STUDY

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Pricing instruments on transport emissions

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RESEARCH FOR TRAN COMMITTEE

Pricing instruments on transport emissions

Overview briefing

Abstract

This briefing provides an overview of pricing instruments on road transport CO_2 emissions. It presents the current use of these instruments in the EU, the main EU legal framework in this field including the expected developments, and the impacts these instruments may have on the road transport sector and society in general.

This document was requested by the European Parliament's Committee on Transport and Tourism.

AUTHOR(S)

CE Delft: Arno SCHROTEN, Julius KIRÁLY, Peter SCHOLTEN

Research administrator: Davide PERNICE
Project, publication and communication assistance: Krisztina MANYK, Anna DEMBEK, Kinga OSTAŃSKA
Policy Department for Structural and Cohesion Policies, European Parliament

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ABOUT THE PUBLISHER

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DISCLAIMER

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LIST OF ABBREVIATIONS

CO_2	Carbon dioxide
EC	European Commission
ETD	Energy Taxation Directive
ETS	Emission Trading System
EU	European Union
FQD	Fuel Quality Directive
g	Gram
GHG	Greenhouse Gas
GJ	Gigajoule
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
Km	Kilometre
LCV	Light Commercial Vehicle
LDV	Light Duty Vehicle
MJ	Megajoule
MRV	Monitoring, Reporting & Verification
nETS	National Emission Trading System
PPP	Purchasing Power Parity
RED	Renewable Energy Directive
SCF	Social Climate Fund
TEN-T	Trans-European Transport Network

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EXECUTIVE SUMMARY

KEY FINDINGS

- Pricing instruments on road transport CO_2 emissions are widely applied in Europe, although there are significant differences between Member States. More broadly, Member States also differ to the level by which their road transport sectors meet the 'polluter-pays' and 'user-pays' principles.
- The European Commission has presented proposals to incentivise the pricing of CO_2 emissions of road transport by introducing emission trading for this sector as well as by revising the Energy Taxation Directive. One of the aims of the latter is to incentivise the uptake of low-carbon energy carriers by the transport sector.
- Pricing instruments (particularly emission trading and fuel taxes) are effective in reducing CO_2 emissions in the road transport sector. They may, however, also have significant distributional impacts, which should be carefully considered in order to gain social acceptance for this type of instruments.

Fair and efficient pricing in transport is one of the core elements within the European Commission's vision to decarbonise the transport sector. By using a mutually compatible and complementary mix of pricing instruments, like emission trading, infrastructure charges, energy taxes and vehicle taxes, transport users should be incentivised to make more sustainable transport decisions. This briefing provides a general overview of the current and proposed pricing instruments on road transport CO_2 emissions in the EU.

State of play of pricing instruments on road transport CO_2 emissions

Pricing instruments on road transport's CO_2 emissions are widely applied in the EU. All Member States levy fuel taxes, although tax levels differ significantly between countries. Most countries also apply purchase and ownership taxes for passenger cars, but the extent by which these taxes are CO_2 based differs widely. For heavy goods vehicles (HGVs), only (non-CO_2 based) ownership taxes are applied in the majority of the countries. Finally, about half of the Member States apply a road infrastructure charge (i.e. a toll or vignette) for passenger cars, while these charges are applied in almost all countries for HGVs (with an increasing number of countries replacing a vignette scheme by a distance-based road charging scheme). Although road user charges are not differentiated to CO_2 emissions in any of the Member States, they may indirectly have a CO_2 reducing impact by curbing overall transport demand and incentivise transport efficiency.

Because of the wide differences in the type of pricing instruments applied, the tax/charge levels set and the level of differentiation to CO_2 emissions applied, Member States differ significantly in the extent by which CO_2 emissions of road transport are effectively charged. In general, CO_2 emissions of passenger cars are more heavily charged than emissions of vans and HGVs. This is because of higher fuel taxes on petrol than on diesel, and because CO_2 differentiated vehicle taxes are more often applied for passenger cars. More broadly, Member States also differ to the level by which their road transport sectors meet the 'polluter-pays' and 'user-pays' principles. Although in almost none of the EU countries external and infrastructure costs of road transport are fully covered by taxes and charges, some countries have made much more progress in this respect than others.

EU legislative framework

Transport pricing is mainly a Member State competence. The current EU legislative framework is mainly focused on harmonising (to some extent) the design of national instruments. The Energy Taxation Directive (ETD) harmonises national fuel taxes by setting minimum rates[1]. However, as these minimum rates have not been indexed since 2003, their effectiveness has diminished over the years. Furthermore, the current ETD presents some voluntary and mandatory exemptions of fuel taxes, e.g. the mandatory exemptions for aviation and maritime shipping. Road infrastructure charges in the EU are harmonised by the Eurovignette Directive. Although this Directive does not oblige Member States to implement a road charging scheme, it does provide some rules that should be followed once a country decides to implement such a scheme. In the recently adopted revision of this Directive, a mandatory switch from time-based to distance-based road charging for heavy duty vehicles is introduced, to be implemented by 2030 at the latest. Furthermore, a mandatory CO_2 differentiation of charges for HGVs is introduced as well, incentivising the use of low- and zero-emission trucks.

In order to better align the EU legal framework on transport pricing instruments with the decarbonisation objectives of the EU, the Commission recently proposed to revise the ETD by removing the disadvantages for clean technologies and introducing higher levels of taxation for inefficient and polluting fuels. Furthermore, the Commission proposed to launch a new, separate emission trading scheme (ETS) for road transport (and buildings).

Impacts of pricing instruments

Pricing instruments have a broad range of impacts on the transport sector and society in general. Some relevant impacts are:

- *Impacts on road transport CO_2 emissions*. Pricing instruments are effective in reducing CO_2 emissions. Fuel taxes and ETS can be considered as first best instruments, as they incentivise all relevant CO_2 reduction options. CO_2 based purchase taxes may provide a significant additional incentive for the uptake of low- and zero-emission vehicles.
- *Impacts on budget revenue.* Transport taxes contribute, on average, about 5-10% to the overall tax revenues of national governments in the EU. The rise of the number of low- and zero-emission vehicles may significantly lower the income from fuel taxes and CO_2 based vehicle taxes. Keeping tax income at a stable level may become an important challenge for national governments in the next decade.
- *Impacts on transport prices.* Current transport taxes and charges contribute significantly to transport prices for passenger and (to a lesser extent) freight road transport. The introduction of an ETS for road transport and the revision of the ETD will have a limited additional impact on transport prices (about 4% to 10%, based on CO_2 price of EUR 50 per tonne).
- *Distributional impacts.* Pricing instruments on road transport CO_2 emissions will probably have a regressive impact, implying that the relative impact on disposable income is higher for low-income households as for high-income households. There may also be large differences in fiscal

[1] The ETD covers the taxation of all energy products, but in this briefing we only consider the rules set for transport fuels.

burden for people living in rural areas (who are more car-dependent) and urban areas. Because of these effects, some countries are more severely affected by pricing instruments than others.

- *Impacts on competitiveness and employment.* In general, pricing instruments on road transport CO_2 emissions are expected to have relatively limited impacts on competitiveness of the road transport sector and the production sectors and on employment rates. However, more significant impacts may occur at the level of individual economic sectors (or countries), which may require mitigation actions.

Policy recommendations

To optimise the use of pricing instruments in decarbonising the road transport sector, it is important to:

- *Develop a balanced mix of pricing instruments.* Fuel taxes and/or an ETS would be the cornerstone(s) of an effective package of pricing instruments on CO_2 emissions. However, CO_2 based purchase taxes may provide an effective additional incentive for the uptake of low- and zero-emission vehicles.
- *Integrate pricing instruments in a broader package of CO_2 reduction policies.* As pricing instruments are largely complementary to other climate policies, like CO_2 vehicle standards, they should be preferably combined in an overall climate policy for (road) transport.
- *Consider political and social acceptance of pricing instruments.* Large distributional impacts may negatively affect the political and social acceptance of pricing instruments. Developing mitigation measures for these impacts is therefore key, e.g. by designing effective recycling channels for the revenues of pricing instruments.
- *Regularly re-adjust the pricing instruments.* In order to maintain the effectiveness and revenue of pricing instruments, regular updates of CO_2 based pricing instruments are required, taking trends in the car industry (e.g. decreasing average CO_2 emissions of vehicles) and consumer preferences (e.g. increased preferences for zero-emission vehicles) into account.
- *Consider other transport externalities as well.* An overall transport pricing policy should not only consider CO_2 emissions, but also other externalities like air pollution and congestion. Differentiated distance-based road infrastructure charges may play an important role in this respect.

1. INTRODUCTION

1.1. Background

The European Green Deal (EC, 2019) aims to accelerate the transition to a climate-neutral economy in the EU in 2050. To reach climate neutrality, a 90% reduction in transport emissions is targeted for 2050. In the Strategy for Sustainable and Smart Mobility (EC, 2020b), the European Commission presents its vision on how this reduction target can be achieved. An important element within this vision is the further implementation of fair and efficient pricing in transport. By using a complementary and coherent mix of pricing instruments like emission trading, infrastructure charges, energy taxes and vehicle taxes, people should be incentivised to make more sustainable transport decisions. In this light, the Commission presented an extension of the EU ETS to road (and maritime) transport (EC, 2021c) and a revision of the Energy Taxation Directive (EC, 2021f) as part of the 'Fit for 55' package. These instruments may be added to the different pricing instruments on road transport emissions currently applied at the EU and national level.

1.2. Objective and scope of the briefing

The overall objective of this study is to provide an overview of the different pricing instruments on road transport CO_2 emissions[2] that are currently used in the EU, the main developments that are expected in this field and the impacts these instruments may have on the transport sector and society in general. Furthermore, recommendations on general criteria for effective pricing instruments are presented.

As this is a briefing, the focus is on general overviews and recommendations, mainly based on existing literature. Detailed assessments are beyond the scope of this study. Quantitative results will be presented for passenger cars and heavy goods vehicles[3] (HGVs)[4]. In addition it will be discussed in qualitative terms to what extent these results are also valid for other road vehicle categories, particularly light commercial vehicles (LCVs)[5].

1.3. Overview of the briefing

In the remainder of this study, we first provide an overview of the pricing instruments on road transport CO_2 emissions that are currently applied in Europe (Chapter 2). In Chapter 3, the EU legislative framework with respect to pricing instruments for road transport is described. Some impacts of pricing instruments on the road transport sector and society in general are discussed in Chapter 4. Finally, the main conclusions and some policy recommendations are presented in Chapter 5.

