Electric vehicles

# Fiscal instruments favouring electric over conventional cars are greener

Financial incentives and taxes set by countries can encourage consumers to buy passenger cars with lower carbon dioxide (CO2) emissions. An increase in the uptake of electric vehicles reduces emissions of CO2 and air pollutants such as nitrogen oxide (NOx) and particulate matter (PM). Examples from a number of countries show that this uptake can be enhanced by well-designed incentives and taxes. In contrast, tax schemes that promote conventional cars labelled as cleaner do not always result in reduced emissions.

**Main findings**

- Countries that actively promote zero- and low-emitting cars, such as battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs), have significantly reduced CO2 emissions.
- There have also been other environmental benefits in these countries: emissions of air pollutants such as NOx and PM have decreased as a result of the uptake of electric vehicles.
- The effects of tax incentives promoting low-emitting conventional cars on CO2 emissions are less clear. Measures of emissions are based on officially reported 'type-approval' emissions, which are lower than 'real-world' emissions. The gap between type-approval CO2 emissions and real-world emissions increased over the period 2010-2017. Therefore, the average real-world emissions of new passenger cars have decreased at a rate significantly slower than that predicted by trends based on type-approval emissions.

This briefing summarises the results of a study performed by the European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution [1] for the EEA. The study assessed the impacts of taxes and incentives on real-world emissions of $CO_2$ and air pollutants from new passenger cars over the period 2010-2017. It follows up on a previous EEA study, published in

2018, that looked at the effects of vehicle taxation on the type-approval emissions [2] of new cars in seven European countries (France, Germany, Greece, Ireland, the Netherlands, Norway and Poland). These countries were selected because of their different approaches to taxation and consumer incentives for the purchase of low-$CO_2$-emitting vehicles. The same countries were selected for the present study. The analysis considered the cumulative fleet of new vehicles registered every year from 2010 to 2017. The results are presented in terms of the emissions savings for all new passenger cars registered between 2010 and 2017.

This study focused on emissions related to only the use phase of vehicles. The comparative impacts of electric cars and conventional cars on climate change, air quality, noise and ecosystems were analysed in an EEA report published in 2018.

## Appropriate taxes and incentives encourage purchases of new cars with lower type-approval $CO_2$ emissions

Average type-approval $CO_2$ emissions from new passenger cars have dropped in all European countries over the past two decades, from above 170 g $CO_2$/km in 2001 to around 118 g $CO_2$/km in 2017. This corresponds to a total reduction of around 30 %, or an average annual reduction of 2 %. This decrease was particularly pronounced in countries where a range of taxes, subsidies and other incentives were used to encourage consumers to purchase low- or zero-$CO_2$-emitting vehicles. $CO_2$ emission reductions were also observed in countries where the market share of diesel vehicles increased.

**Type-approval versus real-world emissions**

According to EU legislation, vehicles must be tested to verify that they are compliant with the required environmental, climate, safety and security standards, and to determine their fuel consumption and CO2 emissions. For determining exhaust emissions, standardised tests are performed in laboratories. The results of these tests are used to calculate the 'type-approval' emissions.

Laboratory tests can never capture the full range of conditions experienced on the road. Furthermore, CO2 emissions due to the operation of certain energy-consuming devices (e.g. air conditioning systems) are not measured during type-approval testing. Therefore, type-approval emissions will deviate from real-world emissions produced by a car driven on a real road. The former were tested under New Emissions Driving Cycle (NEDC) test conditions until 2017. However, the gap between type-approval emissions tested in accordance with the NEDC and real-world emissions has grown over the years. Since 2017, the Worldwide Harmonised Light Vehicles Test Procedure (WLTP) has been in place for type-approval testing, as have portable emission measurement systems that test real driving emissions (RDE) for air pollutant emissions. These new procedures will allow more realistic information on a vehicle's emissions to be obtained from the type-approval tests.

In the Netherlands and Norway, new passenger cars emitted on average 38 % and 54 % less $CO_2$ in 2017 than in 2001, respectively. These reductions were due to the electrification of the fleet, driven by policies that favoured low-emitting vehicles.

In Ireland, the dieselisation of the fleet led to a 31 % decrease in type-approval $CO_2$ emissions over the period 2007-2017 [3]. This is because diesel cars emit comparatively less $CO_2$ than petrol cars.

