incentives	
Country	Purchase subsidy	Registration tax	VAT	Scrappage scheme	Other	Annual circulation tax	Parking	Tolls / charging zones	Lane use	Other	Subsidised private charging	Subsidised public charging	Capital allowances	Benefit in kind taxation
Austria	Nationwide		Nationwide			Nationwide	Regional				Regional	Regional	Nationwide	Nationwide
Belgium	Regional	Regional				Regional							Nationwide	
Bulgaria						Nationwide								
Croatia												Regional		
Cyprus						Nationwide	Regional							
Czech Republic						Nationwide								
Denmark	Nationwide	Nationwide			Regional		Regional				Nationwide	Nationwide		
Estonia							Regional		Regional					
Finland		Nationwide												
France	Nationwide	Regional		Nationwide							Nationwide			Nationwide
Germany	Nationwide					Nationwide	Regional		Regional					Nationwide
Greece		Nationwide			Nationwide	Nationwide		Regional						
Hungary	Nationwide	Nationwide			Nationwide	Nationwide	Nationwide			Nationwide				Nationwide
Iceland		Nationwide	Nationwide			Nationwide	Nationwide				Nationwide			
Ireland	Nationwide	Nationwide				Nationwide	Regional				Nationwide	Nationwide		
Italy	Regional					Nationwide		Regional						
Latvia		Nationwide				Nationwide	Regional		Regional					Nationwide
Liechtenstein	Nationwide					Nationwide								
Lithuania							Regional		Regional					
Luxembourg						Nationwide								Nationwide
Malta	Nationwide	Nationwide		Nationwide			Regional		Regional					
Netherlands		Nationwide				Nationwide	Regional					Regional	Nationwide	Nationwide
Norway		Nationwide	Nationwide			Nationwide	Regional	Nationwide	Nationwide	Nationwide	Regional	Nationwide		Nationwide
Poland														
Portugal	Nationwide	Nationwide				Nationwide	Regional						Nationwide	Nationwide
Romania	Nationwide	Nationwide				Nationwide						Regional		
Slovakia						Nationwide	Regional							
Slovenia	Nationwide					Nationwide								
Spain						Regional	Regional	Nationwide	Regional	Nationwide	Nationwide	Nationwide		Nationwide
Sweden	Nationwide					Nationwide	Regional	Regional	Regional					Nationwide
Switzerland					Nationwide	Regional								
United Kingdom	Nationwide						Regional				Nationwide	Nationwide		Nationwide
Total	15	14	3	2	4	23	18	5	8	3	8	9	4	12

Table 3-6. Inventory of major taxes and incentives encouraging uptake of zero and low-emission vehicles in Europe in 2016, by vehicle type

Key
- Battery electric vehicles (BEV)
- Fuel-cell electric vehicles (FCEV)
- Plug-in hybrid electric vehicles (PHEV)
- Hybrid electric vehicles (HEV)
- Not specified

	Acquisition incentives					Recurring incentives					Company incentives	
Country	Purchase subsidy	Reg. tax	VAT	Scrappage scheme	Other	Annual circulation tax	Parking	Toll / charging zone	Lane use	Other	Capital allowance	Benefit in kind taxation
Austria	BEV, PHEV		BEV, FCEV			BEV, FCEV	Not specified				BEV, FCEV	BEV, FCEV
Belgium	BEV, FCEV	BEV, FCEV, PHEV				BEV, FCEV, PHEV					BEV, FCEV, PHEV	
Bulgaria						BEV, FCEV						
Croatia												
Cyprus						BEV, FCEV, PHEV, HEV	BEV, FCEV					
Czech Republic						BEV, FCEV, PHEV, HEV						
Denmark	Not specified	BEV, FCEV			BEV, FCEV, PHEV		BEV, PHEV					
Estonia							Not specified		Not specified			
Finland		BEV, FCEV, PHEV, HEV										
France	BEV, FCEV, PHEV, HEV	BEV, FCEV, PHEV, HEV		BEV, PHEV								BEV, FCEV, PHEV, HEV
Germany	BEV, FCEV, PHEV					BEV, FCEV	BEV		BEV			BEV, FCEV
Greece		BEV, FCEV, PHEV, HEV			BEV, FCEV, PHEV, HEV	BEV, FCEV, PHEV, HEV		BEV, FCEV				
Hungary	BEV, FCEV	BEV, FCEV, PHEV, HEV			BEV, FCEV, PHEV	BEV, FCEV, PHEV	Not specified			Not specified		BEV, FCEV, PHEV, HEV
Iceland		BEV	BEV			BEV	Not specified					
Ireland	BEV, FCEV, PHEV	BEV, FCEV, PHEV, HEV				BEV, FCEV, PHEV, HEV	BEV, PHEV					
Italy	BEV, FCEV, PHEV					BEV, FCEV		BEV, FCEV, PHEV, HEV				
Latvia		BEV, FCEV				BEV, FCEV, PHEV	Not specified		Not specified			BEV, FCEV
Liechtenstein	BEV, FCEV					BEV, FCEV, PHEV, HEV						
Lithuania							Not specified		Not specified			
Luxembourg						BEV, FCEV, PHEV, HEV						BEV, FCEV, PHEV
Malta	BEV, FCEV, PHEV, HEV	BEV, FCEV, PHEV, HEV		BEV, FCEV, PHEV, HEV			Not specified		Not specified			
Netherlands		BEV, FCEV				BEV, FCEV, PHEV, HEV	BEV, FCEV				BEV, FCEV, PHEV	BEV, FCEV
Norway		BEV, FCEV, PHEV	BEV, FCEV			BEV, FCEV	BEV, FCEV	BEV, FCEV	BEV, FCEV	BEV, FCEV		BEV, FCEV
Poland												
Portugal	BEV, FCEV, PHEV	BEV, FCEV, PHEV, HEV				BEV, FCEV	Not specified				BEV, FCEV, PHEV	BEV, FCEV, PHEV
Romania	BEV, FCEV, PHEV	BEV, FCEV, PHEV, HEV				BEV, FCEV						
Slovakia						BEV, FCEV, PHEV, HEV	Not specified					
Slovenia	BEV, FCEV, PHEV					BEV						
Spain						BEV, FCEV, PHEV, HEV	Not specified	BEV, FCEV	BEV	Not specified		BEV, FCEV, PHEV, HEV
Sweden	BEV, FCEV, PHEV					BEV, FCEV, PHEV	Not specified	Not specified	Not specified			BEV, FCEV
Switzerland					BEV	BEV, FCEV, PHEV, HEV						
United Kingdom	BEV, FCEV, PHEV						BEV, PHEV					BEV, FCEV, PHEV

3.3 Historical trends

This section describes how the number and types of environmental vehicle taxes and incentives offered by EU countries evolved between 2010 and 2016.

As discussed in section 3.1.3 , the inventory compiled for this period was restricted to the EU Member States, and to the set of taxes and incentives consistently reported in the ACEA tax guides published during these years. The results presented below focus on changes in the presence or absence of incentives offered by countries, and in the number of countries providing a given incentive type over time.

The definition of tax bands and the size of incentives have also changed over time in many cases, but as described in section A.4 (Appendix A), this could not be summarised consistently for all countries and years.

3.3.1 CO_2-based taxes and incentives

Overall, there was relatively little change in the number of countries employing taxes and incentives based on CO_2 or a proxy during the period 2010 – 2016 (Figure 3-2; Table 3-7).

In 2010, 19 countries had relevant taxes on vehicle acquisition, compared with 21 in 2016, and a peak of 22 in 2014. There was a similarly static picture for CO_2- or proxy-based taxes on ownership, with such taxes present in 23 countries in 2010, compared with 24 in 2016. The basis of taxes on vehicle acquisition and ownership also remained quite steady across the period, in terms of whether taxes were based on CO_2 emissions explicitly or on a proxy variable.

Company car taxation showed a greater change over the period, with the number of countries grading company car taxation by CO_2 or a proxy variable doubling from 5 in 2010 to 10 in 2016. Denmark, Hungary, Latvia, Spain and Sweden all adopted such taxes over the period.

The relative stability in the presence or absence of CO_2 (or proxy) based car taxation between 2010 and 2016 may be partly due to the fact that many countries adopted this form of taxation before 2010. Ideally, this work would have included earlier years in the inventory, but the availability of information limited the feasibility of this.

Nevertheless, it is important to reiterate that although the presence or absence of CO_2 (or proxy) based taxes and incentives was relatively stable, the boundaries between tax bounds and the monetary value of incentives will have shifted over this period in many countries. For example, in Portugal, the CO_2 based component of registration tax for petrol cars emitting more than 195 g CO_2/km was EUR 127 per g CO_2/km in 2010, but this increased to EUR 183 per g CO_2/km in 2016. In the Netherlands, the threshold CO_2 emission value for exemption of petrol cars from registration tax moved progressively downwards over the period, from 110 g CO_2/km in 2010 to 50 g CO_2/km in 2016.

Looking to the future, the New European Driving Cycle (NEDC) test procedure will be replaced by the World Harmonized Light Vehicle Test Procedure (WLTP) in 2021 for CO_2 emission type approval. It seems likely that there will be significant changes in the definitions of CO_2-based tax bands at this time, to reflect differences in CO_2 emissions achievable in the two tests, with the WLTP generally resulting in higher values.

The case studies presented in Chapter 4 of this report provide more information on important quantitative shifts in the grading and value of incentives, helping to shed light on their impact.

Source: Tax and incentive inventory compiled as part of this report, using sources listed in Table 3-1

Figure 3-2. Number of EU Member States with $CO_{2\text{-}}$ or CO_2 proxy-based taxes on acquisition, ownership and company cars, 2010 – 2016.

Table 3-7. Evolution of CO_2- or CO_2 proxy-based taxes on acquisition, ownership and company cars in EU Member States 2010 – 2017*; detailed breakdown by country

Key: Nationwide | Regional | Proxy variable | Absent

Acquisition incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Belgium	Regional	Regional	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Bulgaria	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Croatia	Absent	Absent	Absent	Absent	Nationwide	Nationwide	Nationwide	Nationwide
Cyprus	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Czech Republic	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Denmark	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
France	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Germany	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Greece	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Nationwide
Hungary	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Ireland	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Italy	Proxy variable	Proxy variable	Proxy variable	Nationwide	Nationwide	Proxy variable	Proxy variable	Proxy variable
Latvia	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Absent
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Nationwide
Luxembourg	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Absent	Absent	Absent
Malta	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Netherlands	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Poland	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Portugal	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Romania	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Absent
Slovakia	Absent	Absent	Absent	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Slovenia	Absent	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Spain	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Sweden	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
United Kingdom	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Total	19	20	20	20	22	21	21	20*

Recurring incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Belgium	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Regional
Bulgaria	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Croatia	Absent	Absent	Absent	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Cyprus	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Czech Republic	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Denmark	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Proxy variable	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
France	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Germany	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Greece	Proxy variable	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Hungary	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Ireland	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Italy	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Latvia	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Nationwide
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Malta	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Netherlands	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Proxy variable	Proxy variable
Poland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Romania	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Slovakia	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Slovenia	Absent	Absent	Absent	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Spain	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Sweden	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
United Kingdom	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Absent
Total	23	23	23	23	25	25	25	24*

Company incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Absent	Absent	Absent	Absent	Absent	Absent	Nationwide	Nationwide
Belgium	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Bulgaria	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Croatia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Cyprus	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Czech Republic	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Denmark	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
France	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Germany	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Greece	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Hungary	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Ireland	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Italy	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Latvia	Absent	Absent	Absent	Proxy variable	Proxy variable	Proxy variable	Proxy variable	Proxy variable
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Nationwide
Malta	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Netherlands	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Absent
Poland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Romania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Slovakia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Slovenia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Spain	Absent	Absent	Absent	Absent	Absent	Absent	Nationwide	Nationwide
Sweden	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
United Kingdom	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide	Nationwide
Total	5	7	7	8	8	8	10	10*

3.3.2 Incentives for uptake of zero- and low-emission vehicles

There was an overall increase in the number of EU Member States offering incentives for zero- and low-emission vehicles between 2010 and 2016 (Figure 3.2; Figure 3-3; Table 3-8), but this was more marked for ownership / recurring incentives and company-specific incentives than for one-off incentives for vehicle acquisition.

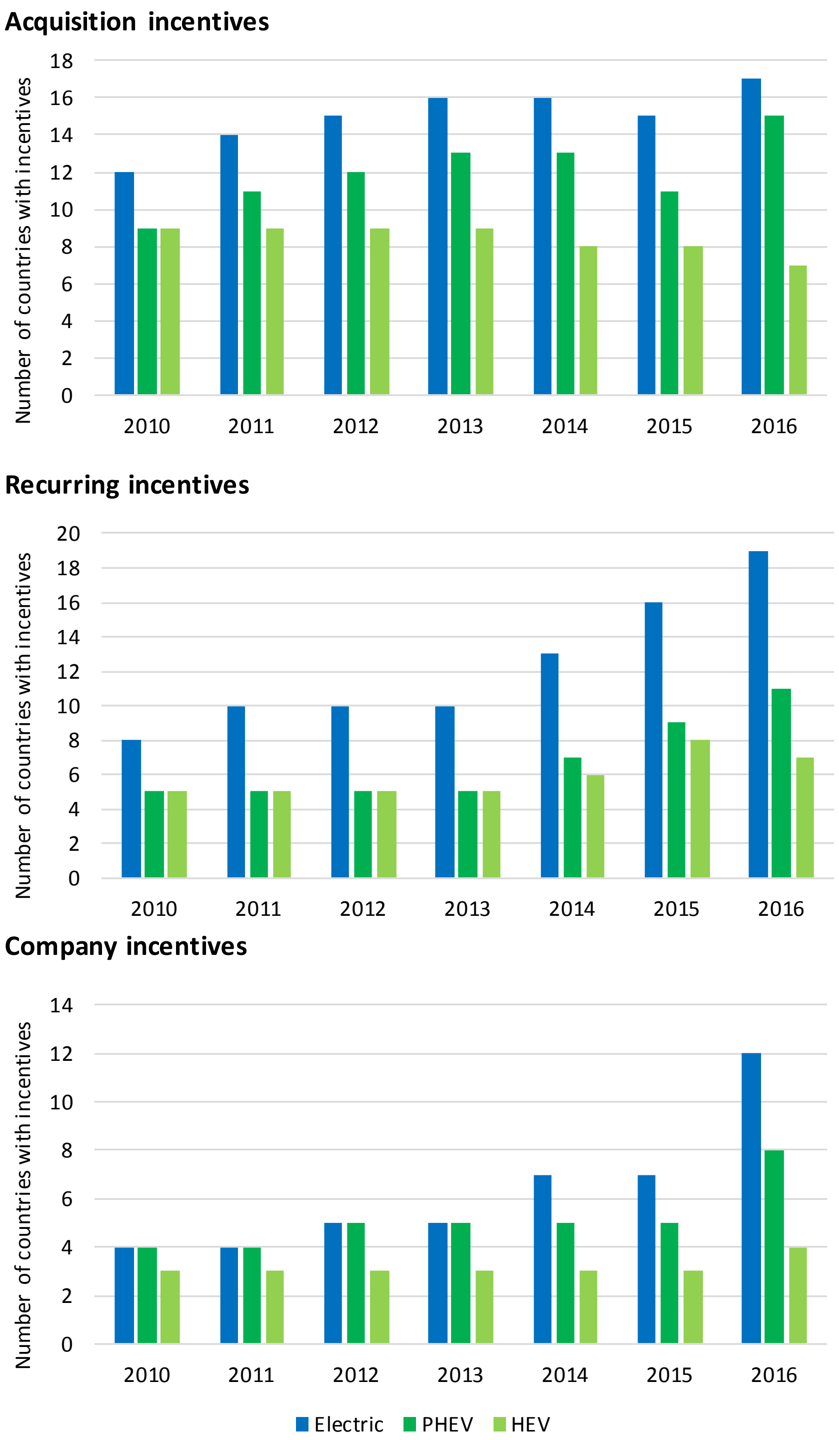
Between 2010 and 2016, the number of countries offering incentives for acquisition rose from 12 to 17, the number offering ownership incentives more than doubled from 8 to 19, and the number offering company-specific incentives tripled from 4 to 12.