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[2] We focus on CO2 emissions in this briefing, which are about 99% of the total GHG emissions of road transport (EEA, 2022). Furthermore, air pollutant emissions, like NOx and particles, are out of scope of the study.

[3] Vehicles for the carriage of goods with a maximum mass of over 3,500 kg.

[4] Passenger cars and HGVs are together responsible for ca. 80% of the CO_2 emissions of road transport in the EU in 2019 (EEA, 2022).

[5] Vehicles for the carriage of goods and having a maximum mass not exceeding 3.5 tonnes.

2. STATE OF PLAY OF PRICING INSTRUMENTS ON ROAD TRANSPORT EMISSIONS IN THE EU

KEY FINDINGS

- Pricing instruments are broadly applied in the EU road transport sector. There are, however, wide differences between Member States with respect to the type of instruments implemented, the extent by which instruments are based on CO_2 emissions and the level of charging applied.
- In general, CO_2 emissions of passenger cars are more heavily charged compared to LCVs and HGVs. This is because of higher excise duties on petrol than on diesel, and because CO_2 differentiated vehicle taxes are more often applied for passenger cars.
- The 'polluters-pays' and 'user pays' principles are not fully applied in almost all EU countries. On average, only 50% of the external and infrastructure costs of passenger cars are covered by taxes/charges and 25% for HGVs. There are, however, large differences in these shares between countries.
- CO_2 emissions of road transport are more heavily charged than in most other transport modes.

2.1. Overview of pricing instruments for road transport emissions

Pricing instruments are widely applied in the EU road transport sector. In general, three types of taxes and charges can be distinguished based on the charge base applied: energy taxes (including CO_2 taxes), vehicle taxes and infrastructure charges[6] (CE Delft et al., 2019b). In the remainder of this section, these three types of pricing instruments are separately discussed.

Pricing instruments may be directly or indirectly linked to CO_2 emissions of road transport. All energy taxes are directly linked to CO_2 emissions, as there is a direct relationship between energy consumption (the tax base of energy taxes) and CO_2 emissions of road vehicles. Vehicle taxes and infrastructure charges may also be considered directly linked to CO_2 emissions in case these levies are differentiated to CO_2 emissions. CO_2 differentiated taxes/charges provide an incentive to buy/use a more fuel-efficient vehicle, resulting in lower CO_2 emissions. Non-CO_2 differentiated vehicle taxes and infrastructure charges may only affect CO_2 emissions indirectly, e.g. by lowering the demand for transport, increasing transport efficiency or decreasing the size of vehicle fleets.

2.1.1. Energy and CO_2 taxes

Fuel taxes, the bulk of which are formed by excise duties, are charged by all EU Member States. In some countries (e.g. Denmark, Finland, France, Ireland, Luxembourg, Portugal Slovenia, and Sweden) specific carbon or CO_2 taxes are applied for road transport as part of the fuel excise duties (see Box 1 for some examples). Germany introduced a national emission trading scheme for transport and heat generation

[6] VAT levied on transport means, fuels or services are not considered in this briefing, as these are considered general instead of transport specific taxes.

in 2021 (see Box 2). As this scheme has a fixed price till 2025, it has in the short term similar characteristics as national carbon taxes.

Box 1: Some examples of a national carbon tax on motor fuels

In 1991, **Sweden** introduced a national carbon tax (CO_2 tax) as one of the building blocks of the Swedish climate policy. This charge applies for all sectors not included in the EU ETS, including road transport. The charge was introduced at a rate of EUR 24 per tonne CO_2 and gradually increased over the years to EUR 114 in 2021 (which is about EUR 0.25 per litre petrol and EUR 0.22 per litre diesel). The stepwise increase of the tax rate has contributed to political feasibility of the tax. As the carbon tax is collected as part of the fuel excise duty, there are no significant additional administrative burden for the government and taxpayers. Revenues from the tax are not earmarked, but added to the general budget.

In **Slovenia** the excise fuel duty also includes a CO_2 charge component which is a fixed part of the fuel tax set by the national government. The carbon tax is part of a broad package of environmental taxes implemented in Slovenia. The charge is currently about EUR 17 per tonne CO_2, which is equal to EUR 0.040 per litre petrol and EUR 0.047 per litre diesel.

Source: EC (2021b); The Government of Sweden (2022)

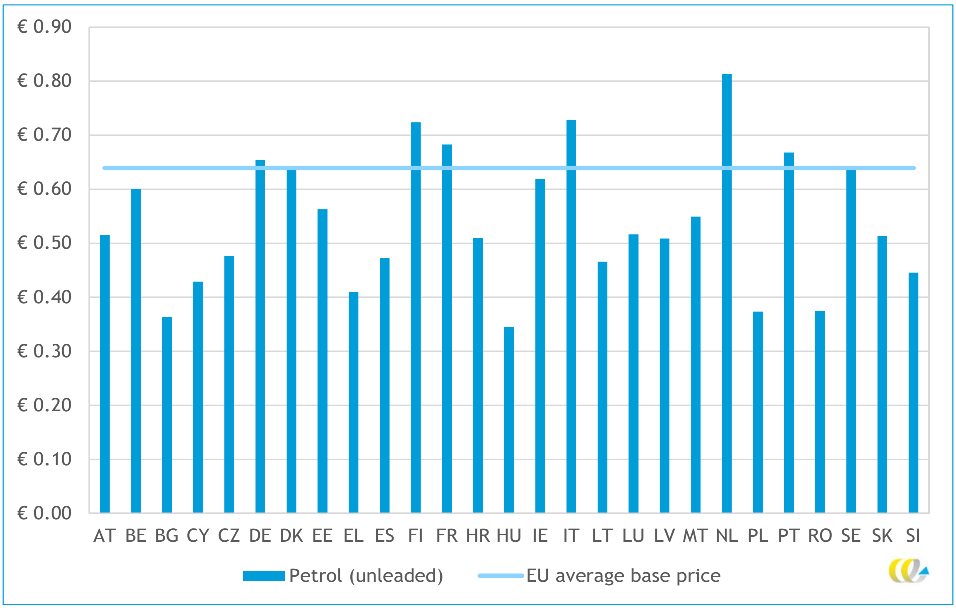
Box 2: National emission trading scheme for transport in Germany

In 2021, **Germany** implemented a national emissions trading system (nETS) for transport fuels (and heating). The aim of this measure is to complement the EU ETS by covering sectors which are currently not (yet) covered by the EU ETS, such as road transport fuels. The price per tonne CO_2 in the nETS starts as a fixed price set by the national government. It was EUR25 per tonne CO_2 in 2021, is currently EUR30 per tonne CO_2 and will rise year-on-year to EUR55 per tCO_2 in 2025. From 2026 onwards, the fixed price will be replaced by a minimum and maximum price of EUR55 to EUR65 per tCO_2 respectively. The market will determine the price within this range. The type of pricing to be applied after 2026 will be decided by an evaluation in 2025. The CO_2 price of EUR55 per tonne in 2025 will result in a price increase of EUR 13 cent per litre petrol, and EUR 15 cent per litre diesel.

Source: Umweltbundesambt (2022)

Figure 1 presents the fuel tax rates applied for petrol in 2021. In all EU countries, the tax levels are equal to or above the minimum level set in the Energy Taxation Directive (ETD) (EU, 2003) (i.e. EUR 0.359 per litre petrol, which is about EUR 150 per tonne CO_2). However, there are significant differences between countries in fuel tax rates, ranging from EUR 0.36 per litre in Hungary to EUR 0.81 in the Netherlands.

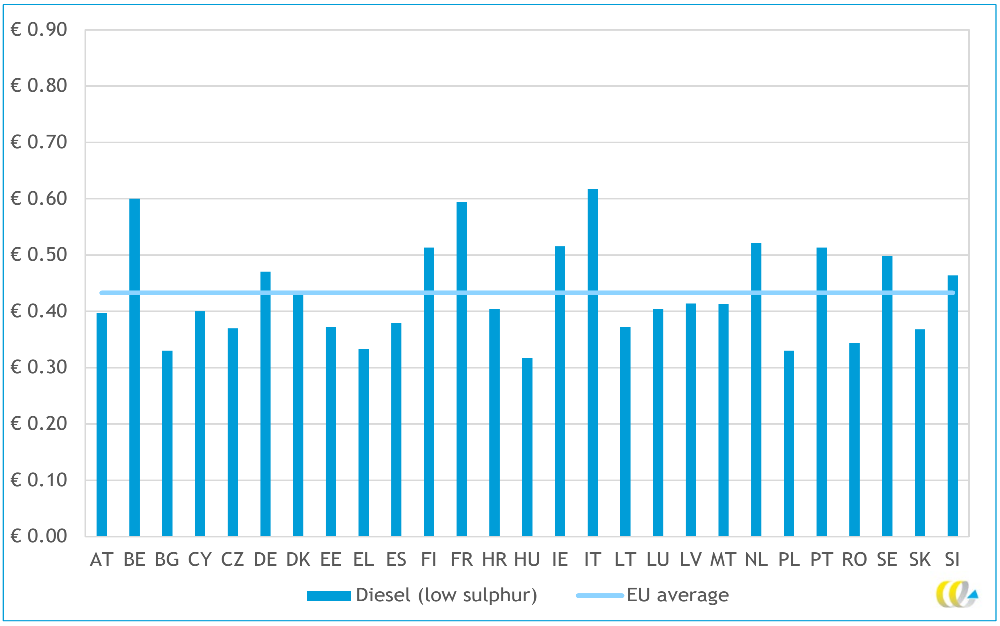
Figure 1: Petrol excise duty level by country in 2021



Source: EC (2021b)

Diesel taxation is in most EU countries lower than petrol taxation, although in all countries the minimum levels (EUR 0.33 per litre diesel, which is about EUR 125 per tonne CO_2) set by the ETD are met (see Figure 2). In Italy and Belgium diesel excise duties are the highest in Europe (about EUR 0.60 per litre), while Bulgaria and Greece have the lowest diesel excise duties (about EUR 0.33 per litre). However, the effective tax rates for diesel used for commercial purposes (e.g. HGVs) may be lower in some countries, as they apply refund schemes for a part of the excise duty. This is also the case in the three countries with the highest diesel taxes, i.e. Italy, Belgium and France (EC, 2021b).