By contrast, in Germany and Poland, where only limited taxes and incentives were in place, the uptake of low- or zero-emission vehicles was low. The reduction in average $CO_2$ emissions from new passenger cars in these countries between 2001 and 2017 was below 30.

## The increasing gap between reported type-approval and real-world $CO_2$ emissions has reduced the effectiveness of taxation schemes based on the type-approval $CO_2$ emissions of conventional cars

The gap between type-approval emissions, based on the NEDC, and real-world emissions has increased over the years. This gap depends on fleet characteristics (such as vehicle category, vehicle mass, engine capacity segment and manufacturer), as well as driver behaviour and environmental conditions. Consequently, it varies considerably among countries.

In Ireland, a registration tax and an annual circulation tax based on type-approval $CO_2$ emissions have been in place since 2008. Because diesel cars generally emit less $CO_2$ than petrol cars, this caused a rapid dieselisation of the fleet (from 27 % of new cars in 2007, to 65 % in 2017). Between 2007 and 2017, the $CO_2$ emissions saving based on type-approval conditions was around 8 %. However, during that period, the difference between real-world and type-approval values grew relatively more for diesel cars (from 30 to 40 g $CO_2$/km) than for petrol cars (from 20 to 30 g $CO_2$/km). This particularly pronounced divergence of type-approval and real-world values for diesel cars, together with the share increase of diesel cars, resulted in a saving of only 0.4 % in terms of real-world $CO_2$ emissions over the period 2012-2017 [4] (Figure 1).

Poland did not implement any tax explicitly based on $CO_2$ emissions during the period 2010-2017. Although its vehicle registration tax is based on engine capacity, its categorisation does not give additional incentives to purchase a more efficient car. Since 2010, Polish consumers have bought increasingly heavier and more powerful new cars. The average mass of a new car in Poland increased from 1 317 kg in 2010 to 1 410 kg in 2017. This has contributed further to increasing the gap between type-approval and real-world emissions. In fact, average real-world $CO_2$ emissions of new passenger cars registered in Poland show a slightly increasing trend: although there was a saving of 7.5 % based on type-approval emissions, real-world emissions increased by 1.7 %. In 2017, new diesel and petrol cars emitted on average 2 % and 1.5 % more $CO_2$ than in 2010, respectively, in terms of real-world emissions (Figure 1).

Over the period 2010-2017, the purchase of a car was not taxed in Germany. However, since 2009, there has been an annual circulation tax in place that increases linearly with engine capacity and the $CO_2$ emissions rate. The level of this tax is so low, however, even for high-emitting cars, that it has had little effect on consumer choices. In 2017, Germany had one of the highest type-approval $CO_2$ emissions in the EU: its fleet is significantly heavier, larger and more powerful than the EU average (1 454 versus 1 388 kg, 1 696 versus 1 577 $cm^3$ and 111 versus 96 kW, respectively). Real-world emissions show a slight downward trend: they dropped by 2 and 4.5 g

$CO_2$/km, respectively, for diesel and petrol cars, in the period 2010-2017. These reductions contributed to a 1.5 % decrease in overall $CO_2$ emissions over the period (Figure 1). Under type-approval conditions, the $CO_2$ emissions saving would have reached 10 %.

## Incentives that promote the purchase of electric vehicles have clear climate-related and environmental benefits

Where strong incentives that promoted the uptake of electric vehicles were in place, clear reductions in overall real-world $CO_2$ emissions from new passenger cars were seen.

Among the seven countries studied, Norway had the highest sales of electric vehicles. In 2017, 39 % of the fleet was electric (21 % BEVs and 18 % PHEVs), while, in 2010, electric vehicles represented only 0.3 % of new cars. Policies promoting zero- or low-emitting vehicles (BEVs and PHEVs), implemented since the 1990s, have had a clear role in reducing $CO_2$ emissions from new passenger cars. Such policies include the exemption of these vehicles from VAT, registration tax and annual circulation tax, as well as additional local benefits such as free parking and no road charges. Registration and circulation taxes in Norway, which normally apply to conventional vehicles but not to electric vehicles, are among the highest in the world and bring the purchase cost of an electric vehicle to the same level as a comparable conventional vehicle. These taxes have favoured the uptake of electric cars, leading to a cumulative $CO_2$ emissions saving of 16 % for new passenger cars registered between 2010 and 2017.