The trend in availability of incentives also differed between vehicle types. Fully electric vehicles have benefitted from incentives in a steadily increasing number of countries, whereas support for plug-in hybrids (PHEVs) has generally grown more slowly. For other hybrids (HEVs), support has grown little or even diminished, with a fall from 9 to 7 countries offering acquisition incentives for HEVs over the period. Incentives for BEVs and FCEVs were grouped together into the category “electric”, because the source information did not usually specify the type of electric vehicle.

Taxes and incentives on vehicle acquisition have comprised a mixture of reductions and exemptions from registration tax, and purchase subsidies and premiums on the other hand. In general, the provision of purchase subsidies and premiums has seen more change over time than have exemptions from registration tax, with premiums being offered for a varying number of years depending on the country, and some being withdrawn during the period. Luxembourg, Italy, Germany, Slovenia, Sweden and the UK all introduced purchase subsidies during the period, but Italy, Luxembourg and Spain also discontinued subsidy schemes between 2010 and 2016.

However, it must be noted that the main sources of information used to compile the inventory for 2010 (ACEA 2010a - 2017a), may not provide comprehensive information about purchase subsidies and premiums, so these outcomes should be treated with caution.

The availability of ownership and company car tax incentives increased over the period largely due to an increase in exemption or reduction of tax rates for electric and hybrid vehicles. In some cases, this occurred due to a shifting of tax boundaries based on CO_2 emissions, to levels not achievable by conventional ICEVs. For example, in the Netherlands the threshold CO_2 emission value for exemption of petrol cars from annual circulation tax moved progressively downwards over the period, from 110 g CO_2/km in 2010 (which is achievable with a conventional ICEV) to 50 g CO_2/km in 2016, which is only achievable by BEVs, FCEVs and PHEVs. In the UK, the emissions limit to qualify for the lowest rate of company car benefit-in-kind taxation shifted from 120 g CO_2/km in 2010 (achievable by an ICEV) to 50 g CO_2/km in 2016.



Source: Tax and incentive inventory compiled as part of this report, using sources listed in Table 3-1

Figure 3-3. Number of EU Member States offering incentives for zero- and low-emission car acquisition, ownership and company cars, 2010 – 2016.

Table 3-8. Evolution of incentives for zero- and low-emission car acquisition, ownership and company cars in EU Member States 2010-2017*; detailed breakdown by country

Key: Present (green) · Absent (grey)

Acquisition incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Present	Present	Present	Present	Present	Present	Present	Present
Belgium	Present	Present	Present	Present	Present	Present	Present	Present
Bulgaria	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Croatia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Cyprus	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Czech Republic	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Denmark	Present	Present	Present	Present	Present	Present	Present	Present
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Present	Present	Present	Present	Present	Present	Present	Present
France	Present	Present	Present	Present	Present	Present	Present	Present
Germany	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Greece	Present	Present	Present	Present	Present	Present	Present	Present
Hungary	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Ireland	Present	Present	Present	Present	Present	Present	Present	Present
Italy	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent
Latvia	Present	Present	Present	Present	Present	Present	Present	Absent
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Absent	Present	Present	Present	Present	Absent	Absent	Present
Malta	Present	Present	Present	Present	Present	Present	Present	Present
Netherlands	Absent	Absent	Absent	Absent	Absent	Present	Present	Present
Poland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Present	Present	Present	Present	Present	Present	Present	Present
Romania	Present	Present	Present	Present	Present	Present	Present	Absent
Slovakia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Slovenia	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Spain	Present	Present	Present	Present	Absent	Absent	Absent	Present
Sweden	Absent	Absent	Present	Present	Present	Present	Present	Present
United Kingdom	Absent	Present	Present	Present	Present	Present	Present	Present
Total	12	14	15	16	16	15	17	18*

Recurring incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Present	Present	Present	Present	Present	Present	Present	Present
Belgium	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Bulgaria	Absent	Absent	Absent	Absent	Absent	Present	Present	Present
Croatia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Cyprus	Absent	Absent	Absent	Absent	Absent	Present	Present	Present
Czech Republic	Present	Present	Present	Present	Present	Present	Present	Present
Denmark	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
France	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Germany	Present	Present	Present	Present	Present	Present	Present	Present
Greece	Present	Present	Present	Present	Present	Present	Present	Present
Hungary	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Ireland	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Italy	Absent	Present	Present	Present	Present	Present	Present	Present
Latvia	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Present	Present	Present	Present	Present	Present	Present	Present
Malta	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Netherlands	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Poland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Absent	Present	Present	Present	Present	Present	Present	Absent
Romania	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Slovakia	Absent	Absent	Absent	Absent	Absent	Present	Present	Present
Slovenia	Present	Present	Present	Present	Present	Present	Present	Present
Spain	Present	Present	Present	Present	Present	Present	Present	Present
Sweden	Present	Present	Present	Present	Present	Present	Present	Present
United Kingdom	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Total	8	10	10	10	13	16	19	20*

Company incentives

Country	2010	2011	2012	2013	2014	2015	2016	2017*
Austria	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Belgium	Present	Present	Present	Present	Present	Present	Present	Present
Bulgaria	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Croatia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Cyprus	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Czech Republic	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Denmark	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Estonia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Finland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
France	Present	Present	Present	Present	Present	Present	Present	Present
Germany	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Greece	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Hungary	Absent	Absent	Absent	Absent	Present	Present	Present	Present
Ireland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Italy	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Latvia	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Lithuania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Luxembourg	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Malta	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Netherlands	Absent	Absent	Present	Present	Present	Present	Present	Present
Poland	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Portugal	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Romania	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Slovakia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Slovenia	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Spain	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present
Sweden	Present	Present	Present	Present	Present	Present	Present	Present
United Kingdom	Present	Present	Present	Present	Present	Present	Present	Present
Total	4	4	5	5	7	7	12	13*

*Information for 2017 may not reflect the most up-to-date situation in all countries, because the ACEA tax guide 2017 (ACEA 2017a) was published early in the year.

3.4 Planned changes to taxes and incentives from 2017 onwards

A limitation of this inventory is that the latest information it contains consistently across all countries is for the reference year 2016. Given that this report is being written near the end of 2017, it seems sensible to include a note of major changes made to taxes and incentives in 2017, based on the information available at the time of writing.

Countries introducing new taxes and incentives in 2017

- Lithuania and Greece use CO_2 emissions as the basis for registration tax
- Latvia and the Flanders region of Belgium now bases annual circulation tax on CO_2 emissions
- Luxembourg introduced tax allowances for BEVs and FCEVs, as well as announcing investment in 800 public charging stations (EAFO, 2017).
- Luxembourg also introduced a CO_2 based company car tax in 2017
- Spain and Slovakia introduced new purchase subsidies for electric and plug-in hybrid vehicles
- Denmark introduced low rates of annual circulation and company car tax for electric and plug-in hybrid vehicles.

Countries removing taxes and incentives in 2017

- Latvia and Romania no longer levy any registration tax
- The UK no longer bases annual circulation tax on CO_2 emissions
- Portugal no longer exempts electric vehicles from the annual circulation tax

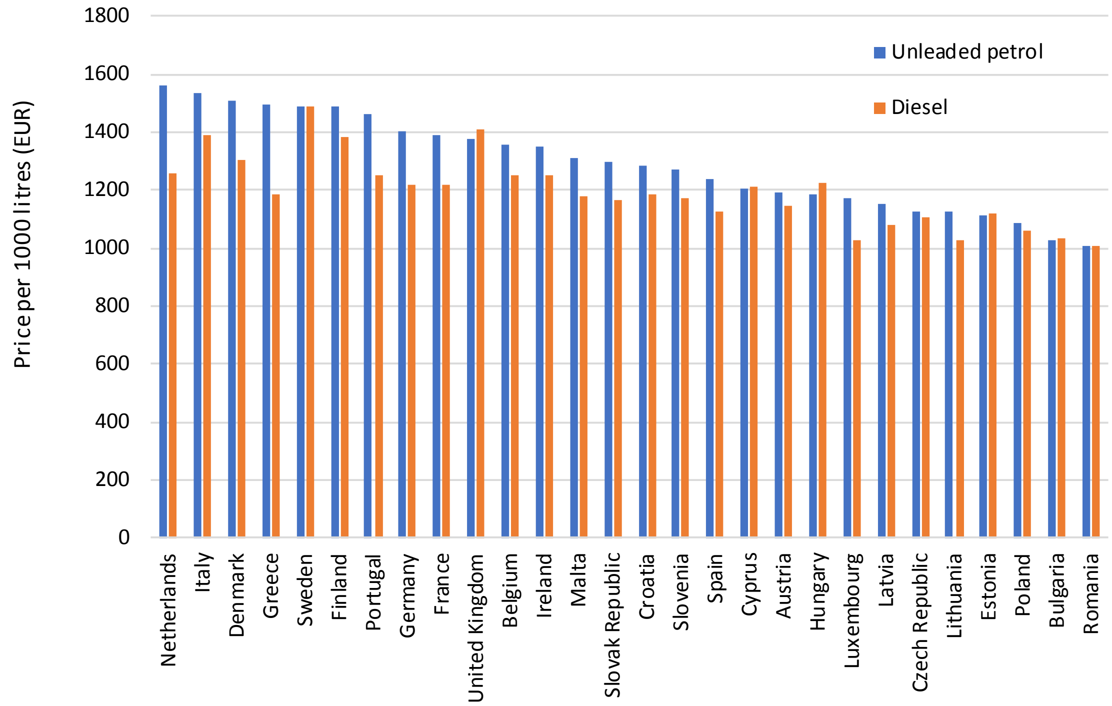
3.5 Fuel taxes

Fuel taxes cannot be directly graded according to the CO_2 emissions of a car, but will indirectly encourage uptake of more fuel-efficient vehicles, or the use of another fuel, to reduce the amount of fuel tax paid to travel a given distance.

The EU specified minimum rates of tax on petrol (unleaded) and diesel fuel are EUR 330 and EUR 359 per 1000 litres respectively (Directive 2003/96/EC). EU Member States therefore levy these rates or higher with countries differing considerably in the rates they charge, as well as in the relative tax rates on petrol and diesel (Figure 3.4 and Figure 3.5).

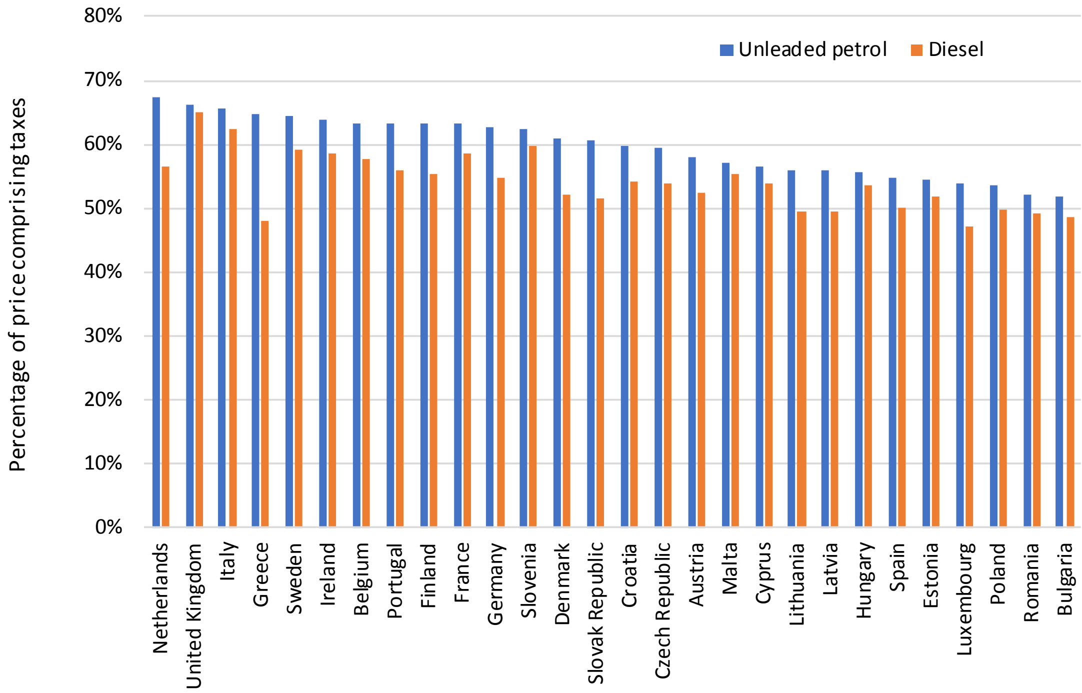
The Netherlands had both the highest average price (EUR 1.56 per litre) and highest tax percentage (67%) for petrol. The lowest petrol prices, and share of tax, were found in Romania (EUR 1.01 per litre; 52% tax) and Bulgaria (EUR 1.03 per litre; 52% tax). It is useful to note that this includes Value Added Tax (VAT).
For diesel, Sweden had the highest price per litre (EUR 1.49), but the UK had the largest share of tax per litre (65%). As with petrol, Romania also had the lowest diesel price (EUR 1.06 per litre), but it was Luxembourg which had the lowest tax share (47%) of the diesel price. It is useful to note that this includes VAT.