Figure 2: Diesel excise duty level by country in 2021



Source: EC (2021b)

In several EU countries, reduced excise duties are applied to natural gas, biofuels or to the biofuel share blended with fossil fuels (CE Delft et al., 2019b). For example, Finland charges excise duty on liquid fuels according to energy content, which implies that a lower excise duty per litre biodiesel is charged as the energy content of biodiesel is lower as for fossil diesel (IEA, 2019). In Poland, excise duty exemptions exist for biofuel components intended for liquid fuels, according to the Energy Law Act (Ministry of Finance Poland, 2022).

With the increasing market share of electric vehicles, electricity taxes are becoming an important pricing instrument in the road transport sector. Most EU countries do apply electricity taxes, although there are large differences in tax rates applied (CE Delft et al., 2019b)[7]. In general, on an energy-content basis electricity taxes are significantly lower than taxes on petrol and diesel (in EUR/MJ), implying that a large-scale switch to electric vehicles will result in lower tax revenues (assuming no changes in tax rates).

2.1.2. Vehicle taxes

The main vehicle taxes applied in the EU are the one-off purchase/registration taxes and the periodical ownership/circulation taxes[8]. Purchase/registration taxes are applied for passenger cars in almost all EU countries (see Figure 3). On light commercial vehicles (LCV) a purchase/registration tax is levied in a significant number of EU countries as well, although in considerably fewer cases than for passenger cars (ACEA, 2021). A smaller number of countries apply purchase/registration taxes for heavy duty vehicles (buses, coaches and HGVs). For HGVs, only four countries (France, Greece, Ireland, and Italy) do levy this charge[9].

Purchase/registration taxes for passenger cars are in about half of the EU countries differentiated to CO_2 emissions (see Figure 3). This is done in several ways, e.g. by using CO_2 as the main tax base or by applying a bonus/malus scheme based on CO_2 emissions. Some examples of CO_2 differentiated purchase/registration taxes are presented in Box 3.

In many EU countries, electric (or more in general zero-emission) cars are not charged a purchase tax at all. Some countries, like Austria, Belgium, The Netherlands and Romania, even have a vehicle purchase bonus for these vehicles, which is often a flat subsidy granted by the government to stimulate the uptake of zero-emission vehicles. Purchase/registration taxes for HGVs, on the other hand, are not differentiated to CO_2 emissions in any of the EU Member States. Indirectly there is a (weak) link with CO_2 emissions, as in most cases purchase/registration taxes are differentiated by vehicle weight, which is related to the average fuel consumption (and hence CO_2 emissions) of the vehicle.

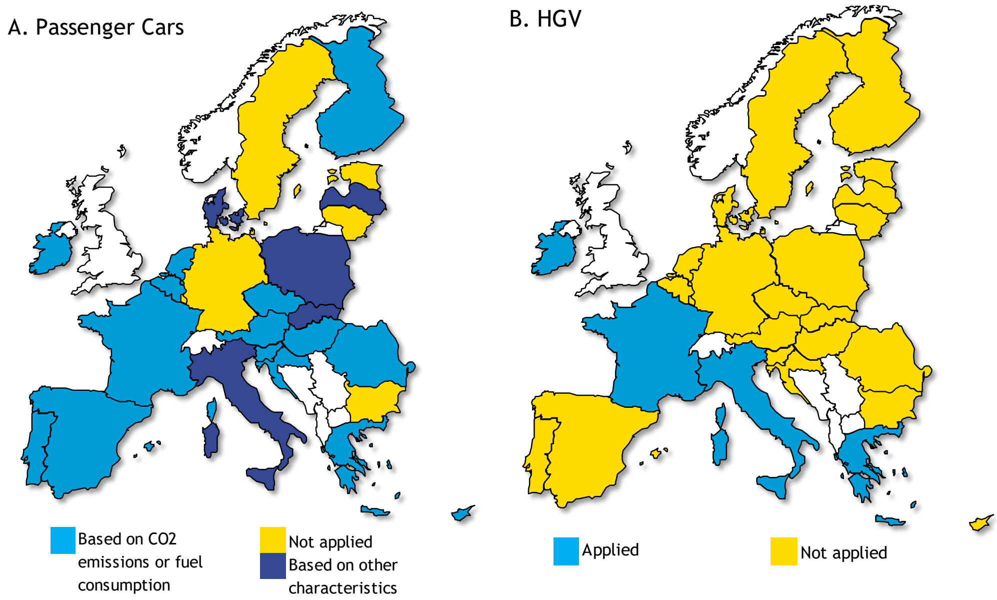
[7] Additionally, electric vehicles are indirectly charged by an ETS price, as power plants are covered by the current ETS.

[8] In line with CE Delft et al. (2019b) we consider company car taxation as an income tax and not as a transport tax (i.e. company car taxations is a type of income taxation as it taxes the benefit in kind that is attributed to company cars). For this reason, company car taxation is not considered in this study.

[9] Additionally, in Denmark a purchase tax on the smallest trucks is levied (below 4,000 tonnes). As the share of these trucks in the entire fleet is rather low, we have not included this in Figure 3. Furthermore, HGVs are levied a purchase tax in Poland as well, but as this tax can be deducted, the effective tax rate is zero.

Purchase/registration tax rates differ widely between Member States. Particularly Denmark applies high rates for (fuel-inefficient) passenger cars, while Poland applies relatively high rates for HGVs.

Figure 3: Purchase/registration taxes in the EU in 2021



Source: ACEA (2021)

Box 3: Some examples of CO_2 differentiated purchase/registration taxes

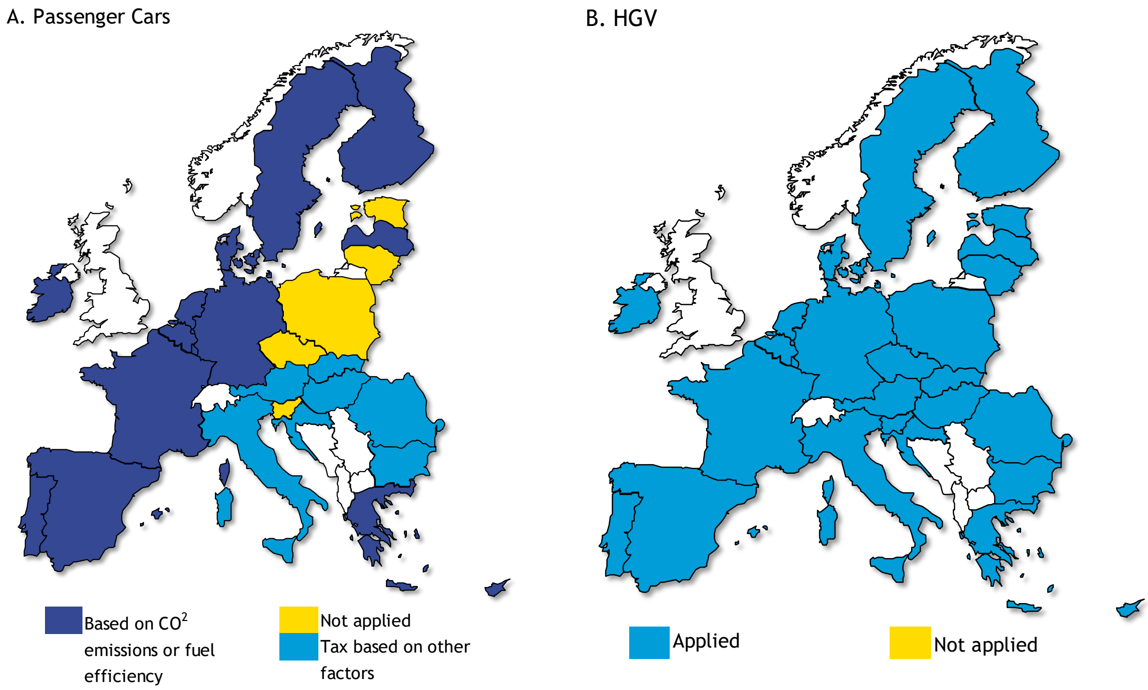
The **Netherlands** has more than ten years of experience with CO_2 differentiated purchase taxes for passenger cars. This started in 2008 with the introduction of a bonus-malus scheme, providing additional charges for very fuel-inefficient cars and bonuses for the most fuel-efficient ones. In 2010, a stepwise switch from list price to CO_2 emissions as a main tax base was started, which was finalised in 2013. Currently, the Dutch purchase tax is fully based on CO_2 emissions of the car, applying a progressive rate such as that for cars with higher emissions per km a relative higher charge is applied. Zero emission cars are fully exempted. Over the years, the Dutch scheme has been modified several times, among other things to stop the reduction in tax revenues (as the environmental effectiveness of the tax was much higher than anticipated, revenues dropped significantly, approximately by 50%).

In 2019 the **Italian** government introduced a bonus-malus scheme for the purchase of new passenger cars in Italy (to be run in 2019-2021 period). For cars with a purchase value under EUR 50,000 and emitting less than 20 gCO_2/km, a one-time bonus of maximum EUR 6,000 (eco-bonus) is available. To get the maximum bonus, a Euro-1 to Euro-4 vehicle has to be traded in (scrapped), addressing the Italian air pollution problem. For cars emitting more than 160 g/km, a penalty (eco-tax) has been introduced, which may be up to maximum EUR 2,500.

Source: Belastingdienst (2022)); ACEA (2021); CPB (2016)

Next to purchase/registration taxes, ownership taxes (also called circulation taxes) are applied in most EU Member States (see Figure 4). Almost all EU27 countries apply an ownership tax for passenger cars, except Estonia, Lithuania, Poland and the Czech Republic[10] . HGVs are charged an ownership tax in all countries, because the Eurovignette Directive (EU, 2022) obliges all Member States to apply this type of a tax (see Section 3.1.2). An LCV ownership tax also exist in almost all EU countries (some exceptions are Estonia and Lithuania).

Figure 4: Ownership tax schemes in the EU in 2021



Source: ACEA (2021)

More than half of the countries do apply a CO_2 differentiation in the ownership tax for passenger cars. This may range from schemes fully based on CO_2 emissions (e.g. in Germany) to schemes applying a malus for cars with CO_2 emission above a certain threshold (e.g. in France) (ACEA, 2021). CO_2 differentiation is not applied for HGVs in any of the Member States, also because CO_2 emission figures are often not known for (older) trucks. For LCVs, CO_2 emissions are used in a small number of countries as differentiation parameter (e.g. in Cyprus, Finland and Malta). In addition to CO_2 emissions, a lot of other parameters are used to differentiate ownership taxes, like fuel type, Euro emission standards[11], vehicle weight and engine power. As some of these parameters (e.g. engine size, vehicle weight) are to some extent related to CO_2 emissions, they may provide an indirect (weak) incentive to the use of fuel-efficient vehicles as well.