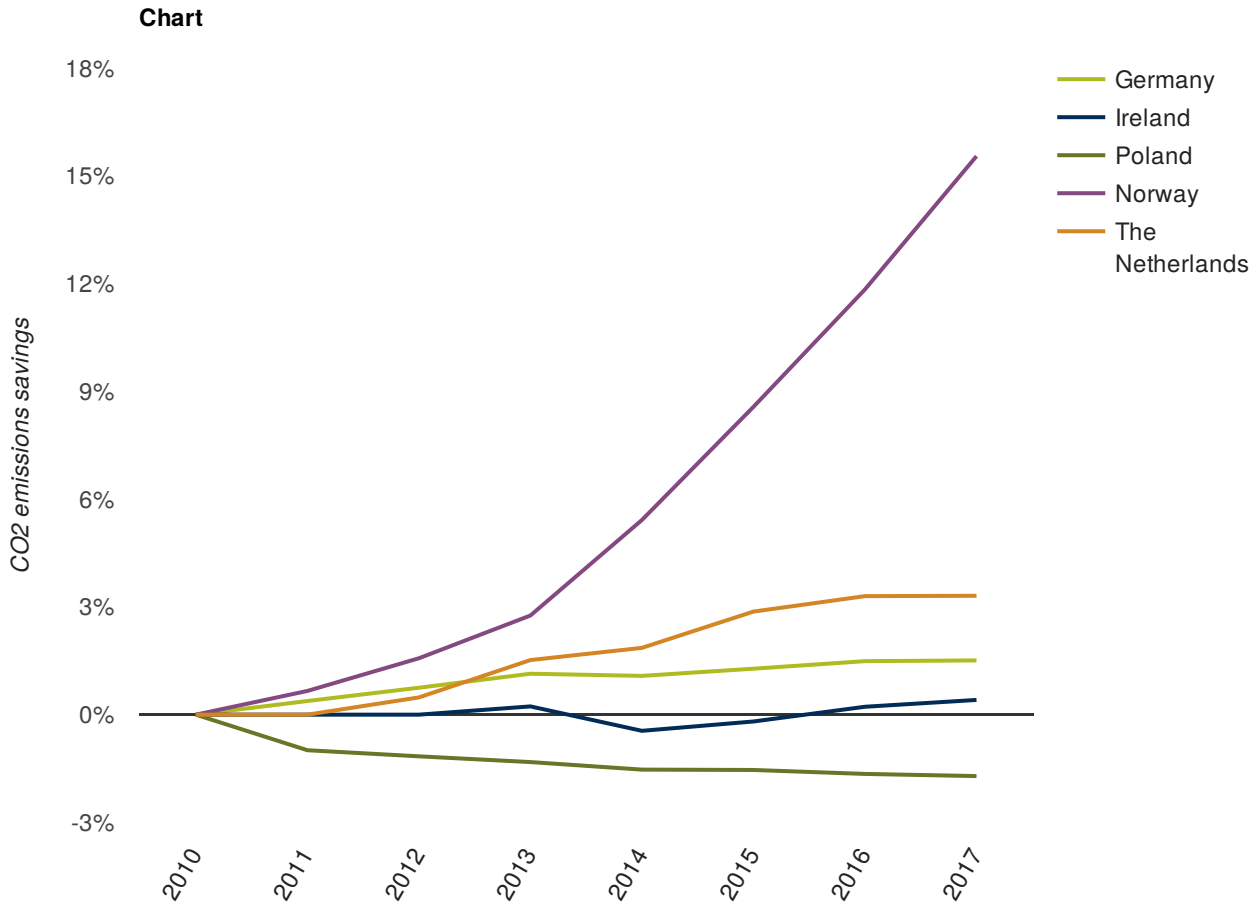
The Netherlands case provides a good illustration of the strong links between consumer preferences, the uptake of electric cars and the tax regime. This country applied a tax system that favoured electric vehicles and low-emission conventional vehicles in the period 2010-2017. Over the years, the tax system became more stringent and focused on the introduction of zero-emission vehicles. Fiscal incentives for PHEVs were gradually reduced to the same level as those for regular cars:

- from 2010 to 2013, PHEVs were exempt from taxation
- in 2014 and in 2015, company PHEV drivers were taxed 7 %
- in 2016 this rose to 15 % and in 2017 to 22 %, which is the same level of taxation as that for conventional cars.