Regarding the tax differential between petrol and diesel, the UK had the most equal taxation system, with tax making up 66% of the petrol price, and 65% of the diesel price. Greece had the largest differential, with 65% and 48% of the petrol and diesel price respective comprising tax.



Source: EC (2017a)

Figure 3-4. Prices of unleaded petrol and diesel for EU countries (Euros), as of 02/01/2017.



Source: EC (2017a)

Figure 3-5. Percentage of the price of unleaded petrol and diesel comprising taxes (including VAT) for EU countries, as of 02/01/2017.

4 Impact of vehicle taxation systems on fleet composition and purchasing behaviour

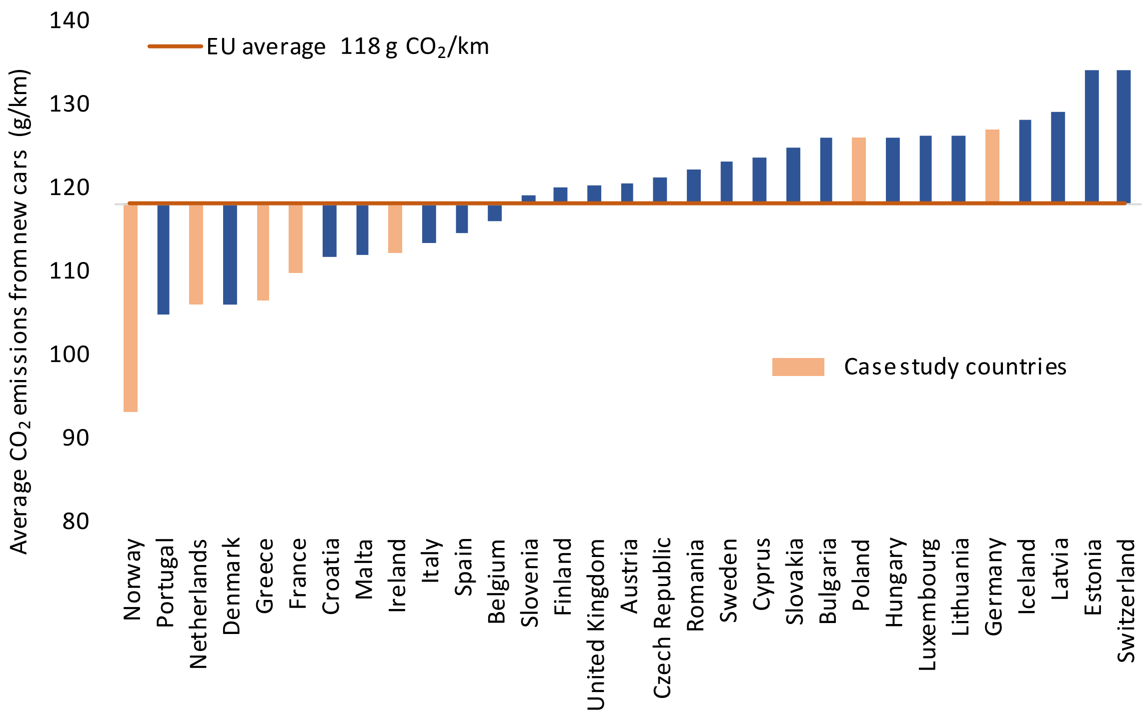
4.1 Introduction

The following chapter consists of 7 country case studies which explore different approaches used to taxation and incentives. The resulting impacts in terms of lower emission vehicle adoption and where possible in terms of impacts on overall CO_2 emissions from car passenger transport are considered.

The case studies are as follows:

- The Netherlands
- Greece
- Norway
- Germany
- Poland
- France
- Ireland

Information on average emissions of new cars by country in 2016 is provided below in Figure 4-1.



Source: EEA (2017b)

Figure 4-1. Average CO_2 emissions of new passenger cars sold in the EU + Norway, Switzerland and Iceland, by country in 2016. The emissions for the chosen case study countries are highlighted in peach.

The case studies look at the ‘frontrunners’ (like the Netherlands and Greece), but also at some ‘laggards’ (like Germany and Poland) and at Norway (as a non-EU Member), known for long-term facilitation of the purchase and use of electric vehicles. It is important to note that for some countries the limited availability of literature would have made the case studies more challenging.

In line with the approach used in Chapter 3, taxes covered in the case studies include those on acquisition (up-front costs); on ownership (recurring costs) and in relation to company car taxation. In terms of broader context on the potential impacts of the different mechanisms, Gerlagh et al. (2016) find that a CO_2 dependent registration tax is the most effective tax to encourage consumers to buy a fuel-efficient car. Gerlagh et al. (2016) used data on emissions and taxes from 15 European countries in the period 2001 to 2010, but did not make the distinction between private and company cars. The research found that due to the changes in registration taxes from 2001 to 2010, the CO_2 emission intensity of the average new car was reduced by 1.3%, partly through dieselisation. In 2016, about half of new sales in Europe concerned diesel cars, but in the Netherlands and Denmark the share of diesel in new sales was much smaller (T&E, 2013). As these two countries are ranked first and third in the list of fuel-efficient new car sales (EEA, 2016b), it shows that dieselisation is not a necessary prerequisite to decrease emissions. Countries with the lowest rates of dieselisation, like the Netherlands and Denmark, tend to have specific taxation surcharges on diesel cars that discourage purchase.

Some countries also use a feebate-system to stimulate the purchase of fuel-efficient cars, for example the Netherlands from 2006 to 2009 and France from 2008 onwards. A feebate is a combination of a vehicle purchase tax/fee and a rebate/subsidy (Gallagher and Muehlegger, 2011) used to reward buyers of vehicles that are more fuel efficient than the average vehicle in that class and penalize buyers of less fuel-efficient vehicles. The set level can correspond to a sales-weighted standard or other value, and can be reduced over time. It is sometimes suggested that feebates are more publicly acceptable than other fiscal and regulatory instruments because of the reward element (Musti and Kockelman, 2011). Feebates can be designed to be revenue neutral (BenDor and Ford, 2006; de Haan et al., 2009; Gallagher and Muehlegger, 2011). However, it can be difficult to ensure budget neutrality as consumer behaviour is difficult to predict. For instance, the French experience with the bonus/malus scheme showed that vehicle purchasers reacted more positively to the feebate than expected with the result that the public budget was estimated to be almost EUR 1.5 billion in debt in 2011 as a result of the scheme, prompting a readjustment. An explanation for this strong consumer's reaction may be that consumers tend to be more responsive to tax and price changes that are more salient (Busse et al. 2006; Chetty et al. 2009; Finkelstein 2009). The French tax increases in discrete steps, dependent on the emissions of the car. This nonlinearity of the tax has increased its salience, and therefore may have increased the effect of a proportional change in the tax on a vehicle's registration (Klier and Linn, 2015).

Some countries subsidise new, CO_2 efficient technologies like (plug-in) hybrids or full-electric cars for a certain period of time or for a certain market only (e.g. company cars). The example of the Netherlands shows the large influence of such subsidy schemes on new car sales.

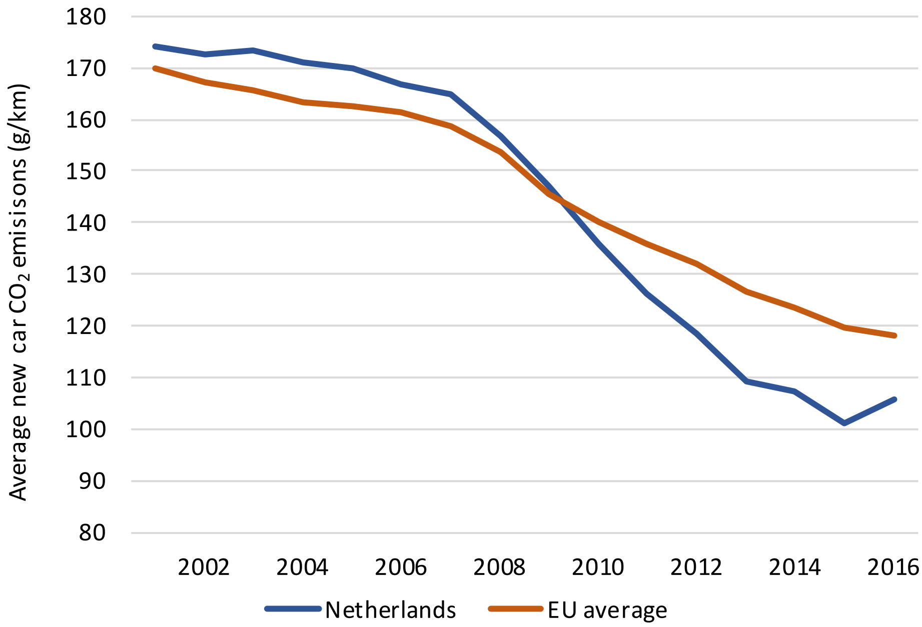
In the remainder of this section, the case studies are considered. A structured approach to the case studies is provided where possible using the following format:

- The rationale for the case study example
- Information on the new car vehicle fleet
- Detailed description of the type of taxes and incentives offered
- Outcomes including impacts and lessons learnt

For each country, charts are provided comparing the average CO_2 emissions of new cars and share of BEVs and PHEVs in the new car fleet against the EU average over time. Note that the geographical scope of the EU data changes over time from EU-15 (up to 2003) to EU-25 (2004-06), EU-27 (2007-12) and EU-28 (2013 onwards).

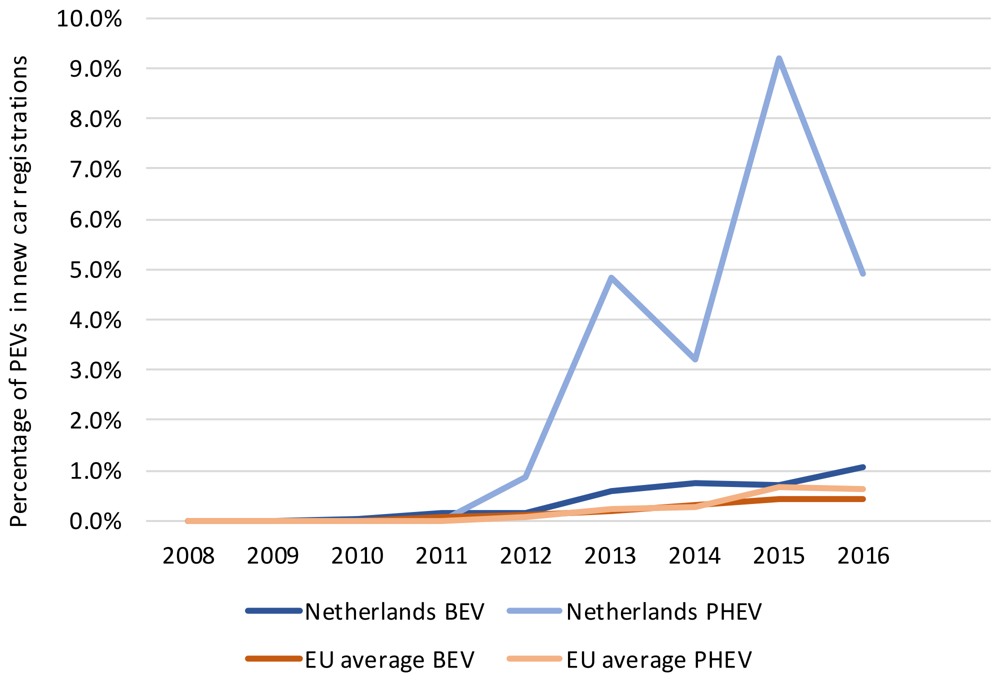
4.2 The Netherlands

The Netherlands was chosen because it shows the impact on new car sales of a (changing) tax regime which favours lower emitting cars (see Figure 4-2). Figure 4-3 shows that the shares of BEVs and PHEVs in new car sales are higher in the Netherlands than the EU average.



Source: EEA (2017b)

Figure 4-2. Average CO_2-emissions of new passenger cars sold in the Netherlands between 2002 and 2016



Source: EAFO (2017)

Figure 4-3. Share of BEV and PHEV in new sales in the Netherlands and Europe between 2008-2016

Over the past decade, the Dutch tax system has been altered a couple of times, favouring CO_2-efficient cars, while at the same time taxing diesel cars at a higher rate than petrol cars, for registration tax as well as in the annual circulation taxes. The scope of these incentives has included taxes on vehicle acquisition, vehicle use and company cars. As of 2008, purchasing a CO_2 efficient car has been encouraged by (partial) exemptions from registration tax and annual circulation tax, combined with a favourable taxation of the benefit of having a company car available for private use. This fringe benefit was taxed as a percentage of the gross list price of the car, to be added to the income and dependent on the CO_2 emissions category. Table 4-1 shows the changes in taxable percentages of the gross list price over the last decade. The coloured cells have the lowest tax percentages; they refer to EVs, PHEVs and BEVs. The grey cells refer to petrol and diesel cars (or all types of car if no coloured cells are present). Between 2008 and 2016, the lowest emitting diesel and petrol cars are taxed lower than the higher emitting classes of diesel and petrol cars. Not shown are the frequent (almost annual) changes in the boundaries between the different classes. Over time the boundaries became more stringent. This was motivated firstly because new cars became increasingly more fuel efficient and secondly because tax revenues dropped sharply, as the market reacted much more strongly than expected.