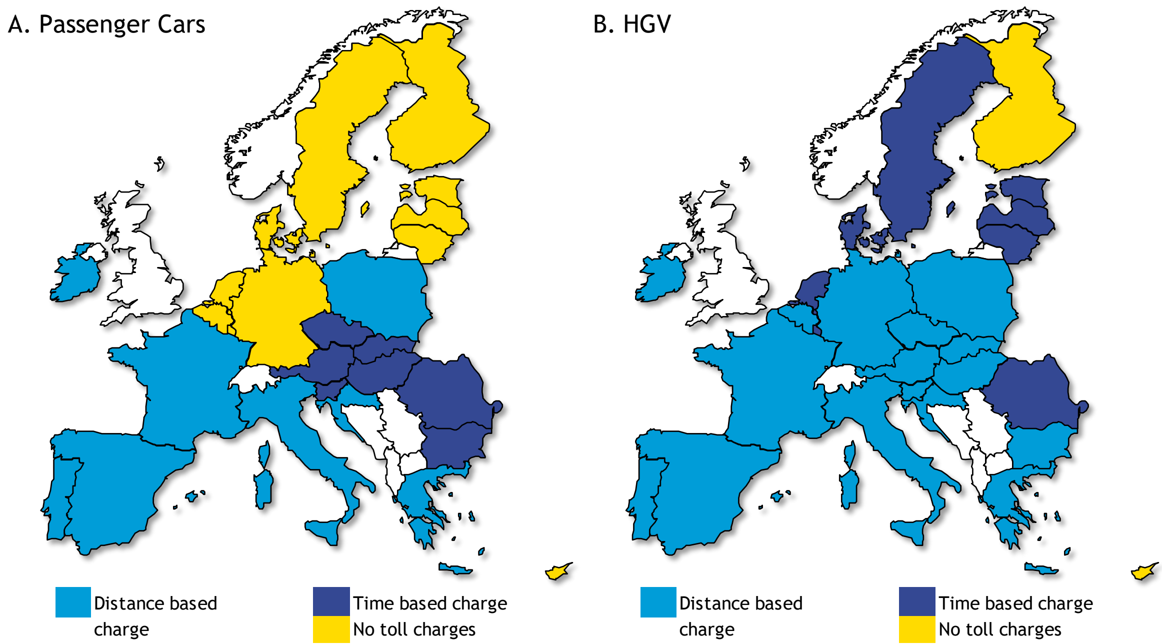
[10] Czech Republic does levy an ownership tax on commercially owned cars, but not on private cars.

[11] European vehicle emission standards for air pollutant emissions (e.g. NO_x, particles). These standards, introduced in the '90s, apply for new vehicles and have been tightened every 4-5 years.

2.1.3. Infrastructure charges

Most EU countries apply a form of infrastructure charges. For passenger cars, 15 EU Member States apply this charge, either as a distance-based charge (8 countries) or as a time-based charge (7 countries). A distance-based road charge can be implemented by the use of physical barriers, as seen in France, Spain, Italy and Poland, or as an (electronic) network-wide scheme which exist, for example, in Portugal. LCVs are in most countries treated in the same way as passenger cars. For HGVs, infrastructure charges are even applied in 24 countries. Over the last decade, many countries (16) have applied a distance-based scheme, often replacing a vignette scheme. But still, there are some countries (8) applying a time-based scheme for HGVs. More detailed information on some national infrastructure charging schemes is presented in Box 4.

Figure 5: Infrastructure charging schemes in the EU in 2021



Source: ACEA (2021)

CO_2 emissions are not used as differentiation parameter in any of the European road charging schemes yet. Euro emission standards, on the other hand, are often applied to differentiate these charges, particularly in HGV-schemes. Other differentiation parameters applied are, for example, vehicle weight and location.

Box 4: Some examples of road infrastructure charging schemes

In **Hungary**, HGV are tolled on motorways, expressways and national main roads by the Hu-Go toll system since 2013. This distance-based scheme replaced a vignette scheme, which is still in place for LDVs. The HGV toll level is based on the emission standard, the number of axles, and is differentiated to the type of road. The toll has been introduced to recover infrastructure costs, allocate costs based on actual road use and stimulate more sustainable vehicles. The distance-based toll payment has resulted in a significant increase in revenues, particularly as Hungary is located on main international transit traffic routes in Central Europe.

For the use of most highways in **Portugal** a distance-based toll applies to all types of vehicles, i.e. both LDVs and HDVs. The toll roads are divided according to the payment method. On some highways one can pay at toll gates where manual payment is allowed. At another part of highway routes, it is only possible to pay toll automatically using the *EasyToll* system (electronic payment card linked to the licence plate), *Via Verde* on-board unit scanned by the toll, prepaid Toll Card or and unlimited 3-day Toll Service card (time-based vignette, for cars only). On the routes with electronic payment, cameras which are located above the driving lanes scan either the plate of the vehicle or a sensor which recognises the payment device behind the window screen.

Source: HU-GO (2022), Infraestruturas de Portugal (2022), Tolls.eu (2022)

2.2. Coverage of external costs of transport

Pricing of CO_2 emissions of road transport is part of the broader EU strategy to apply the 'user-pays' and 'polluter-pays' principles. The principles were already mentioned in the 2011 White Paper on Transport (EC, 2011) and their importance was re-emphasised in the recent Strategy for Sustainable and Smart Mobility (EC, 2020b).

As is shown by Figure 6, the external[12] and infrastructure costs of passenger cars and HGVs are in almost none of the EU Member States completely covered by the taxes and charges levied[13], indicating that the 'user-pays' and 'polluter-pays' principles are not fully applied yet[14]. The only exception are passenger cars in Denmark, which is linked to the relatively high vehicle taxes. On average, only about half of the external and infrastructure costs of passenger cars and a quarter of the costs of HGVs are internalised in the EU. The relatively large difference between passenger cars and HGVs can be explained, on average, by the lower fiscal burden on HGVs and the higher cost levels of HGVs. Also for the other road vehicle types, external and infrastructure costs are only partly internalised in the EU. For example, for LCVs about 35% of these costs are covered by taxes and charges in the EU. Figure 6 also shows that the level of internalisation varies widely over Europe, which is partly explained by the many differences in the level and type of pricing instruments applied in the various Member States. As part of the Fit for 55 package, the European Commission proposed some policies that may increase the level

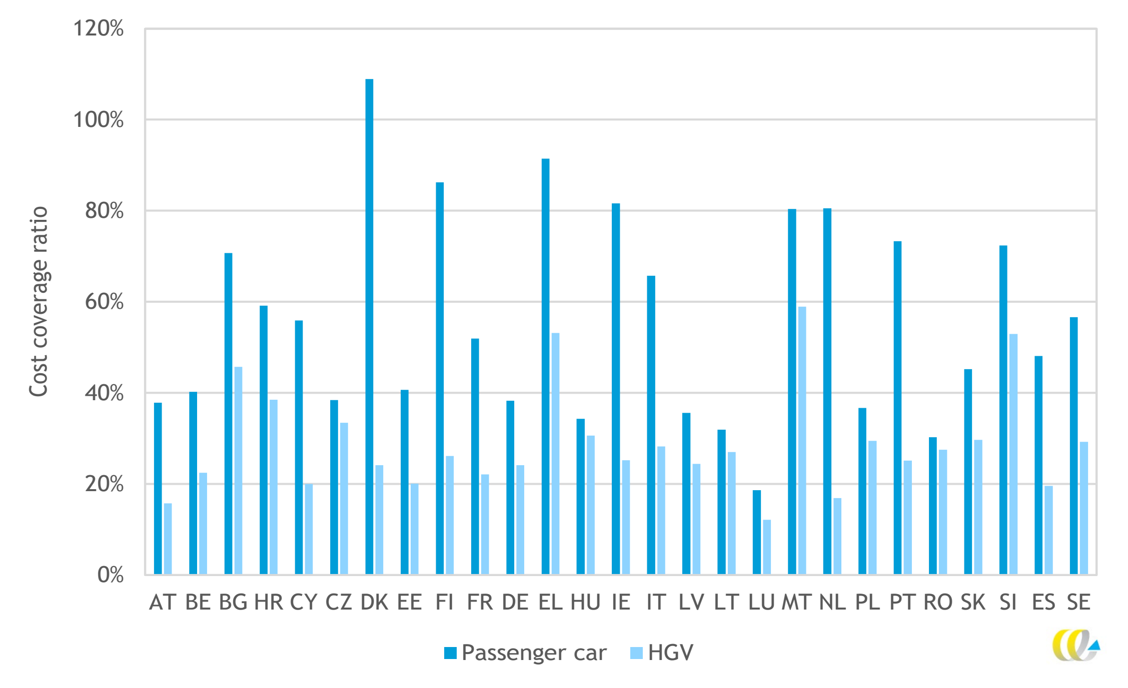
[12] Externalities that are included in these costs are air pollution, climate change, noise, accidents, congestion, emissions from fuel/energy production, and habitat loss.

[13] As transport taxes and charges are rarely legally linked to specific externalities, it is not feasible to assess to what extent the costs of CO2 emissions are covered by taxes and charges in the EU.

[14] Figure 6 shows the situation in 2016. Although there may be some changes in cost levels or taxes/charges applied over the last years in specific Member States, the overall picture shown by this figure is also relevant for the current situation.

of internalisation of external and infrastructure costs of road transport. These proposed policies are presented in Section 3.2.

Figure 6: Level of coverage of external and infrastructure costs by taxes and charges for passenger cars and HGVs in the EU28 in 2016



Source: own analysis based on CE Delft et al. (2019a)

2.3. The use of pricing instruments in other transport modes

Compared to road transport, taxes and charges directly related to CO_2 emissions are much less levied on the non-road transport modes (i.e. aviation, inland navigation, maritime shipping and rail transport). An overview of the main pricing instruments that are applied in one or more EU Member States for the various transport modes is given by Table 1.