As a result, PHEV sales declined from 9.2 % in 2015 to 0.3 % in 2017. Over the same period, the proportion of BEVs increased from 0.7 % to almost 2 %. Overall, the electrification of the fleet reduced $CO_2$ emissions by more than 3 % over the period 2010-2017.

# Transport

## Figure 1 $CO_2$ emissions savings within the fleets of newly registered cars in Germany, Poland and Ireland, and in Norway and the Netherlands where the uptake of electric vehicles has been promoted most




**Note:** $CO_2$ emissions savings within the fleets of newly registered cars in Germany, Poland and Ireland, and in Norway and the Netherlands where the uptake of electric vehicles has been promoted most

**Data sources:** EEA. Monitoring of CO2 emissions from passenger cars – Regulation (EC) No 443/2009

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European Environment Agency

## Diesel vehicles may be better than petrol cars in terms of $CO_2$ emissions, but cannot compete with electric vehicles in terms of air pollutant emissions

According to the 2018 EEA report Electric vehicles from life cycle and circular economy perspectives, an electric car in Europe produces on average less greenhouse gases and air pollutants than its petrol or diesel equivalent, across its life cycle.

BEVs and PHEVs offer air quality benefits because of zero or low exhaust emissions of air pollutants such as $NO_x$ and PM. For example, the introduction of electric cars to the Norwegian fleet resulted in cumulative $NO_x$ and PM emissions savings of 17 % and 6.6 %, respectively, over the period 2010-2017.

Because diesel vehicles have lower $CO_2$ emission levels than petrol cars, the uptake of diesel vehicles has been incentivised in the past to meet $CO_2$ emissions targets. However, the dieselisation of fleets has led to negative effects on air quality. In Greece, the proportion of diesel cars in the fleet increased rapidly. This was due to the lifting, in 2012, of a long-standing ban on diesel cars in the two largest cities, Athens and Thessaloniki, and the lowering of taxes on diesel fuel. While these measures are thought to have resulted in large $CO_2$ emissions savings (3.7 % in the period 2013-2017), they have also had adverse effects on air quality, as $NO_x$ and PM emissions increased drastically during the same period (by 44 % and 4 %, respectively).

The introduction of Euro 6 emissions standards meant stricter limits, which led to a reduction in the $NO_x$ emissions of the newly registered fleet. For all countries, the transition from Euro 5 to Euro 6 standards for conventional cars had a positive effect on $NO_x$ emissions: from a 4.3 % reduction in emissions in Norway to 10 % reductions in Ireland and Greece. For PM, the EU emissions standards were the same for Euro 5 as they are for Euro 6.

## Conclusions

Over the years, most European countries have based their vehicle taxation schemes on type-approval $CO_2$ emission values and increased the number of incentives to purchase new electric vehicles. However, taxation and incentive programmes can differ in several aspects, which may affect their effectiveness in reducing $CO_2$ and air pollutant emissions. Countries such as Norway and the Netherlands, which have promoted electric vehicles more than any of the other countries, managed to achieve significant reductions in emissions, both in terms of $CO_2$ and air pollutants. Many electric vehicles were introduced into these countries' fleets, because policies specifically targeted these technologies. In other countries, taxation schemes based on NEDC-based type-approval $CO_2$ emissions complemented EU legislation that set targets for manufacturers. This has resulted in a steady reduction in the average type-approval emissions of new passenger cars

since 2001. However, the increasing divergence between real-world emissions and type-approval $CO_2$ emissions has undermined the effectiveness of such tax and incentive schemes. In some countries, such as Poland, a slight increase in average real-world emissions of new vehicles since 2004 has even been observed.

## Footnotes

[1] The European Topic Centre on Air Pollution and Climate Change Mitigation until 2018.

[2] Type-approval emissions designate the emissions of new vehicles as tested using 'type-approval' procedures, in accordance with the New European Driving Cycle (NEDC), in place during the whole period covered by this briefing (2010-2017). See the box 'Type-approval versus real-world emissions' for further details.

[3] Since 2008, car taxes (registration tax as well as annual circulation tax) in Ireland have been based on $CO_2$ emissions per kilometre.

[4] A complete fuel type data set for Ireland is available for the period 2012-2017.

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