Table 4-1. Percentages of annual taxation of private use of company car in the Netherlands

Key — BEVs and PHEVs — BEVs — PHEVs — ICEVs

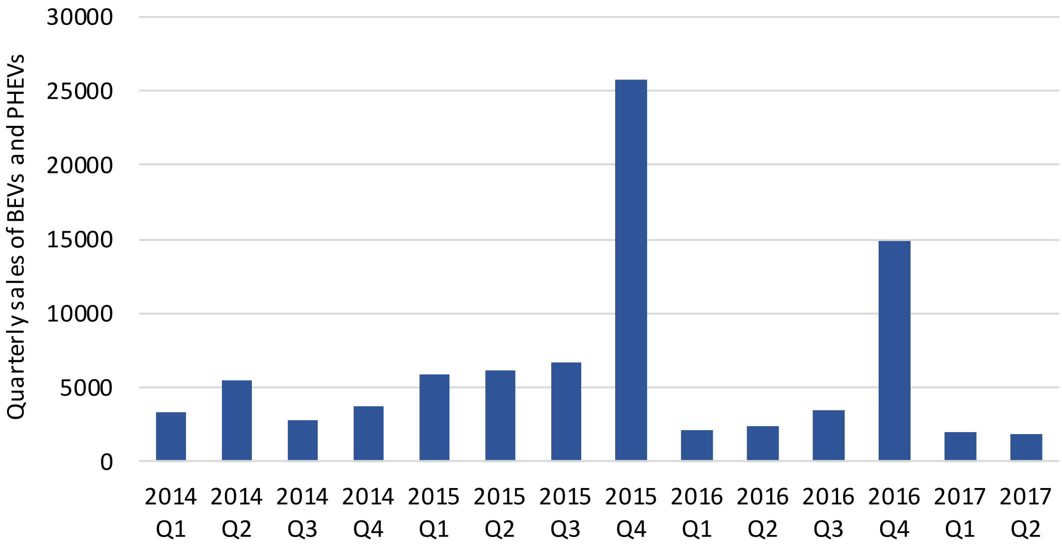
Table cells: Tax rate as a percentage of vehicle gross list price

Tax band	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
A	22%	14%	14%	0%	0%	0%	0%	4%	4%	4%	4%
B		25%	20%	14%	14%	14%	14%	7%	7%	15%	22%
C			25%	20%	20%	20%	20%	14%	14%	21%	22%
D				25%	25%	25%	25%	20%	20%	25%	
E								25%	25%		

N.B. Tax band boundaries (expressed as g CO_2/km) differ between petrol and diesel and are subject to (almost) annual changes.

Source: ACEA tax guides 2007 – 2017

In the Netherlands around half of new car sales consist of company cars, with the other half private cars. The company car market has, in particular, reacted sharply to changes in the tax regime. From 2010 – 2014, BEVs and PHEVs were exempt from taxation of private use. As of 2014, the fringe benefit of BEV company car drivers was taxed as additional annual income at 4% of the gross list price. PHEV company car drivers were taxed 7 % of the gross list price in 2014, 15 % in 2016 and 22 % in 2017, which is the same as the taxation of ICEVs (see Table 4-1). Figure 4-3 shows that PHEV sales rose steeply in 2013. This can at least partially be explained by anticipated changes in the tax regime, as taxation for PHEV-company car drivers became more unfavourable in 2014 (see Table 4-1). In 2015 sales hit a record high, again partially explained by consumers anticipating the less favourable taxation of company car PHEVs in 2016. In 2017, PHEVs are taxed like ICEVs and new sales of PHEVs dropped dramatically. Figure 4-4 illustrates the impacts of anticipation by consumers: the highest sales figures are recorded in the fourth quarter of years just before unfavourable tax reforms.



Source: EAFO (2017)

Figure 4-4. Quarterly sales of BEVs and PHEVs in the Netherlands 2014 – 2017

Kok (2015) showed that the car model types with emissions just below the tax boundaries had the highest sales. This illustrates, again, how consumers take the tax system into account when deciding which car to purchase.

In 2007, the Netherlands were ranked 17th on the European list of countries with low-emitting new cars. The average emissions at that time was 165 g CO_2/km for new cars, 6 grams above the European average. In 2015, at least partly due to the changes in car taxes, the Netherlands were ranked first in the same list with an average emission of new sold cars of 101 g CO_2/km, 18 grams below the European average. In 2016, the taxation became less favourable for new fuel-efficient company cars. Emissions of new cars increased towards 105.9 g CO_2/km, leaving the Netherlands in a second place after Portugal, where new cars are relatively small (and therefore light-weight) and 65 % of them were fuelled by diesel. CO_2-based tax incentives for company cars seem to have contributed the most to the observed turnaround in purchasing behaviour towards lower CO_2-emitting passenger cars (Kok, 2015).

4.2.1 Impacts

Kok (2015) concluded that in the period 2007-2010, the impact of the CO_2-differentiated taxes resulted in an additional reduction of CO_2 emissions of 1.3% over the autonomous technological improvement of 4.8% by manufacturers. Emissions would not have dropped from 165 g/km in 2007 to 136 g/km in 2010, but instead they would have dropped only to 142 g/km in 2010. Around 20 % of the observed emission reduction could thus be attributed to the greening of the taxes. Similar conclusions were drawn by Cambridge Econometrics (2013). They found that CO_2-based vehicle taxation contributed to around 15 % of the observed reduction in emissions rates in the Netherlands, over the 2005-2012 period.

4.2.2 Rebound effects

The greening of the taxation system influenced not only the type of cars, but also the number of cars sold. Due to the changes in the taxation system, small, low-emitting cars were taxed less and therefore became cheaper. It is estimated that this caused an annual extra sale of some 25,000 to 30,000 cars (i.e. 5 – 8 % of annual Dutch sales, Geilenkirchen et al. 2014).

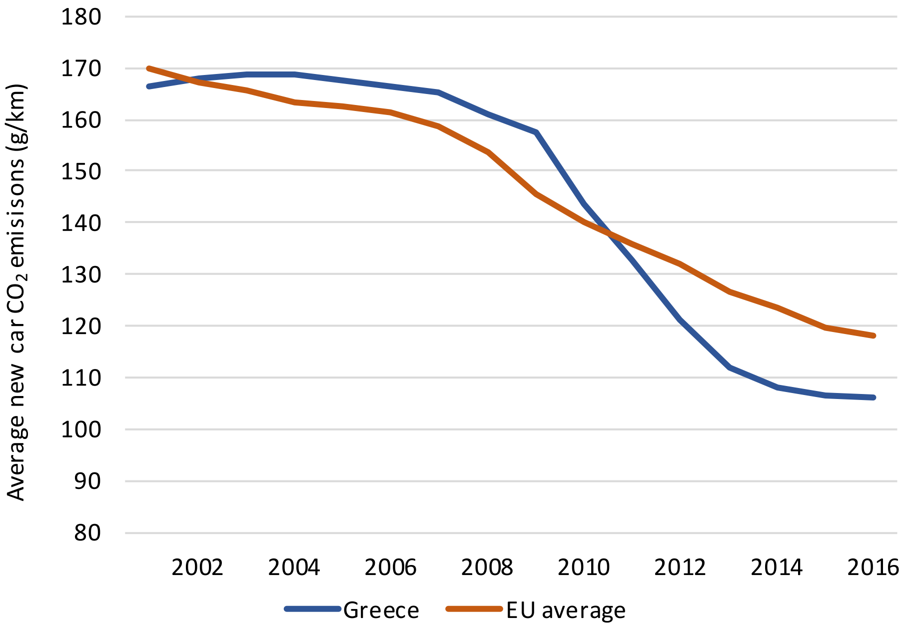
In addition, a further rebound effect has to do with the increased fuel-efficiency of the new cars. If vehicles become more fuel efficient, they become cheaper to drive. As a consequence, people might drive more. Although there is general agreement that rebound effects exist, opinions vary on their size and causes (Sorrell, 2007). Based on a literature review, Sorrell (2007) suggested that 10 % to 30 % of expected CO_2-savings due to driving more fuel-efficient cars is 'compensated for' by this rebound effect.

4.2.3 Lessons

Consumers tend to react strongly to taxation benefits. The impact of greening of taxation is partly counteracted by so-called rebound effects. Restructuring the car-related taxes, taxing the use of a car more heavily (and taxing car ownership less), is generally seen as one of the few ways to diminish the rebound effects. The example of the Netherlands shows that decreasing CO_2 emissions can be achieved without dieselisation of the fleet.

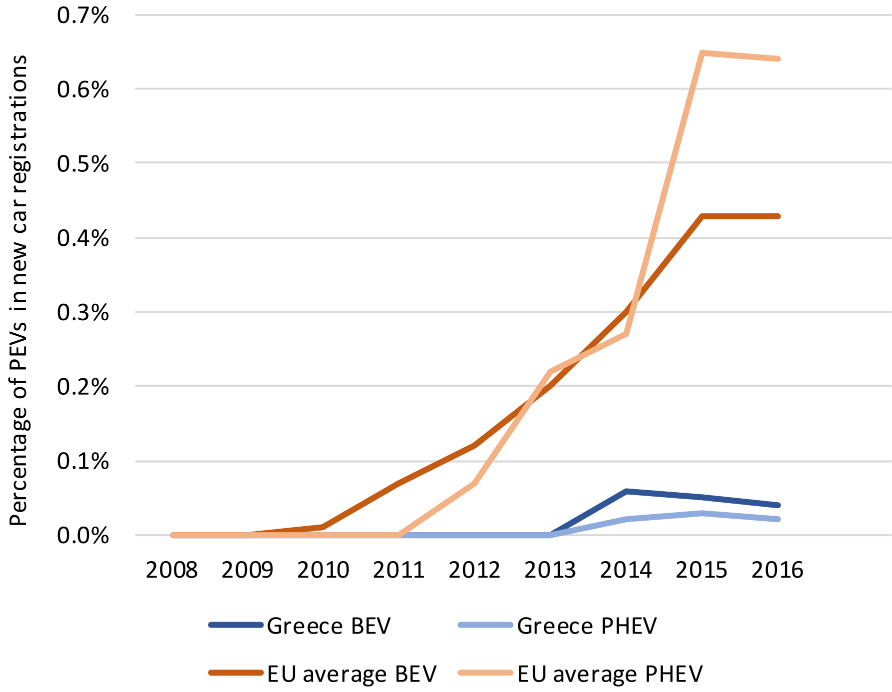
4.3 Greece

Greece was chosen as a case study example as it helps illustrate that taxes are not the only factor influencing new car sales. The economic crisis and local measures like the removal of bans on diesel vehicles may also be important. As shown in Figure 4-5 the average CO_2 emissions associated with new car passenger vehicles in Greece is lower than the EU average from 2012. Figure 4-6 shows the limited contribution from BEVs and PHEVs to this lowering.



Source: EEA (2017b)

Figure 4-5. Average CO_2-emissions of new passenger cars sold in Greece between 2002 and 2016



Source: EAFO (2017)

Figure 4-6. Share of BEV and PHEV in new passenger cars sold in Greece and Europe between 2008-2016

After Malta, the new car vehicle fleet in Greece has the lowest mass (on average 1250 kg, EEA, 2017) and the lowest engine capacity and engine power in Europe. The demand for diesel cars, which are often heavier than petrol cars, was tempered by a ban on diesel cars in Athens and Thessaloniki. The ban was lifted in 2012, having been in place since 1991 (to protect citizens and building from the heavy air pollution). Correspondingly the share of diesel cars in new car sales has increased from 20 % in 2012 to 55 % in 2015 (EEA, 2017).

The potential for unwanted impacts in terms of demand for large, heavy cars with a large engine capacity was tempered by a so-called annual luxury tax, which applied only to owners of cars not older than 10 years with an engine capacity of 1929 cc or over.

4.3.1 Impacts

Between 2009 and 2016, new cars sold in Greece became much more fuel-efficient. In 2009, Greece was ranked 14th on the European list of low-emitting countries with an average emission of 157.4 g CO_2/km by new sold cars, above the EU-27 average of 145.7 g/km. Greece has since moved to fourth place in the league table in 2016 with an average emission of 106.3 g CO_2/km by new sold cars (EEA, 2017).

It would be difficult to attribute these changes due to tax incentives. As, firstly, the registration tax in Greece has no CO_2-component (ACEA, 2017) and, secondly, the annual circulation tax, although based upon CO_2 emissions and cylinder capacity, is low. Fuel taxes for petrol, on the other hand, are amongst the highest in Europe whereas diesel is taxed at a minimum rate. In the period from 2012 to 2015, diesel prices decreased with 33%, whereas petrol prices decreased by 27 %. This too has probably contributed, to some degree, to the dieselisation.

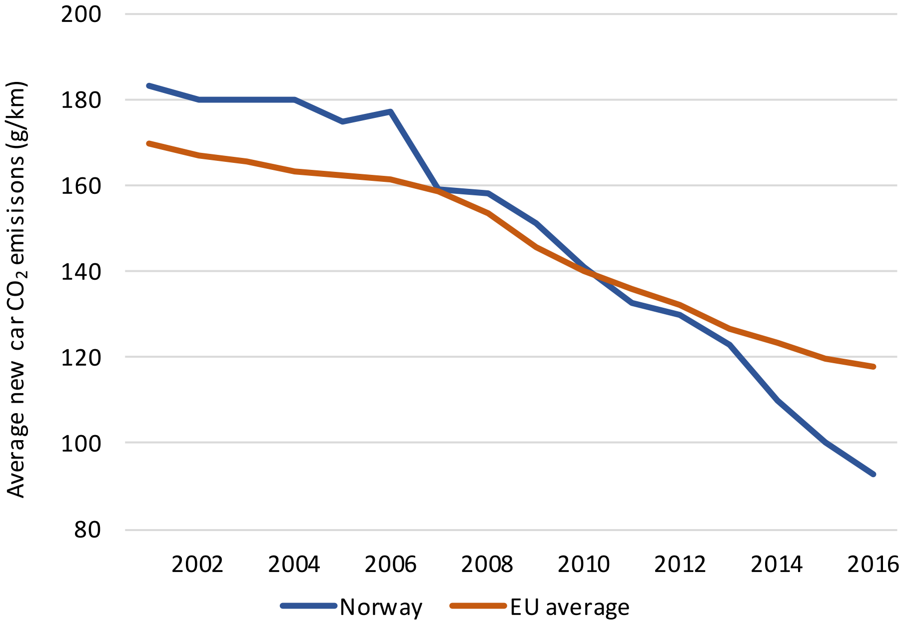
Therefore, it is suggested the decrease in emissions between 2009 and 2016 reflects the increased dieselisation and the impacts of the severe economic crisis on Greece, which has resulted in a reduction in demand for cars, especially larger (more expensive and higher emitting) ones.

4.3.2 Lessons

In the European context the more vulnerable economies have been hard hit by the economic crisis, which is reflected by the size and the composition of new car sales. Here local measures like the lifting of a diesel ban have a major impact on the composition of car sales. Improved understanding is required on the impacts this may have had on air quality.