Table 1: Overview of pricing instruments applied in non-road transport modes

	Rail transport	**Inland Navigation**	**Maritime transport**	**Aviation**
Direct CO_2 related taxes	• Fuel/electricity tax • EU ETS	• Fuel tax		• EU ETS (intra-EU flights)
Indirect CO_2 related taxes and charges	• Rail infrastructure access charges	• Port charges • Fairway dues	• Port charges • Fairway dues	• Aviation taxes • Airport charges

Source: CE Delft et al. (2019b)

The Energy Taxation Directive (ETD) (EU, 2003) prescribes that aviation and maritime shipping should be fully exempted from fuel taxation in the EU[15]. Also for inland navigation, fuel taxes are scarcely levied in the EU, which is mainly because the Rhine States (i.e. The Netherlands, Belgium, Germany, France, Switzerland) agreed, as part of the Mannheim Convention, not to impose any toll, tax, duty or charge on navigation along the Rhine or its tributaries (CE Delft et al., 2019b). For this reason, there are only a few EU countries (i.e. Bulgaria, Italy, Hungary, Lithuania, and Slovakia) charging a tax on the diesel used by inland navigation EC (2021b). In rail transport, electricity taxes are levied in more than 50% of the countries, while taxes on diesel use are applied in most EU countries[16].

Two transport modes are partly covered by the current EU ETS (CE Delft et al., 2019b). For aviation, all CO_2 emissions of intra EEA-flights are covered by this scheme since 2012. However, airlines receive the majority (82%) of their emission rights for free, lowering the environmental effectiveness of this scheme[17]. The CO_2 emissions of electric rail transport are also (indirectly) covered by the EU ETS, as electricity power supply is one of the sectors under this scheme.

In addition to these directly CO_2 emissions related taxes, different types of infrastructure charges are applied for the non-road modes. These charges affect transport demand and hence indirectly CO_2 emissions of these modes. However, none of them is directly differentiated to CO_2 emissions anywhere in Europe (CE Delft et al., 2019b). Also the aviation taxes applied by various EU Member States (e.g. Austria, Germany, France, Croatia, The Netherlands) do only affect CO_2 emissions indirectly by curbing transport demand.

Based on the discussion above, it can be concluded that CO_2 emissions in inland navigation, maritime transport and aviation are charged to a lower level than in road transport. More in general, also the overall fiscal burden on these modes is lower than for road transport (CE Delft et al., 2017). A similar picture arises when comparing the tax/charge levels with the external and infrastructure costs: particularly for inland navigation and maritime shipping (but to a lesser extent for aviation) a smaller share of the external and infrastructure costs is covered by taxes and charges than for road transport (CE Delft et al., 2019a), implying that the 'user-pays' and 'polluter-pays' principles are met to a lesser extent than for road transport. These differences in fiscal burden affect the level playing field between modes, often resulting in a disadvantage for road transport. However, as it was made clear in Section 2.2, also in road transport the tax/charge levels are in many Member States too low to meet the polluter/user pays principle.

[15] In the proposed revision of the ETD (EC, 2021f), abolition of the (mandatory) exemption from fuel taxes for aviation and shipping is proposed (see Section 3.2.2).

[16] There are a few countries applying an exemption, such as Belgium, Hungary and Sweden (EC, 2021b).

[17] In the proposed revision of the ETS Directive (2021e), a reduction of freely allocated emission allowances for aviation is proposed. Furthermore, an extension of the ETS to maritime shipping is considered.

3. EU LEGISLATIVE FRAMEWORK

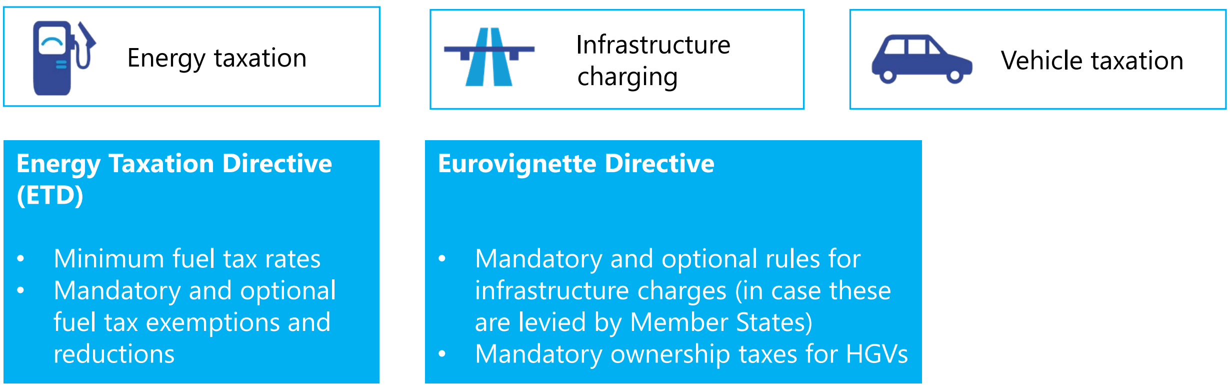
KEY FINDINGS

- Transport pricing is mainly a Member State competence. The current EU legislative framework is mainly focused on harmonising (to a certain extent) the design of national instruments.
- At the EU scale, the design of national fuel taxes and road infrastructure charges are currently harmonised by the Energy Taxation Directive (ETD) and the Eurovignette Directive. National vehicle taxes are hardly affected by EU regulation.
- As part of the 'Fit for 55' policy package, the European Commission has presented proposals for the introduction of a new emission trading system for road transport (and buildings) and a revision of the ETD. One of the aims of the latter is to more effectively incentivise the uptake of low-carbon energy carriers by the transport sector.

3.1. Current EU legislative framework

Although introducing transport pricing instruments is largely a Member State competence, the EU partly harmonises the design of these instruments through two Directives: the Energy Taxation Directive (ETD) and the Eurovignette Directive. As it indicated by the Figure 7, these Directives mainly cover the areas of energy taxation and infrastructure charging. Vehicle taxation is only very slightly regulated by the EU, via mandatory ownership taxes for HGVs. In the remainder of this section, we will briefly introduce the relevant Directives in more detail.

Figure 7: Overview of current EU legislative framework



Source: own analysis

3.1.1. Energy Taxation Directive

The Energy Taxation Directive (Directive 2003/96/EC) sets minimum excise duty rates for energy products used as motor or heating fuels, and for electricity. Member States are free to levy fuel taxes (or electricity taxes) that are above these minimum rates, which for transport is done at a large scale as shown in Section 2.1.1. In addition to the minimum rates, the ETD also provides some mandatory and optional exemptions of energy taxation. Mandatory exemptions concern, among others, fuels used by international aviation and maritime transport. Relevant optional exemptions refer to fuels or electricity used for the carriage of goods and passengers by rail, metro, tram and trolley bus, fuels used for inland waterways transport, and biofuels.

The current minimum excise duty rates for fuels do not consider the energy content or environmental impact of the fuels. In that respect, the current version of the ETD is not in line with the GHG reduction targets of the EU. In 2011, the Commission presented a first proposal to amend the ETD (COM(2011) 169) in order to bring it in line with their climate objectives. For that reason, it was proposed to tax energy products in line with their energy content and CO_2 emissions. However, there was no agreement between Member States on this proposal and therefore the Commission withdrew it in 2015.

3.1.2. Eurovignette Directive

Road infrastructure charging is regulated by the Eurovignette Directive, which was initially adopted in 1999 (Directive 1999/62/EC), and amended in 2006 (Directive 2006/38/EC) and 2011 (Directive 2011/76/EU). In 2017, the Commission presented a proposal to revise this Directive (COM (2017)275), but it took 5 years of negotiations to agree on a revised Directive (Directive 2022/362/EU) in February 2022.

The Eurovignette Directive does not oblige Member States to introduce distance-based tolls or time-based vignettes for road vehicles, but it sets common rules for the Member states who have implemented (or will implement) such charges. The main rules are presented in Table 2.

Table 2 Main characteristics of the Eurovignette Directive

Characteristics	Heavy duty vehicles (HDVs)	Light duty vehicles (LDVs)
Type of charge	• Tolls mandatory on TEN-T network from 2030 onwards • Vignettes allowed on other parts of the network	• Both tolls and vignettes are allowed
Environmental differentiation of charge	• Mandatory differentiation to CO2 emissions (starting with heaviest trucks)	• Environmental differentiation to CO_2 emissions and/or Euro emissions standard is optional.
External cost charging	• Mandatory external cost charging for air pollution • Voluntary external cost charging for noise and/or CO2 emissions	• Voluntary external cost charging for air pollution, noise and/or CO2 emissions
Congestion charging	• Voluntary charge that may only be applied on road sections that are regularly congested and at times that they are regularly congested.	
Mark-ups	• Additional charges to infrastructure charges (up to 50%) that can be applied in any regularly congested or sensitive area.	
Use of revenues	• Revenues from mark-ups and congestion charges are earmarked for reducing congestion, alleviating environmental damage or developing sustainable transport.	

Source: Directive 2022/362/EU

In the recently adopted revision of the Eurovignette Directive, Member States are required to phase out the use of vignette schemes for HDVs on the main part of the road network and replace these schemes with distance-based charges. For LDVs[18], both types of infrastructure charges are allowed.

In general, tolls may consist of three elements:

- An *infrastructure charge*. For HDVs, the level of this charge must be set to recover (some part of) the construction, maintenance and operating costs of the infrastructure network concerned. Furthermore, for HDVs this charge will be mandatory differentiated in CO_2 emissions[19], replacing the differentiation in Euro emission standards that was optional in the earlier versions of the Directive. It provides a strong financial incentive for low and zero emission trucks, as the discount on charge levels may be up to 75%. For light duty vehicles, the environmental differentiation of charges is optional. This differentiation may also be applied as a (partly) exemption of zero emission vehicles.
- An *external cost charge*, which may be levied on top of the infrastructure charge. This charge may be related to traffic-based air pollution[20], noise and or CO_2 emissions. From 2026, external cost charging for air pollution (i.e. based on Euro emissions standards) will become mandatory for HDVs on the entire tolled network[21].
- A *congestion charge*, which may be introduced on any section of the road network that is regularly congested. It shall be applied in a non-discriminatory manner to all vehicle categories[22].

In addition to these three charges, Member States are allowed to levy a mark-up on the infrastructure charges on road sections that are regularly congested or where transport results in significant environmental damage. This mark-up may not be combined with a congestion charge. For all three charging elements as well as the mark-ups, specific calculation rules are provided by the Directive.