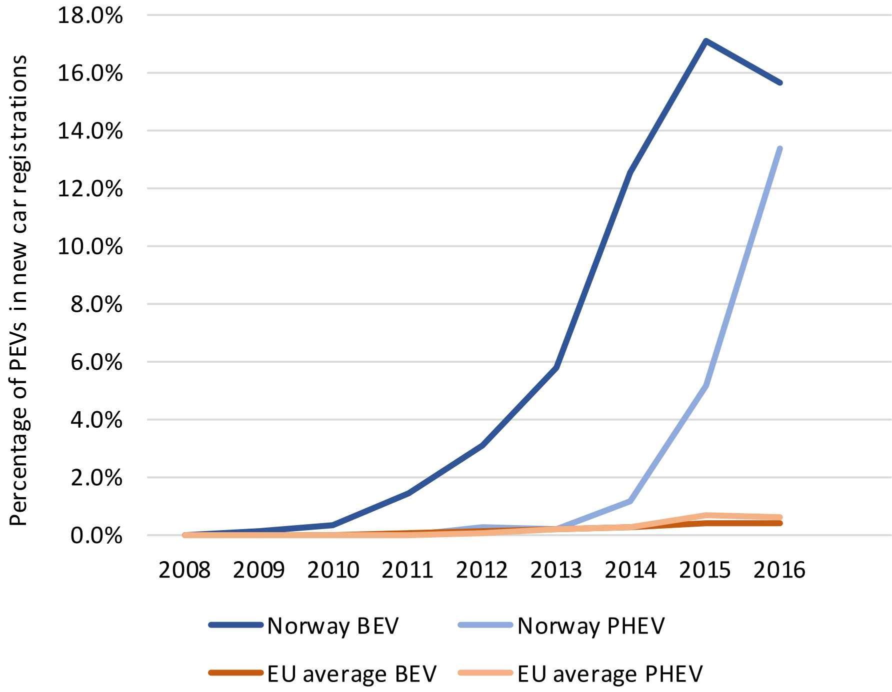
4.4 Norway

Norway was chosen reflecting that it has the highest level of electric vehicle sales of the European countries considered. With Figure 4-8 showing the level of battery electric and plug in hybrid vehicles in Norway compared with the EU average. This reflects that electric vehicles have been subsidised over a long time-period. As Figure 4-7 shows this has helped to contribute to average CO_2 emissions of new passenger cars sold being well below the EU average.



Source: EU – EEA (2017b); Norway – OFV (2017) and NAF (2017)

Figure 4-7. Average CO_2-emissions of new passenger cars sold in Norway between 2002 and 2016

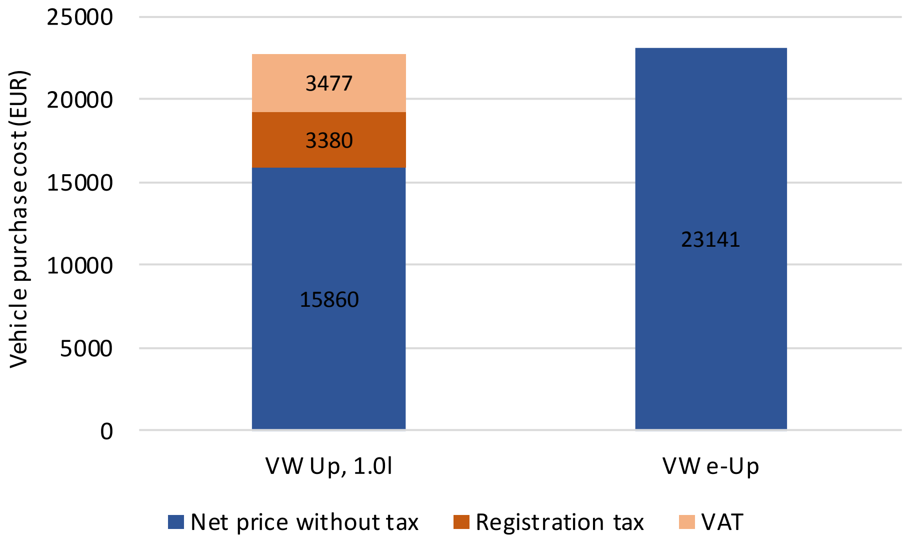


Source: EAFO (2017)

Figure 4-8. Share of BEV and PHEV in new passenger cars sold in Norway and Europe between 2008-2016

In Europe, Norway has had the highest proportion of full-electric cars (BEV's) for many years. This reflects an active, long term policy of relevant incentives, covering one-off benefits on acquisition and recurring incentives. From the early 90's electric cars have been exempt from registration taxes (an upfront incentive). While, from the late 90's electric cars are exempt from toll and parking fees and from annual circulation taxes (recurring incentives). Incentives have also been applied for manufacturers. To stimulate the national electric car manufacturers, EVs were exempt from VAT in 2001. A range of additional incentives have also been employed. In 2003, EVs were allowed in bus lanes. As of 2009, EVs did not have to pay on ferries.

The tax benefits (exemption from VAT and registration tax) ensured that BEVs became about as expensive to purchase as ICEVs.



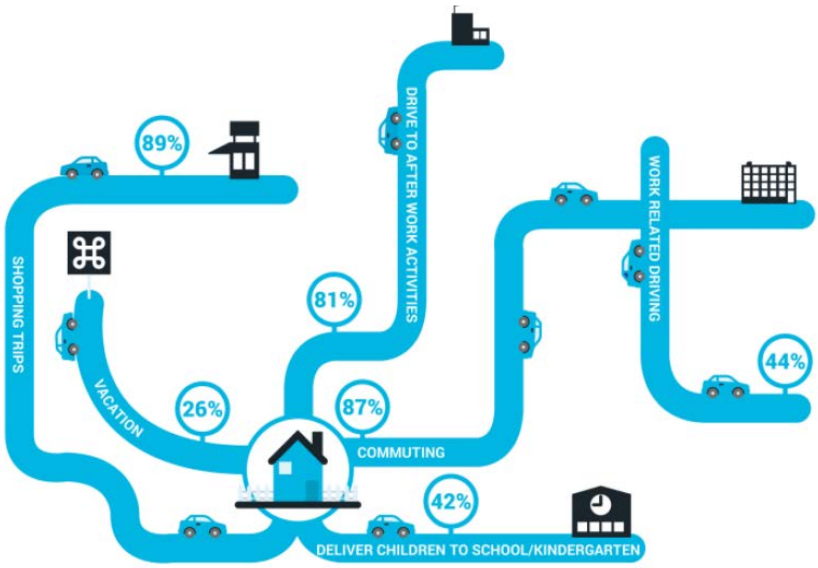
Source: Figenbaum (2015)

Figure 4-9. Comparison of purchase costs of VW e-up and a comparable petrol VW-up

Figure 4-9 shows that the purchase costs of an electric version of the VW-up is only marginally (EUR 400) higher than a comparable version on petrol, due to taxes.

The exemption from annual circulation tax and the additional local benefits made EVs an attractive option for many Norwegians, in spite of the harsh Norwegian winters and the big, scarcely populated country, which are unfavourable factors for driving an EV. Since late 2013, PHEVs have also received favourable fiscal treatment. Since then sales figures of PHEVs have risen strongly whereas sales figures of BEVs have stabilised.

A survey among 3400 BEV drivers in Norway shows that the exemption from registration tax and VAT were critical for the purchase of a BEV for over 80 % of the respondents, while exemption from road tolling and vehicle license reduction were critical for almost half of the consumers (Bjerkan et al., 2016). Moreover, an EV is often bought as a second or third car, but in many cases soon functions as a first car, as most daily activities can be done with it very well. On average, an EV replaces 82 % of the use of an ICEV with examples of the types of trip journeys replaced provided in Figure 4-10.



Source: Haugneland et al., 2016

Figure 4-10 Share of EV as vehicle during various activities of EV-owners

4.4.1 Impacts

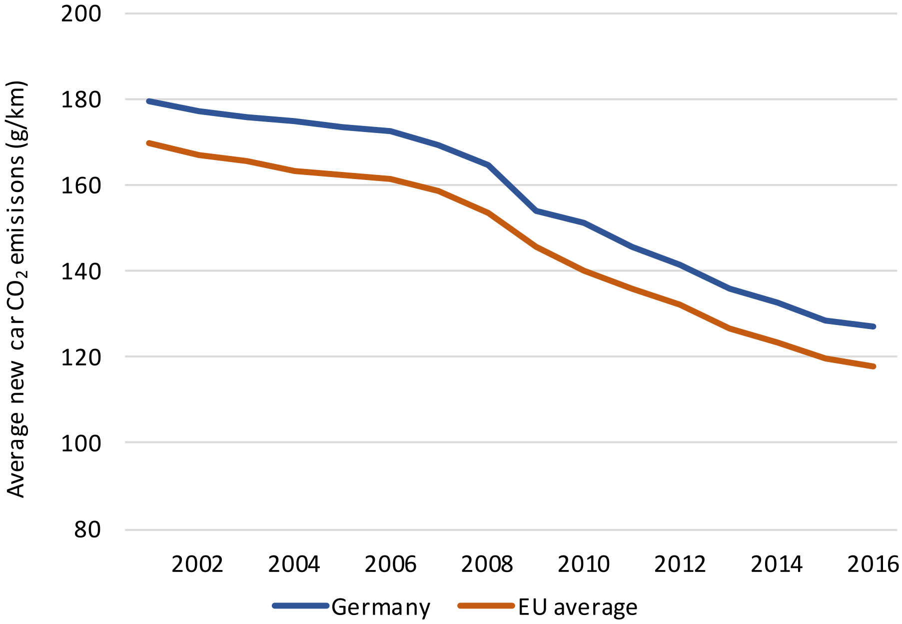
Norway's average CO_2 emissions of new passenger cars in 2016 was the lowest in Europe, at 93 g CO_2/km, well ahead of Portugal as second lowest with 104.7 g CO_2/km and below the EU average target of 95 g CO_2/km for 2020/2021. However, until 2010 Norway's average CO_2 emissions of new passenger cars was actually above the EU average, then just slightly below until 2013. It is only since 2013 that Norway has overtaken all other European countries, with average CO_2 emissions falling by almost 25% from the 123 g CO_2/km recorded in 2013, compared to a 7% reduction on average in the EU. This sharp reduction coincides with the rapid increase of zero and low emission vehicles in the new car fleet (Figure 4-8) over the same period.

4.4.2 Lessons

Norway shows that long-term consistent policies to promote electromobility are attractive for consumers. National and local financial and non-financial incentives form part of these policies.

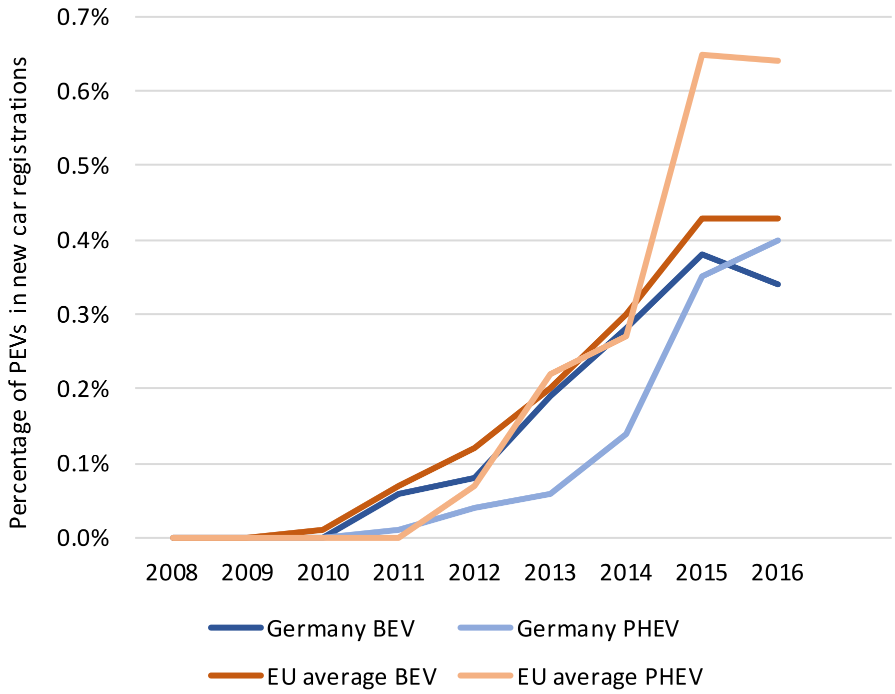
4.5 Germany

Germany was chosen firstly because it is by far the biggest market for new cars in Europe, and secondly because it provides an illustration of what happens to emissions if there are no specific CO_2 taxes or incentives in place. Figure 4-10 illustrates Germany's average new car CO_2 emissions being consistently higher than the EU average. Levels of BEV and PHEV ownership are overall lower than the EU average, as illustrated in Figure 4-11.



Source: EEA (2017b)

Figure 4-11. Average CO_2 emissions of new passenger cars sold in Germany between 2002 and 2016



Source: EAFO (2017)

Figure 4-12. Share of BEV and PHEV in new passenger cars sold in Germany and Europe between 2008-2016

Germany is the European country with the largest car fleet (around 45 million cars, about 3.2 million new car sales yearly, (Eurostat, 2017a), a high rate of car ownership per inhabitant and the largest automotive industry in Europe. The German car fleet consists of relatively heavy (1443 kg on average), large and powerful cars. In 2015, about half of the new cars sold were petrol, the other half were diesel, while a very small share (1.75 %) were alternatively fuelled (Eurostat, 2017a). Since April 2016, a subsidy for electric cars (BEVs and PHEVs) has been in place. This did not immediately lead to a much higher share in new sales (see e.g. EAFO (2017), or RP-Online, 2017), with the share of BEVs and PHEVs combined remaining at just over 0.7% in both 2015 and 2016 (EAFO, 2017). However, preliminary figures for 2017 suggest the share of PHEVs and BEVs has risen more recently, to nearly 1.3% of new car sales (EAFO, 2017).

Until 2015 (ACEA, 2017d) the proportion of diesel cars grew, especially the powerful, heavy diesel cars. Germany does not tax the purchase of a car, but does impose an annual circulation tax. In July 2009, Germany introduced annual circulation taxes that increase linearly with the engine capacity and the CO_2-emission rate (ACEA, 2016). Yet, the level of the tax is so low, even for high emitting cars, that it will have little or no effect on consumer choice. For example, the annual circulation tax for the average German car in 2016, 1715 cc, emitting 127 g CO_2/km is EUR 100, for a high emitting car (2000 cc, 170 g CO_2/km) it is EUR 190.

4.5.1 Impacts

The average CO_2 emission from new passenger cars sold in Germany declined from 190 g CO_2/km in 1998 to 126.9 g CO_2/km in 2016, about 9 grams above the European average (KBA 2011a,b,2016). Only six, all Eastern European countries, sell new cars with higher average emissions.

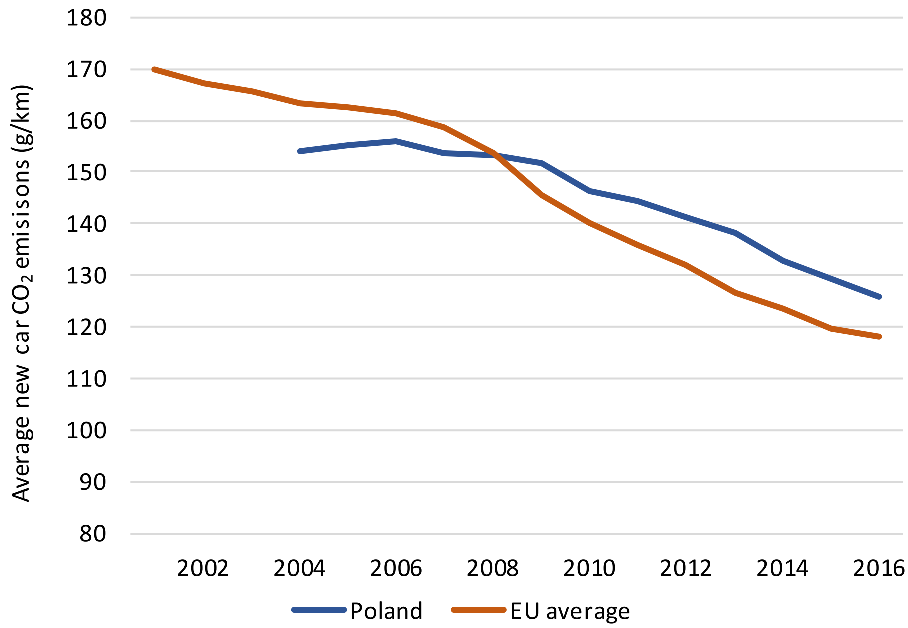
Furthermore, although German cars have become much more efficient in terms of fuel use per km, total emissions from German road transport have remained constant since 1990, due to volume growth. This is not in line with the government's ambition to reduce road transport emissions by 40-42% by 2030 (Gössling et al., 2017). Efficiency standards can therefore be a limited measure of progress on absolute emission reductions. To reduce fuel use, in addition to emission standards a balanced tax system is needed, which taxes not only the possession of a car, but importantly the use of it by taxing the fuel (see e.g. Austin and Dinan, 2005, Sterner, 2007, 2012, Cropper and Chugh, 2014). Yet, significant fuel tax increases can be politically challenging. Furthermore, an increasing share of new registrations in Germany concerns company car registrations (in 2015 66 %, Gössling et al., 2017). Company car drivers tend to be less sensitive to increases in fuel prices, which makes it more difficult to steer customer's behaviour by means of fuel taxes. Fuel prices, especially petrol, in Germany are slightly above the EU average. Thus, in spite of Germany's leading position on the automobile market, both as a manufacturer and as a consumer, it does not deliver the market signals necessary to encourage a major reduction in CO_2 emissions.

4.5.2 Lessons

In spite of high aspirations of the government, Germany did not succeed in cutting down overall transport GHG-emissions. The exact reasons are not clear, but most likely it is to do with the relatively low car taxes and the high share of company cars.

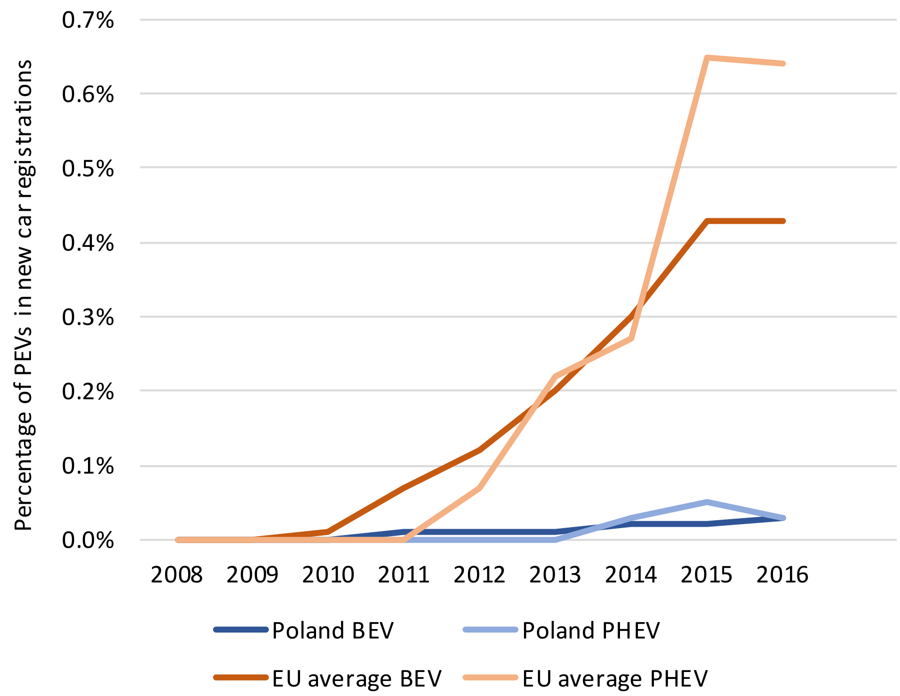
4.6 Poland

Poland was chosen as a representative of Eastern European countries that entered the EU relatively recently. Furthermore, Poland has the largest car market of these new Member States. Poland also provides an illustration of the impacts of the absence of fiscal incentives. Figure 4-13 shows how average CO_2 emissions of new passenger cars in Poland have become higher than the EU average over time. Figure 4-14 shows the low levels of PHEV and BEV adoption compared with the EU average.



Source: EEA (2017b)

Figure 4-13. Average CO_2 emissions of new passenger cars sold in Poland between 2002 and 2016



Source: EAFO (2017)

Figure 4-14. Share of BEV and PHEV in new sales in Poland and Europe between 2008-2016

In Poland, the rise in car ownership can linked to 1) the large political and associated socio-economic changes which have occurred over the past thirty years, following the fall of the Berlin Wall and 2) ready availability of car models from Western Europe.

In 1991, car ownership per 1000 inhabitants was 159, in 2006 this figure was already 351 (Waskiewicz and Balke, 2008) and in 2015 it was 546 (Eurostat, 2017a). Poland imports (including imports from within EU) far more second-hand than new cars. The majority of second hand cars used in Poland have been acquired from one of EU Member States. In 2004, the year of Poland's entry in the EU, more than 800 000 second-hand cars were imported. In that same year, 200 000 new cars were registered. Since 2009, tax on cars only relates to the value of a car, and that could be one of the reasons why the share of relatively old cars in Poland has risen since then, as the valueof old cars, and thus the taxes levied upon them, is relatively low (see Table below). In 2015, the import of second-hand cars (including cars acquired from other EU Member States) was still higher than the registration of new cars, but whilst the import of second-hand cars decreased to 618 000, the registration of new cars had increased to 355 000.

4.6.1 Impacts

When Poland first reported under the monitoring mechanism in 2004, the average emissions were 154.1 g CO_2/km, significantly below the EU average. However, relatively little progress has been made since then and Poland is now well above the EU's average level (in 2016 on average in Poland 125.9 g CO_2/km against 118.1 g CO_2/km in Europe). This is at least partly due to the tax system, which lacks any explicit incentive for fuel efficiency. The rate of excise duty to register a car in Poland (new or second-hand) only relates to the value and the engine capacity of the vehicle. This rate is 3.1% or 18.6% of the value, for engine capacities under or over 2,000 cc respectively. No circulation tax exists. Over the years, Polish consumers have bought increasingly heavier cars. In 2004, the average mass of Polish new car was 1183 kg, in 2013 it was 1376 kg. In 2016, only 260 BEVs and PHEVs were newly registered in Poland, illustrating that there is hardly any demand for electric or hybrid cars, partly explained by the lack of incentives, partly by the lack of charging infrastructure.

Table 4-2 The age structure of second-hand imported/registrations passenger cars (in %) in Poland 2008 to 2015

	More than 10 years old	From 4 to 10 years	Less than 4 years old
2008	42.1	43.4	13.6
2009	41.5	46,7	11.8
2010	43.0	45.9	11.1
2011	46.7	43.5	9.8
2012	46.3	45.6	8.1
2013	48.3	43.9	7.7
2014	50.8	41.5	7.7
2015	55.6	37.9	6.5

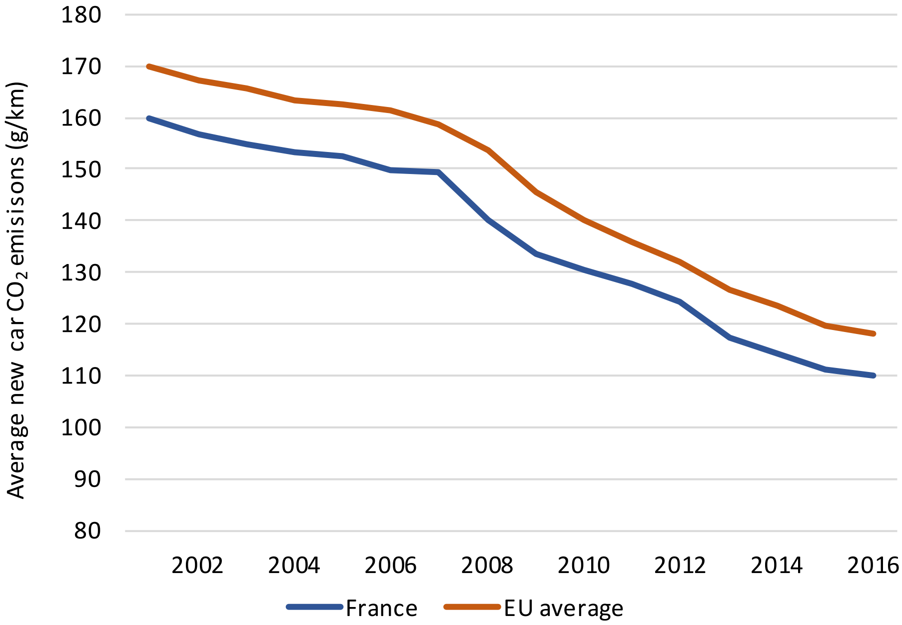
Source: PZPM, 2017

4.6.2 Lessons

In fast growing economies, like Poland, the number of cars (new or second-hand) is growing fast as well. Without fiscal incentives to buy low-emission cars, consumers may be attracted to buy heavy, higher-emitting cars. It is important to note that the remit of this study is on emissions from tank to wheel rather than from a lifecycle perspective, consideration of this broader context is referenced in the further work section.

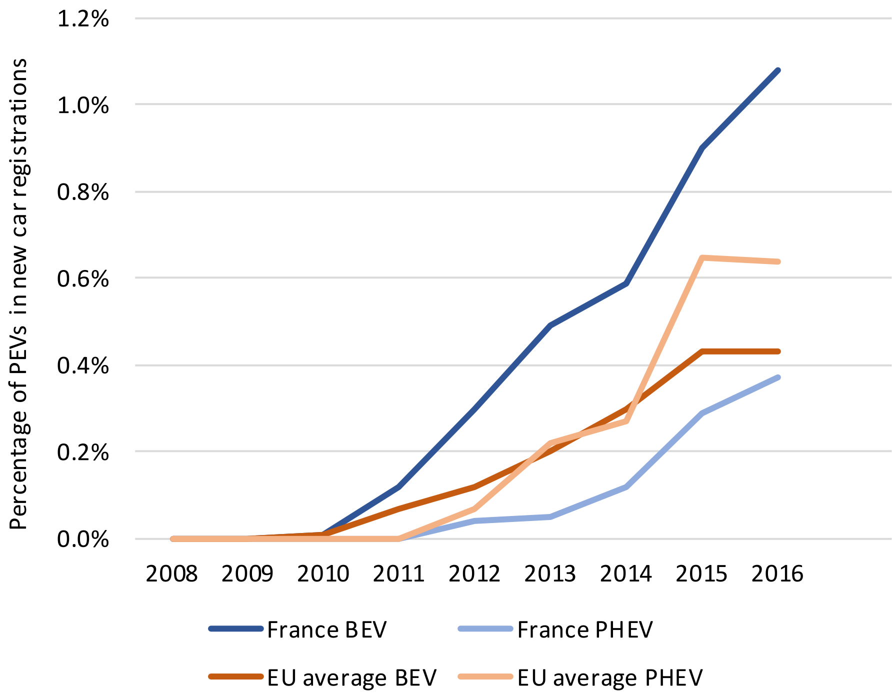
4.7 France

France was chosen firstly because it is one of Europe's largest car markets, and secondly because it has an interesting feebate system, which is a specific way of influencing consumer purchasing behaviour. Figure 4-15 illustrates average CO_2 emissions of new passenger cars sold in France, with average emissions being consistently lower than the EU average, while Figure 4-16 shows the share of battery electric and plug-in hybrid vehicles. In line with the CO_2 emission figures there are greater levels of battery electric and lower levels of plug-in hybrid vehicles compared with the EU average.



Source: EEA (2017b)

Figure 4-15. Average CO_2 emissions of new passenger cars sold in France between 2002 and 2016



Source: EAFO (2017)

Figure 4-16. Share of BEV and PHEV in new passenger cars sold in France and Europe between 2008-2016

With around two million new car sales per year, France is the third largest car market in Europe after Germany and the UK. Until 2008, the French vehicle registration taxes were based largely on the horsepower of the car and to a lesser extent on CO_2 emissions. Since 2009, French annual circulation taxes are based upon CO_2 emissions above a certain limit (in 2009 the limit was 250 g CO_2/km, from 2012 onwards, the limit is 190 g CO_2/km). Since 2008, in addition to the existing registration tax, a feebate system based on the CO_2 emissions was introduced. The feebate increased in discrete steps from a bonus of EUR 5000 for vehicles with emissions below 60 g CO_2/km to a malus of EUR 2600 for vehicles with CO_2-emissions above 250 g CO_2/km. Electric and hybrid-electric vehicles benefit from a premium of EUR 5000 under the bonus-malus scheme and are exempt from registration tax and annual circulation tax. Although in recent years their share in total new registrations is rising, in 2016 it was no more than a mere 1.5 %. On top of the feebate system, in 2009 a vehicle retirement program was introduced for cars older than ten years. Consumers who traded in their old car were eligible for a subsidy of EUR 1 000 if the new car had an emission rate below 160 g CO_2/km. The aim of the scrapping subsidy was to stimulate the car industry, which is an important economic sector in France. In 2017, the French sales for new passenger cars consisted for a large part of small diesel vehicles (average mass 1430 kg, EEA, 2017).

4.7.1 Impacts

With on average 109.8 g/km for new sold cars in 2016, France was below the European average of 118 g/km. From 2007 to 2009, the average emissions dropped by 8.7 g CO_2/km. Klier and Linn (2015) showed (with a significance at the 1 percent level) that the anticipated tax reform accounted for 90 % of this reduction.