With respect to vignettes, the Eurovignette Directive sets maximum rates. Furthermore, rates should be proportionate to the duration of the use of the infrastructure. In case vignettes (or tolls) are introduced for passenger cars, vignettes for light commercial vehicles should be applied as well at equal or higher charge levels.

As for the revenues from road infrastructure charges, only the revenues from congestion charges and mark-ups are earmarked (i.e. for mitigating congestion or supporting sustainable transport).

Finally, in addition to the rules set for infrastructure charging, the Eurovignette Directive also sets minimum levels for obliged ownership taxes on HGVs. This was also reflected in Figure 5 in Section 2.1.3, where it was shown that every Member State levies ownership taxes on these vehicles.

[18] All motorised vehicles with a maximum mass not exceeding 3,500 kg.

[19] Some (temporarily) exemptions are made possible in the Directive, e.g. for road infrastructures covered by concession contracts signed before 24 March 2022.

[20] It is not allowed to levy an external-cost charge related to traffic-based air pollution to vehicles which comply with the most stringent Euro emission standards (until four years after the introduction of those standards).

[21] As for the mandatory CO_2 differentiation of infrastructure charges, some exceptions for the mandatory air pollution charge are made possible by the Directive, e.g. for roads covered by current concessionary contracts.

[22] With the exception of (mini)buses and coaches, which may be (partly) exempted.

3.1.3. Vehicle taxes

At present, there is little EU regulation on vehicle taxation nor any harmonisation of national fiscal provisions in this field. The only exception are the minimum levels set for vehicle taxes to be applied to HGVs by Member States (see Section 3.1.2). Although there is no EU-broad policy framework for vehicle taxes, national tax measures are obliged to be in line with the general principles of the Treaties, meaning that they must respect the non-discrimination principle and may not hamper cross-border trade between Member States.

In 2005, the European Commission presented a proposal for a Directive (COM(2005) 261) that would require Member States to restructure their passenger car taxation. This proposal aimed to establish an EU structure for these taxes, but would not require Member States to introduce new taxes or to harmonise tax rates. The main objectives of the proposal were to remove any tax obstacles to the cross-border transfer of cars within the EU and to promote sustainability by (partly) differentiating both registration and circulation taxes on the amount of CO_2 emitted per kilometre. However, in 2015, the Commission withdraw this proposal after unsuccessful negotiations within the Council.

3.2. Proposed developments in the EU legislative framework

In July 2021, the European Commission presented the Fit for 55 policy package with the aim of making EU's climate, energy, land use, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55 % by 2030, compared to 1990 levels (EC, 2021a). Two important elements of this package are the extension of the current EU Emission Trading System (EU ETS) to road transport (and buildings) and the revision of the Energy Taxation Directive. Both policies are very relevant for the road transport sector and therefore these proposals will be discussed in more detail below.

3.2.1. Extension of the EU ETS to road transport

As part of the proposal for the revision of the EU ETS (COM(2021) 551), the introduction of a separate but adjacent emission trading system for the road transport and buildings sectors is proposed by the Commission. A separate system, rather than the inclusion in the existing ETS, is considered in order to avoid any disturbance of the functioning of the ETS for stationary installations and aviation. The new ETS should be established from 2025. In the first year, the trading entities will be required to only report on their emissions for years 2024 and 2025, while from 2026 compliance obligations will become applicable. This staged introduction of the ETS should contribute to a smooth and efficient start of the system.

Emissions should be attributed to regulated entities on the basis of fuel quantities released for consumption and combined with an emission factor.

The main elements of the new ETS for road transport and buildings are:

- The new ETS will, in line with the current EU ETS, be a cap-and-trade system, implying that the total emissions from road transport and heating will be capped and that this cap will be gradually tighten year by year. For this annual tightening of the cap, a linear reduction factor will be set in such a way that emission reductions of 43% in 2030 compared to 2005 for the road transport and buildings sector will be reached.
- Fuel suppliers will act as regulated entities (i.e. the entities required to surrender emission allowances) in the new ETS. On this aspect the new system differs significantly from the current EU ETS, where regulated entities are allocated downstream (the final emitters). However, given the very large number of emitters in the road transport (i.e. vehicle owners) and buildings sector, this would have resulted in very high administrative costs and a complex trading and

MRV (monitoring, reporting, verification) system. Appointing fuel suppliers as regulated entities also has the advantage to be in line with the system of excise duty of Directive 2020/26231/EU, such that a robust monitoring and reporting scheme is already available for the quantities of fuels released for consumption[23]. It is expected that fuel suppliers will pass the (majority of the) carbon price onto the final consumers, who will be the ones that have to actually apply CO_2 mitigation measures (e.g. buying a low-emission vehicle or applying a fuel-efficient driving style).

- All emission allowances will be auctioned, rather than (partly) allocated for free. As actors in the buildings and road transport sector are under no or very small competitive pressure from outside the EU and are not exposed to risks of carbon leakage, this more efficient allocation approach[24] can be applied.
- Members States are required to use auctioning revenues to stimulate CO_2 reduction measures in the transport and/or buildings sectors or to provide support to those low-income households who will be affected financially by higher energy prices, following the introduction of the new ETS. Additionally, the Commission is intended to include 25% of the revenues in a new Social Climate Fund (SCF), which would be used to finance temporary income support measures to people in Europe at risk of transport and/or energy poverty (see COM(2021) 568). At least half of the estimated costs of these measures should be financed by Member States themselves. Criteria used to allocate transfers from the SCF include income per capita, the share of the population at risk of poverty, the share of the population with arrears on their utility bills, etc. Finally, the Commission also intends to make part of the revenues available to the Innovation Fund to stimulate the green transition.
- To ensure market stability, a Market Stability Reserve will be implemented for the new ETS. This instrument may also be used to mitigate excessive price increases, by releasing additional allowances to the market in order to lower the average allowance price.

3.2.2. Energy Taxation Directive

In the 2019 evaluation of the ETD, it was recognised that this Directive was not in line with current EU policy objectives, like decarbonisation of transport, and that there are some shortcomings with respect to the functioning of the internal market. Some relevant issues in this respect are:

- The ETD does not adequately incentivise the uptake of electricity and alternative fuels (e.g. advanced biofuels, renewable hydrogen, and synthetic fuels). This is because new, less carbon-intensive fuels that have come to the market after the 2003 adoption of the ETD are taxed at the same level (per litre or kilogramme) as their fossil equivalent. This even results in higher tax levels for biofuels than fossil fuels, as the energy content per litre of biofuels is in general lower as for their fossil counterparts.
- The ETD contains a wide range of tax exemptions and reductions for fossil fuels. For transport, particularly the mandatory exemptions of fuel taxes for aviation and shipping are relevant in this respect.

[23] Fuel quantities released for consumption combined with an emission factor will be used to calculate the emissions per regulated entity.

[24] In contrast to free allocation, auctioning does not require that detailed data have to be collected for new entrants, avoiding risks on windfall profits, rewards early action of actors, and results in lower transaction costs (CE Delft, 2021).

- The minimum tax rates set by the ETD have not been updated since 2003. Therefore, national tax rates are in many cases significantly above these minimum rates and hence the converging effect on national tax rates of the ETD has been lost. This increases the risks of distortions of the internal market, while lowering the environmental effectiveness of the ETD.

As effective energy taxation may significantly contribute to decarbonising the transport sector, the revision of the ETD was one of the key policies announced in the European Green Deal. In July 2021, the Commission presented the proposal for this revision, aiming to bring the ETD in line with the EU's energy and climate objectives. The most relevant proposed changes include:

- A switch from volume-based to energy-based (EUR/GJ) taxation of fuels and electricity.
- Minimum tax rates are ranked according to their environmental performance. Therefore, different groups of energy products are defined, based on their environmental performance. In a first category, fossil fuels like gas oil and diesel are grouped and will be taxed at the highest rates. In a second group, fossil-based fuels which have the potential to contribute to decarbonisation on the short/medium term (e.g. natural gas and hydrogen of fossil origin) are placed for a transitional period of 10 years. The third group covers sustainable but not advanced biofuels, while the last group includes electricity, advanced biofuels, bioliquids, biogases and hydrogen of renewable origin. The energy products in the fourth group are expected to contribute most to decarbonisation and are therefore taxed at the lowest rates.
- The minimum tax rates will be updated and in the future they will be automatically adjusted annually, based on relevant consumer price figures. This will result in significantly higher minimum rates to be met by the national fuel taxes.
- Removing the full exemption of intra-EU aviation and shipping from energy taxation. Over a period of 10 years, the minimum rates for the fuels used in these sectors will be gradually increased, while for sustainable fuels a minimum rate of zero will be implemented to promote the uptake of these fuels. For shipping, reduced tax rates will exist in order to lower the risk on fuel bunkering outside the EU. Exemption of fuel taxation of extra-EU aviation and maritime transport is still possible in the proposed revision of the ETD.

3.2.3. Interactions with other EU policies

The extension of the ETS to road transport and the revision of the ETD may be largely complementary to other EU climate policies for the transport sector, like the Effort Sharing Regulation (ESR) (EU, 2018), CO_2 vehicle performance standards and the Renewable Energy Directive (RED) (CE Delft, 2021) (ICF, et al., 2021).

- Pricing instruments may complement the current ESR by providing economic incentives necessary to achieve the cost efficient reduction options in the road transport sector. At the same time, incentives and accountability for national actions is covered by the ESR, complementing EU wide pricing instruments like the ETD and ETS.
- Pricing instruments target reduction options (e.g. modal shift, reducing transport demand) that are not addressed by other policy instruments. This may also help to tackle some of the potential rebound effects of CO_2 vehicles standards. For example, increased fuel-efficiency may create an incentive to drive more. Higher fuel prices (due to an ETS or higher minimum fuel taxes set by the ETD) may curb this additional transport volume.
- Regulatory policies like CO_2 vehicle standards and fuel standards may address other market barriers than pricing instruments. For example, the conditions set for the sustainability of

renewable fuels by the RED is complementary to pricing instruments, as the latter would not guarantee that sustainable renewable fuels will be used. Furthermore, regulatory policies may provide more investment security to car manufacturers and biofuel producers than pricing instruments, because of the perceived uncertainty on the long-term financial incentive provided by these instruments.

- Pricing instruments may support the effectiveness and efficiency of other policy instruments. For example, pricing instruments may increase the demand for more fuel-efficient vehicles, which in turn makes it easier for car manufacturers to meet the objectives set by the CO_2 vehicle standards.