4.7.2 Rebound effects

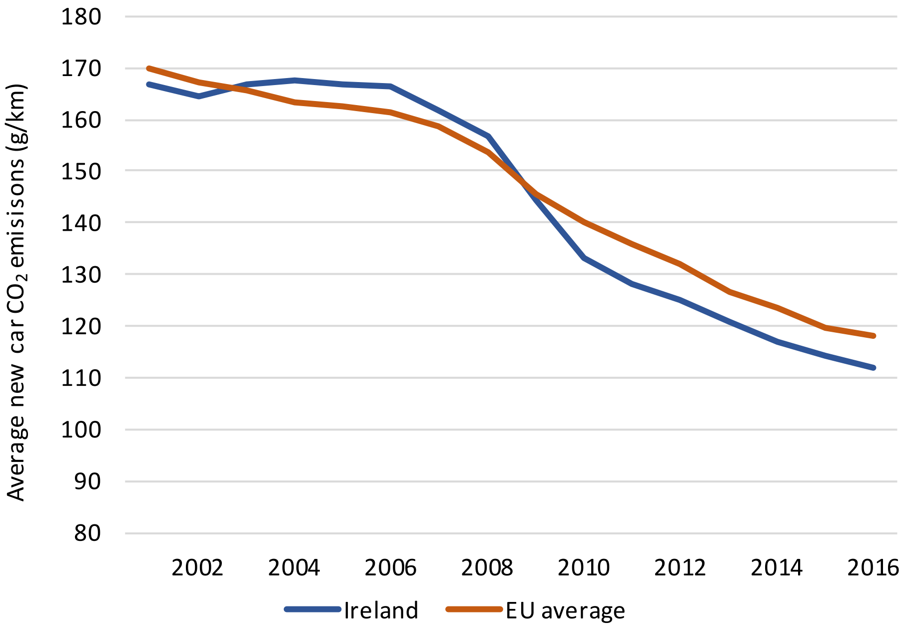
The feebate system with taxes and subsidies was designed to be budget-neutral, based on expected consumer reactions. However, in 2008 the program had a debt of EUR 225 million, attributed mainly to more substantial consumer reactions than expected (D'Haultfoeille et al., 2010). French consumers bought low instead of high-emitting cars in greater numbers than expected. One explanation for these reactions might be the fact that consumers seem to be more responsive to price changes in discrete, non-linear steps; the so-called 'salience' of the tax-system (Finkelstein, 2009, Chetty et al., 2009). Sales of new vehicles increased by 3.5 % in the period from January to September 2008. As the feebate-system led to an increase of new car sales in France (Callonec and Sannie, 2011), this counteracted the aim of the system, i.e. a reduction in CO_2-emissions. More cars lead to more kilometres driven, thus to an increase in overall CO_2 emissions. D'Haultfoeuille et al (2014) conclude that the 'rebound effect' may offset the reduction of CO_2 emissions from the use of lower emission vehicles. Although the feebate-system was altered throughout the years to ensure budget-neutrality, Whitana et al (2014) report a cumulative deficit of nearly EUR 1.5 billion over the period 2008-2011.

4.7.3 Lessons

Consumer behaviour is very difficult to predict. Therefore, it is extremely difficult to design a feebate system in a budget-neutral way. Furthermore, rebound-effects may counteract the aim of the feebate-system, i.e. less CO_2-emissions: in France, feebates facilitated consumers firstly to buy fuel-efficient cars, but secondly, as these cars were relatively cheap, to buy more cars. This led to more kilometres driven, which may have offset the reduction of CO_2 emissions from the use of lower emission vehicles.

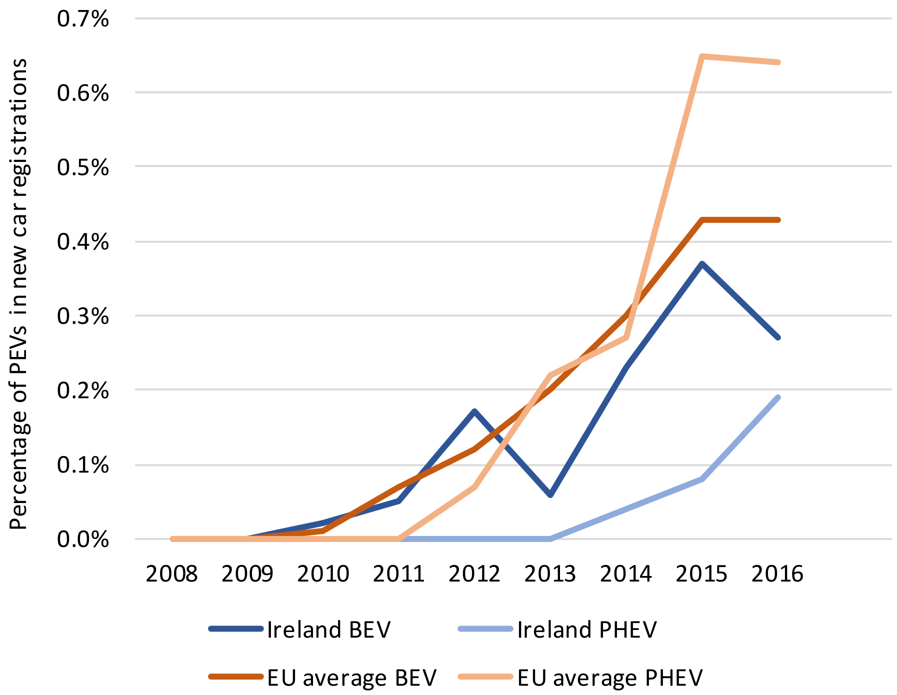
4.8 Ireland

Ireland was chosen as it shows the impact of a CO_2-based tax reform on the share of diesel vehicles in the car passenger vehicle fleet if no accompanying measures are taken. Figure 4-17 illustrates how average new car emissions in Ireland fell below the EU average in 2009, while Figure 4-18 shows that battery electric and plug-in hybrid vehicles are consistently below the EU average.



Source: EEA (2017b)

Figure 4-17. Average CO_2-emissions of new passenger cars sold in Ireland between 2002 and 2016



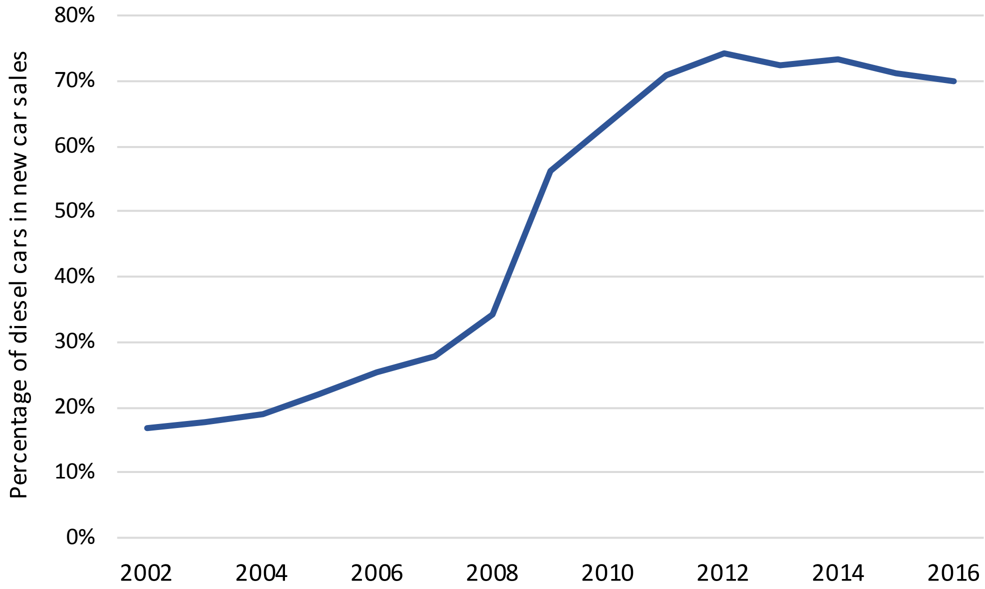
Source: EAFO (2017)

Figure 4-18. Share of BEV and PHEV in new passenger cars sold in Ireland and Europe between 2008-2016

Since July 2008, car taxes (registration tax as well as annual circulation tax) in Ireland are based on CO_2 emissions per kilometre rather than engine size. This has resulted in a more carbon efficient fleet, although there may be increases in mileage that partly offset these gains.

4.8.1 Impacts

Before 2008, average emissions of new cars sold in Ireland were well above the European average (Figure 4-17). Since then, emissions have dropped much faster than the average European emissions. Ireland is now one of the frontrunners in terms of fuel efficiency of new cars sold. Unlike for example the Netherlands, there are no surcharges on diesel cars. This has led to the rapid dieselisation of the Irish fleet. In 2007, just before the tax reform, 27 % of new car sales in Ireland were diesel cars. In 2011, the figure had increased to 70 % (see Figure 4-19). Since then, the diesel share has remained more or less constant at this level.



Source: CSO (2017)

Figure 4-19. Percentage of diesel cars in new passenger cars sold in Ireland from 2002-2016

4.8.2 Rebound effects

In terms of potential rebound effects Hennessy and Tol (2011) conclude that, because diesel cars are more fuel efficient, carbon dioxide emissions fall, but only modestly. As travel costs fall, people may well drive more; correcting for this rebound effect, they conclude that the drop in overall emissions is minimal. On top of that, the tax reform resulted in a loss of tax revenue (Rogan et al., 2011).

4.8.3 Lessons

Tax reforms based on CO_2 lead to a more fuel-efficient fleet. If no surcharges on diesel are in place, the fuel-efficiency may be well achieved by dieselisation of the fleet, this has potential negative consequences for air quality.

4 Conclusions and Further work

The analysis described in this report was framed around two key objectives. The first was to create an inventory of the different vehicle taxation and incentive schemes in place across Europe. The second objective was to better understand the impacts that different tax and incentive approaches have had on CO_2 emissions of the European new passenger car fleet.

The report was not able to quantitatively compare the incentives offered in different countries, so instead focused on the presence or absence of different kinds of incentive. While at least one type of tax or incentive scheme was identified in all of the 32 countries considered, there is variation between the countries in the number and types of tax or incentive in place. The majority of countries did, however, offer incentives acting at more than one point in the car ownership process, with 26 countries offering both vehicle acquisition and recurring incentives. On the other hand, specific incentives for companies (e.g. variable capital allowances and benefit-in-kind taxation) were provided in only about half of the countries, and evidence of government support for electric charging infrastructure was only found for 13 countries.

The focus of the incentives varied considerably among countries. For instance, France had many different taxes and incentives based on CO_2 emissions, including a purchase bonus/malus, registration tax, annual malus and company car tax. In contrast, Norway had only one CO_2 based tax (the import tax), but a large array of incentives for electric vehicles including exemption from import and annual circulation taxes, high levels of investment in public charging infrastructure, and nationwide exemption from tolls and ferry charges.

Over the time period studied (2010-2016), there was relatively little change in the number of countries implementing CO_2-based taxes on vehicle acquisition or ownership, although there was a small increase in the number of countries adopting CO_2-based company car taxation. The relative stability may be due to most countries adopting CO_2-based taxation before 2010. In contrast, there was a large increase in the proportion of countries offering incentives benefitting zero- and low-emission vehicles over the period. Fully-electric vehicles have seen the largest increase in incentives, while support for hybrid vehicles has risen more slowly. Overall, this suggests that incentives have become broader and more comprehensive over time.

An in-depth case study review of seven key relevant countries was undertaken to achieve the second objective. This drew from the outcomes of the first stage of the research. A mixture of countries was purposefully considered from those that could be considered 'front runners' to those that could be considered 'laggards'.

The outcomes of the review illustrate that where there were appropriate levels of taxes and incentives in place, consumer adoption of lower CO_2 emitting vehicles followed. This is seen in the case study examples for electrification for the Netherlands, Norway, France and dieselisation for Ireland. In contrast, where there were more limited taxes and incentives in place as was the case in Germany and Poland, adoption rates were lower. The case studies highlight the importance of country context; for example the role that the economic crisis played in the adoption of cheaper, lighter vehicles in Greece. They also illustrate the wider, often unintended, impacts of vehicle taxation. These unintended impacts include 1) the potential for additional vehicle mileage and associated impacts on CO_2 emissions if less costly vehicles result in increased vehicle ownership ("rebound effects"), 2) the potential for air quality impacts of increased dieselisation, and 3) the potential for people to replace their cars more often and the impacts this could have from a life cycle perspective e.g. in terms of emissions from vehicle production and scrappage. The need to understand impacts highlights the importance of the research undertaken in this and related project.

Through the analysis undertaken for this report, potential areas of further research and data collection opportunities have been identified.

- As recognised in Chapter 3, time series data was limited for the different countries across the literature sources. Discussions with relevant organisations and at the country level could potentially help undertake these assessments going forward, through helping ensure data gaps were addressed.
- It was also not possible due to limited data availability to include quantitative measures of the strength or monetary value of incentives in the inventory. This considerably limits the comparisons and inferences which can be made by comparing the evolution of incentives over time with trends in car CO_2 emissions or zero-emission vehicle uptake. Tools such as the I-CVUE decision support tool (I-CVUE, 2017) for policy makers is the most promising approach for making comparisons of incentive size across countries and over time, but this is currently limited to very few countries, and lacks a time dimension. Extending such a tool to include a greater range of countries would not present any major technical challenges, but would require a large investment of time and effort to collect the necessary data.
- The analysis was an inventory of approaches and impacts and in line with the NEDC it focused on tank to wheel emissions. Further work should consider life cycle emissions including fuel and vehicle production to improve understanding on overall impacts on CO_2 emissions.
- Finally, the analysis covered a specific period in time reflecting data availability and the project remit. It is important to note that the introduction of incentives is, however, on-going. Future, further updates to the work are therefore necessary. For example, Poland introduced legislation on incentives for electromobility and alternative fuelled vehicles in January 2018.

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Appendix A: Detailed methodology for inventory compilation

A.1 Scope and categorisation of taxes and incentives

The first step in creating an inventory was to identify the range of taxes and incentives to be considered, and the best means of categorising relevant taxes and incentives for reducing CO_2 emissions from passenger cars.

Categorisation is a key part of this project, because it allows information for each country and in each year to be summarised in a consistent way, enabling comparisons over time and between countries.