A potential risk of combining pricing instruments with other EU climate policies is that it may lower the support for maintaining and particularly increasing the targets of these policies (CE Delft, 2021). Stakeholders and Member States may become reluctant to provide support for higher ambition levels for policies like the CO_2 vehicle standards and the RED, as CO_2 emissions of road transport are dealt with in an ETS and/or increased fuel taxes. Particularly because these non-pricing instruments have been very effective in reducing the emissions of road transport, this may seriously hamper the effectiveness of EU climate policy for the road transport sector. Therefore, this risk should be carefully considered in developing an EU-wide policy mix to address the transport CO_2 emissions.

4. IMPACTS OF PRICING INSTRUMENTS

KEY FINDINGS

- Pricing instruments are effective in reducing CO_2 emissions in the road transport sector. Particularly fuel taxes and ETS are relevant in this respect, as they incentive all possible decarbonisation options. CO_2 based vehicle taxes are effective in stimulating the uptake of low- and zero-emission vehicles.
- Road transport taxes significantly contribute to tax revenues in EU countries. The increase in market shares of low- and zero-emission vehicles may lower the income from fuel taxes and CO_2 based taxes. Keeping tax income at a stable level may become an important challenge for national governments in the next decade.
- Current transport taxes and charges contribute significantly to transport prices of passenger and (to a lesser extent) freight road transport. The introduction of the revised ETD and an ETS for road transport would have a relatively limited additional impact.
- CO_2 pricing instruments are, in general, regressive, implying that their impact on disposable income is higher for low-income households than for high-income households. These distributional impacts could be (partly) neutralised by recycling the revenues of the pricing instruments in a smart way.

4.1. Impacts on road transport CO_2 emissions

Pricing instruments may induce several CO_2 reduction options, as shown by Table 3.

Table 3: Overview of CO_2 reduction options incentivised by the various pricing instruments

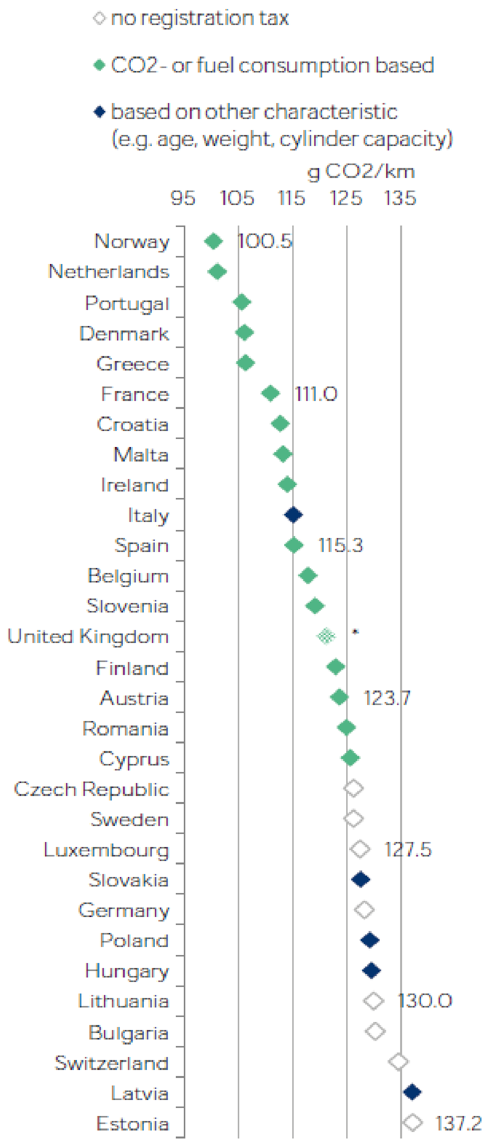
Pricing instruments	Reduced vehicle ownership	More fuel efficient vehicles	Shift to low-carbon energy carriers	Fuel efficient driving	Increased transport efficiency	Modal shift to low-carbon modes	Limiting overall transport demand
Increase fuel tax level	■	■		■	■	■	■
Carbon content differentiation of fuel taxes			■				
ETS for road transport	■	■	■	■	■	■	■
Increase of vehicle taxes	■					■	■
CO_2 differentiation of vehicle taxes		■					
Flat road infrastructure charges					■	■	■
CO_2 differentiated road infrastructure charges		■					

Source: own analysis based on Van Essen et al. (2010)

Instruments targeting energy use (i.e. fuel taxes and ETS) are, in theory, the most effective options to reduce CO_2 emissions, as these instruments stimulate the uptake of all relevant reduction options. By increasing fuel tax levels by 10%, a long-term reduction of fuel consumption (and hence CO_2 emissions) by about 6 to 8% may be achieved for passenger cars and about 3% for HGVs (KiM, 2018). An assessment of the impact of the Swedish carbon tax on passenger car CO_2 emissions supports these figures, as this study shows a long-term CO_2 reduction of about 6% (Andersson, 2017). The proposed changes in fuel taxes according to the revision of the ETD are expected to result in a CO_2 reduction in the road transport sector of a few percentages (about 1-3%), with highest reduction figures in those Member States whose current national fuel tax rates are close to the ETD minima (EC, 2021c). The extension of the ETS to road transport and buildings is expected to result in higher CO_2 reductions in the road transport sector, i.e. in the order of 18%-20% (EC, 2020a)

Vehicle taxes mainly affect vehicle-ownership, and indirectly transport demand and modal shift as these behavioural reactions are induced by lower vehicle ownership. Purchase and registration taxes appear to have a significant effect on car ownership. KiM (2018) reports a price elasticity of about -0.5, indicating that a 10% higher purchase price (because of a tax) results in 5% lower car ownership. Annual ownership taxes, on the other hand, are much less effective in affecting car ownership, which is reflected by a price elasticity of about -0.03. Differentiating vehicle taxes to CO_2 emission is an effective way of stimulating the uptake of fuel-efficient (or zero-emission) vehicles (Nordic Council of Ministers, 2017) (FÖS & GBG, 2018) (Meireles, Robaina, & Magueta, 2021). This is, for example, illustrated by Figure 8, which shows for 2015 that the average CO_2 emissions of new passenger cars in countries with a CO_2 based registration tax are significantly lower compared to countries with registration taxes based on other characteristics. The clear and significant price advantage on fuel-efficient vehicles that can be provided to consumers upon acquisition largely explains the high environmental effectiveness of CO_2 differentiated registration taxes (FÖS & GBG, 2018) (ICCT, 2018). CO_2 differentiation of annual ownership taxes, on the other hand, proved to be less effective in this respect (Nordic Council of Ministers, 2017) (ICCT, 2018). In order to maintain the environmental effectiveness of CO_2 differentiated vehicle taxes over time, regularly re-adjusting the design of the differentiation for technological developments in the car industry is required (ICCT, 2018).

Figure 8 : Registration taxes and average CO_2 emissions of cars in 2015



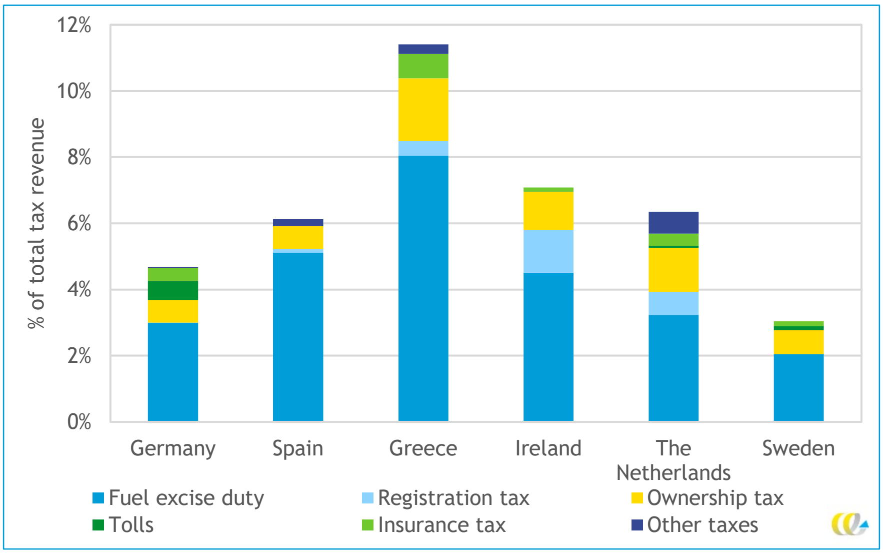
Source: FÖS & GBG (2018)

Finally, infrastructure charges may result in CO_2 reductions by reducing the demand for road transport and increasing the transport efficiency (e.g. higher load rates of HGVs). Detailed assessments for the Netherlands show that particularly the introduction of a distance-based infrastructure charge for passenger cars may be effective in terms of CO_2 reductions (up to 20% reduction), although the actual reductions achieved heavily depends on the design of the scheme (MUConsult et al., 2020). Road infrastructure charging for HGVs and LCVs is less effective (about 5% and 8% CO_2 reduction respectively (MUConsult et al., 2020) (MUConsult et al., 2018)) as the use of these vehicle categories is less price sensitive. By differentiating infrastructure charges to CO_2 emissions, higher reductions can be achieved although the level of reduction depends on the actual design of such a differentiation (Ricardo et al., 2017). Finally, distance-based road charges may be effective in reducing other externalities as well, like congestion and air pollutant emissions.

4.2. Impacts on budget revenue

Road transport taxes contribute significantly to the total tax revenues of EU countries. In the majority of the EU countries, 5% to 10% of the total tax revenues are coming from transport taxes. Figure 9 illustrates this for a selection of countries. In all countries, fuel excise duties are the most significant source of income, followed by the ownership tax. Charge revenues from concessionary road infrastructure schemes are not added to the public budget in most countries, which explains why these revenues are not shown for some countries like, for example, Greece, Ireland and Spain.

Figure 9: Share of transport taxes in total tax revenues for a selection of countries (2019)



Source: CE Delft based on ACEA (2021) and Eurostat (2020).