Following a brief review of available data and of other key literature on the topic (EAFO, 2017; Jordal-Jørgensen et al., 2017; Hardman et al 2017; Kok, 2015), a list of the relevant categories of tax and incentive was created, which comprised the following:

- **Up-front, one-off taxes or incentives affecting vehicle purchase price (acquisition incentives).** This comprises differentiated purchase, import or registration tax, purchase subsidies, bonus/malus schemes (also known as 'feebates'; either a subsidy or a surcharge may apply depending on the vehicle), or a scrappage-for-replacement scheme (offering a bonus to exchange an old car for a particular kind of new car).
- **Recurring taxes and financial incentives affecting cost of ownership and use**. This includes differentiated annual circulation taxes, road tolls, congestion or low emission zone charges for different vehicle types, and subsidised electricity (for plug-in vehicles).
- **Non-financial recurring incentives.** Examples of this are benefits such as preferential lane use, access or parking for particular types of vehicle.
- **Infrastructure subsidies.** For example, government funding for the installation of refuelling and charging facilities for low emissions vehicles.
- **Company-specific taxes incentives.** Various taxes and incentives applying to company-owned cars may be differentiated according to vehicle characteristics. Most often, this comprises the extent to which costs which can be deducted from company profits before tax (sometimes referred to as the writing-down or capital allowance), and the level of additional income tax imposed on employees who enjoy access to company cars for private journeys as a benefit-in-kind.

Depending on the way taxes and incentives are structured, they may encourage uptake of either efficient internal combustion engine vehicles (ICEVs), low- and zero-emission vehicle technologies or both. This distinction is relevant because instruments which continue to provide an incentive for efficient ICEVs and those encouraging zero-emissions technology potentially have very different impacts on the future trajectory of vehicle and infrastructure development.

To reflect this, the list of taxes and incentives presented above was further subdivided to create separate categories for incentives graded by CO_2 emissions which encourage efficient ICEVs, and those incentivising uptake of low- or zero-emissions vehicles such as battery-electric (BEV), fuel cell electric (FCEV), plug-in hybrid (PHEV) and hybrid electric (HEV) vehicles.

In undertaking the analysis 32 countries were considered: the EU-28 plus Norway, Iceland, Switzerland and Liechtenstein.

The full list of tax and incentive categories used in the compilation is available in Appendix B

A.2 Sources of taxes and incentives information

Following the definition of tax and incentive categories, the next step was to systematically review available sources of tax and incentive information for each country, cross-checking across different sources, to establish a consistent picture of taxes and incentives in that country.

Information on taxes and incentives for each member state and country using the sources list in table A-1 below.

Table A-1. List of sources of tax and incentive information used to compile the inventory

Information source	Description
European Automobile Manufacturers Association (ACEA) tax guides, 2010 – 2017 (Listed as ACEA 2010a – ACEA 2017a in the bibliography).	The ACEA tax guide is compiled each year by representatives from each country, covering EU, EFTA and a selection of non-European countries. It provides almost complete information on general and company-specific taxes in place at the time of compilation, but does not always contain details of purchase subsidies available, and generally does not cover wider incentives such as infrastructure subsidies or non-financial benefits.
European Automobile Manufacturers Association (ACEA) overview of CO_2 based taxes in the EU 2010 – 2017 (Listed as ACEA 2010b – ACEA 2017b in the bibliography).	This overview document provides a summary of CO_2 related taxes in the EU-28 (EU-27 prior to 2014). It is useful for cross-checking, but information can be missing or incomplete, so the full tax guides must be used for comprehensive information.
European Automobile Manufacturers Association (ACEA) overview of tax incentives for electric vehicles in the EU 2010 – 2017 (Listed as ACEA 2010c – ACEA 2017c in the bibliography).	This overview document provides a summary of incentives for electric vehicles in the EU-28 (EU-27 prior to 2014). It covers incentives for BEVs, FCEVs, PHEVs and sometimes HEVs, but suffers from the same incompleteness as the CO_2 tax overview.
Website of the European Alternative Fuels Observatory (EAFO), 2017 (Listed as EAFO (2017) in the bibliography)	The EAFO website provides comprehensive details of the taxation, subsidies and wider incentives available for BEV, PHEV, FCEV, and LPG and CNG fuelled vehicles. This complements the information available from the ACEA tax guides. However, the information provided relates to the latest policies only, and does not provide any information on the historical evolution of incentives.
European Commission 'Urban Access Regulations in Europe' website. (Listed as EC (2017b) in the bibliography).	This website provides information on congestion and low emission charging zones, and urban access restrictions across Europe. Up-to-date information is available, but historical information is not available in a consistent form.
Targeted literature searches	For specific countries and incentives not covered by other materials, bespoke literature searches were undertaken. This was necessary, for example, to find information on non-financial incentives such as free parking, and for

Information source	Description
	information about taxes in Liechtenstein. Usually, only the most up-to-date information was available, with historic data absent or unavailable.

A.3 Assigning taxes and incentives to a category

Working through the sources of information by country and year, each relevant tax or incentive was assigned to a category.

Categorising taxes and incentives into the main bold groups listed in section 3.2.2 was relatively straightforward, but identifying those incentivising the uptake of zero- or low-emission vehicle technology (BEVs, FCEVs, PHEVs and HEVs) was more difficult.

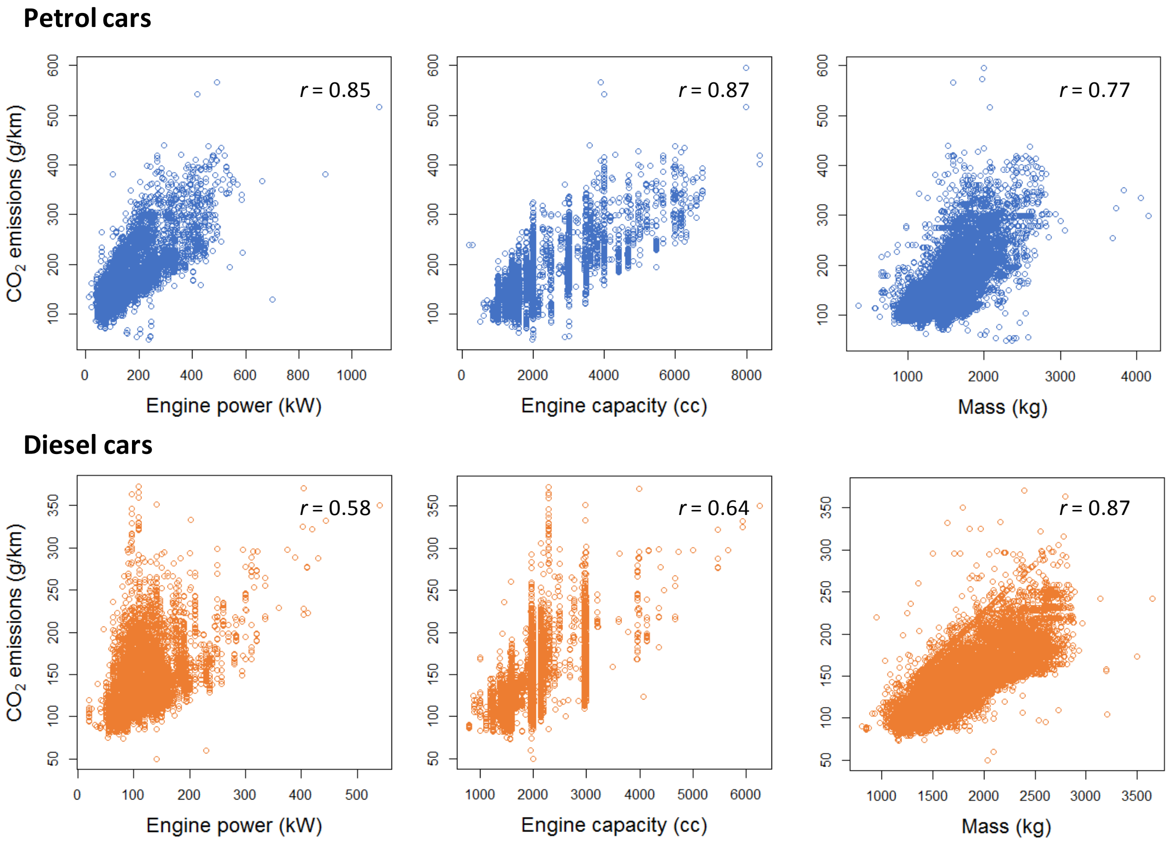
In some cases, a CO_2-based gradation contained emissions bands which can only realistically (at the time the research was undertaken) be attained by electric or hybrid vehicles. In these cases, the incentive in question was categorised as both a CO_2-based instrument per se, and one favouring uptake of zero- or low-emission vehicle technology. For the purposes of this categorisation, the type of vehicle technology favoured was decided based on the lowest official CO_2 emissions value for vehicles currently available in each category of propulsion technology (Next green car, 2017). The models with the lowest emissions in each category available in the UK were as follows:

- Petrol ICEV – 84 g CO_2/km (Suzuki Celerio 1.0l)
- Diesel ICEV – 79 g CO_2/km (Peugeot 208 1.6l)
- Non plug-in hybrid (HEV) – 70 g CO_2/km (Toyota Prius 1.8l)
- Plug-in hybrid (PHEV) – 22 g CO_2/km (Toyota Prius plug-in 1.8l)
- Electric vehicles (BEV and FCEV) - 0 g CO_2/km

Using this information, more rounded threshold CO_2 levels were defined to determine which propulsion types are favoured by particular tax bands. Tax thresholds of 75 g CO_2/km exclude all ICEVs (currently), and favour the all other low-emission vehicles. Below 50 g CO_2/km, both ICEVs and HEVs are excluded, so PHEVs and electric (BEV and FCEV) vehicles are favoured. Only fully electric vehicles (BEVs and FCEVs) can achieve 0 g CO_2/km. Of course, many HEVs emit more than 75 g CO2/km and many PHEVs emit more than 50 g CO_2/km, but as some models in the propulsion category can achieve these limits, uptake of that category of vehicle in general is incentivised.

In other cases (e.g. company car tax in the Netherlands in 2017), the tax is described as being based on CO_2 emissions, but only allowed an exemption or preferential rate for zero-emission vehicles. Here, the incentive was categorised only as encouraging zero- or low-emission vehicle technology.

Taxes and incentives based on vehicle mass, engine capacity or power were categorised as CO_2 based taxes due to the strong correlation of these vehicle characteristics with CO_2 emissions (Figure 3 1). Policies encouraging uptake of vehicles with lower mass and smaller or less powerful engines is also likely to favour vehicles with lower CO_2 emissions. These were labelled as “proxy” variables when compiling the inventories.



Source: EEA (2017b)

Figure A-1. Scatterplots showing the relationship between CO2 emissions per km and vehicle mass, engine capacity and engine power, for individual petrol (top) and diesel (bottom) car models in 2016.
The Pearson's correlation coefficient (r), is given for each pair of characteristics, where a value of 0 would signify no correlation, and a value of 1 perfect correlation.

A.4 Coding of taxes and incentives

Countries can differ both in the presence or absence of a particular type of incentive, and also in the strength of the incentive, e.g. the monetary size of a tax saving or grant.

Unfortunately, due to the varied ways in which countries calculate tax rates and the wide variety of vehicles on the market, it is not possible to express the strength of incentives as a single scalar variable which could be compared over time or between countries. One method used by other authors (e.g. Lévay et al., 2017) to make quantitative comparisons is to choose representative vehicle models, and use data and assumptions of costs and usage patterns to calculate the taxes and incentives applicable in each country or year. However, the necessary work involved to do this in a meaningful way meant that this was not feasible within the project.

Therefore, the information on taxes and incentives was coded in the inventory in a purely qualitative way, indicating presence or absence of that tax or incentive for each year and country. The coding used was:

i) **"Yes – National"** – tax or incentive is applicable throughout the whole country for that year.
ii) **"Yes – Local"** – tax or incentive is applicable in some parts of the country for that year.
iii) **"Proxy"** – tax or incentive is based on a variable correlated with CO_2 emissions, but not on CO_2 emissions *per se* (see section A.3).

Additionally, where the tax or incentive encourages uptake of zero- or low-emission vehicle technology, the kinds of technology favoured were listed. The list comprised one or more of battery-electric vehicles

(BEV), fuel-cell electric vehicles (FCEV), plug-in hybrid vehicles (PHEV) and hybrid electric vehicles (HEV; not plug-in). Incentives for other fossil fuels such as liquefied petroleum gas (LPG) and compressed or liquefied natural gas (CNG or LNG) were not recorded.

Some terminology used in descriptions of taxes was ambiguous, so an interpretation of these terms had to be applied consistently across countries. Where incentives were described as applying to “electric” vehicles, this was always interpreted as including both BEVs and FCEVs unless otherwise specified. Likewise, where the term “hybrid” was used with no further clarification, this was taken to mean both plug-in and non-plug-in hybrid cars.

A.5 Differences in scope between the analysis of the evolution of taxes over time, and the snapshot of taxes and incentives in place in 2016

The inventory compilation was approached in two separate ways, because of limitations in the coverage and consistency of historical data on taxes and incentives, in comparison to information about the situation in 2016.

While an inventory showing the evolution of taxes and incentives over time could be produced for most taxes and countries, a subset of countries and types of incentive could not be included in this. Therefore, in order to examine the remaining incentive types and countries, a second inventory was compiled focusing on taxes and incentives available in a recent year (2016), to take advantage of the much larger amount of information available for this.

The differences in scope are summarised in table below.

Table A-2. Scope of the two parts of the inventory, in terms of geography, time period and range of incentives considered.

Analysis	Geographic scope	Temporal scope	Range of incentives covered
Evolution of taxes and incentives over time	EU-28 Member States (EU-27 prior to 2014)	2010 – 2016 (and partial 2017)	-Taxes and incentives on acquisition (purchase subsidies and grants may be missing in some cases) -Taxes on ownership -Company car taxes
2016 snapshot of taxes and incentives	EU-28 + Norway, Switzerland, Iceland and Liechtenstein	2016	-Taxes and incentives on vehicle acquisition -Taxes on ownership -Company car taxes -Other recurring incentives (e.g. parking and toll exemptions) -Infrastructure incentives

The choice of 2016 as the most recent year for which to provide information is due to differences between countries in the timing of changes to taxation and reporting of this information. For some countries, changes due to occur during 2017 were not yet in place at the time that the ACEA tax guide 2017 (ACEA, 2017a) was compiled - the main source of consistent information on vehicle taxes. To allow fair comparisons between countries, the latest year for which a full inventory was made is 2016.

A.6 Fuel tax

Fuel prices are a further factor which may affect the usage of passenger cars, implicitly favouring cars with low CO_2 emissions due to the strong correlation of this with fuel consumption. The level of fuel duty, and the difference in taxation between diesel and petrol, differ considerably among Member States. However, because all Member States impose some level of taxation, and fuel duty does not explicitly vary according to car characteristics (except by fuel type), analysis of fuel duty rates in Member States was considered separately (in Section 3.6) to other taxes and incentives. Data on fuel prices and duty for Member States for 2017 was obtained from the EC Weekly Oil Bulletin (EC, 2017a).

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