With the rise of the market share of zero- and low-emission vehicles (combined with the relatively low tax rate on electricity), there may be a downward trend in the governmental revenues from fuel taxes in the coming decade (EC, 2021c). The higher minimum rates proposed in the revised ETD may partly address this issue, as this may result in higher national fuel tax rates in many EU countries. However, at significantly higher levels of zero- and low-emission vehicles, it will be difficult to keep energy tax levels constant by increasing the tax rates on fossil fuels only. As significantly increasing electricity taxes may be politically difficult[25], increasing other taxes (or introducing new taxes) may be an option, either

[25] As this may also affect electricity use in the built environment. Furthermore, it may not be in line with the overall objectives to increase the use of green electricity for decarbonisation purposes.

within the transport sector (e.g. infrastructure charges or vehicle taxes) or within other economic sectors.

The use of CO_2 differentiated vehicle taxes also increases the risk on revenue deficits. Decreasing average CO_2 emissions of vehicles may result in lower income from these taxes. The historic case of the Dutch purchase tax clearly illustrates this risk. In 2008, the Netherlands was one of the first EU countries introducing a CO_2 based purchase tax for passenger cars. Over the period 2008-2013 the revenue from this tax decreased by more than 50% (CPB, 2016). There are several reasons for this strong decrease, but most importantly the government underestimated the behavioural reactions of car consumers and car industry, demanding/offering much more fuel-efficient vehicles as expected. Combined with the fact that the government did not modify the CO_2 thresholds and rates in the purchase tax, this resulted in a significant drop in revenues. Periodically modifying the tax design, taking into account the trends in the car industry and consumer preferences, is therefore key to ensure robust tax revenues.

The introduction of an ETS for road transport and buildings may result in significant revenues from auctioning emission allowances (in the order of EUR 50 to EUR 60 billion per year, depending on the design of the scheme (EC, 2020a)). However, only part of these revenues is allocated to the individual countries and these revenues have to be earmarked to support sustainable transport options or compensate low-income households.

4.3. Transport prices

4.3.1. Impact on fuel prices

Fuel taxes constitute a significant part of the overall fuel prices. For petrol, the share of fuel taxes (including VAT on fuel taxes) in fuel prices ranges from 38% in Bulgaria to 62% in the Netherlands. For diesel, the range is narrower, from 35% in Bulgaria to 50% in Italy. The share of fuel taxes in petrol prices in the various EU Member States is illustrated in Figure 10, showing the expected situation in 2030[26].

As the prices in Figure 10 are corrected for differences in price level between countries[27], this figure also shows the actual impact of fuel prices (and taxes) on the purchase power of people in the various Member States. It makes clear that, although absolute tax rates in countries like Bulgaria, Hungary and Poland are relatively low (see Figure 1), these taxes have rather large impact on purchasing power of households in these countries.

Finally, the impact of the proposed revision of the ETD (higher minimum tax rates) and the proposed introduction of an ETS for road transport and buildings on petrol prices is shown by Figure 10[28]. For most countries, petrol prices are expected to increase by 7-8%. Only in Bulgaria, Hungary, Greece and Poland significantly higher price increases are expected (11-16%), as for these countries the new minimum tax levels set by the revised ETD are above their current national tax rates, requiring them to increase these rates. For diesel, a lot more countries currently charge a tax rate close to the minimum levels, implying that the revised ETD will result in higher diesel tax rates in the majority of the countries. As a consequence, diesel prices are expected to increase at a higher level in most countries, i.e. 9-18%. It should be mentioned that further price increases may be expected for the period after 2030, as the

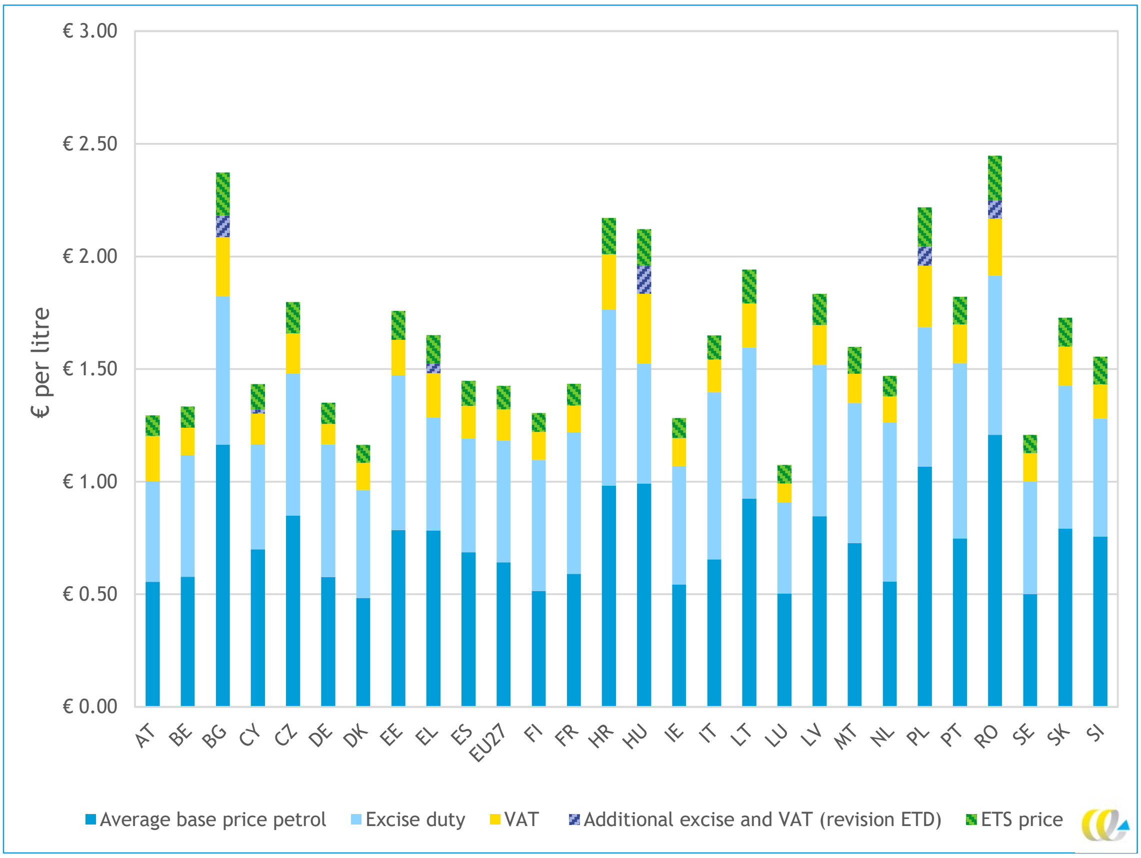
[26] Excise duty and VAT rates are assumed to be constant, in real terms, between 2021 and 2030. Incidental price shocks on the fuel market, like the current one induced by the war in Ukraine, are not considered in this analysis.

[27] This has been done by applying a correction with the purchasing power parity (PPP). This indicator corrects for the fact that you can buy more goods for 1 euro in countries like Hungary and Bulgaria than in Germany or The Netherlands.

[28] For the ETS, an ETS price of EUR 50 per tonne is assumed based on the MIX scenario (EC, 2020a).

minimum fuel tax rates in the ETD are gradually increasing over time and also the ETS price is expected to rise after 2030.

Figure 10: Breakdown of petrol prices in 2030, PPP corrected



Source: own analysis based on ACEA (2021), (CE Delft, 2021), (EC, 2021c)

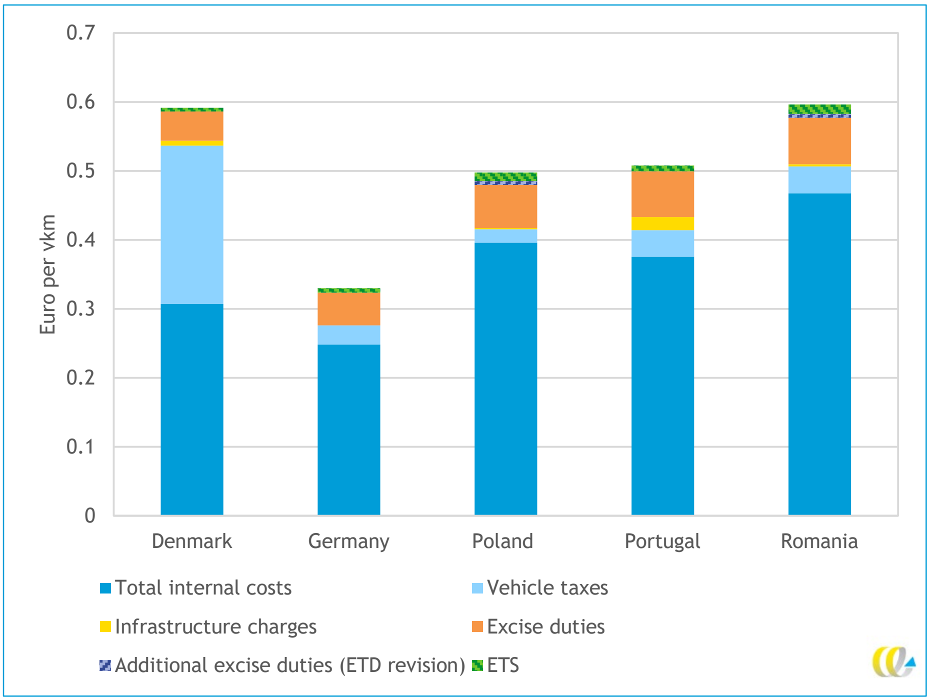
4.3.2. Impact on transport prices

Current taxes and charges have a significant share in the total costs of a passenger car. Figure 11 shows the breakdown of transport prices for a reference passenger car in a few EU countries (PPP corrected). In most countries the share of taxes/charges in the total transport price is about 15% to 25%. In Denmark this share is considerably larger (about 48%), which is mainly the consequence of a very high purchase tax applied on passenger cars. In all countries, internal costs (i.e. purchase costs, maintenance and base fuel costs) take up the largest share of costs.

Figure 11 also shows the impact of the proposed revision of the ETD and the introduction of an ETS for road transport (and buildings) on the total costs of a passenger car. These new policies result in slightly higher costs of using a car, about 1% to 4%. For this analysis, an ETS price of EUR 50 per tonne CO_2 was assumed (see Footnote 28). Assuming an ETS price of EUR 100 per tonne CO_2 would result in a cost increase of car use of 2% to 6%.

As the transport costs are corrected for differences in purchasing power between countries, Figure 11 also shows that in relative terms the transport costs are considerably higher in countries like Romania, Portugal and Poland than in Germany. This again illustrates that comparable tax levels have a more significant impact on purchasing power in countries with lower income levels.

Figure 11: Impact transport taxes/charges on transport prices for a reference passenger car (PPP corrected)

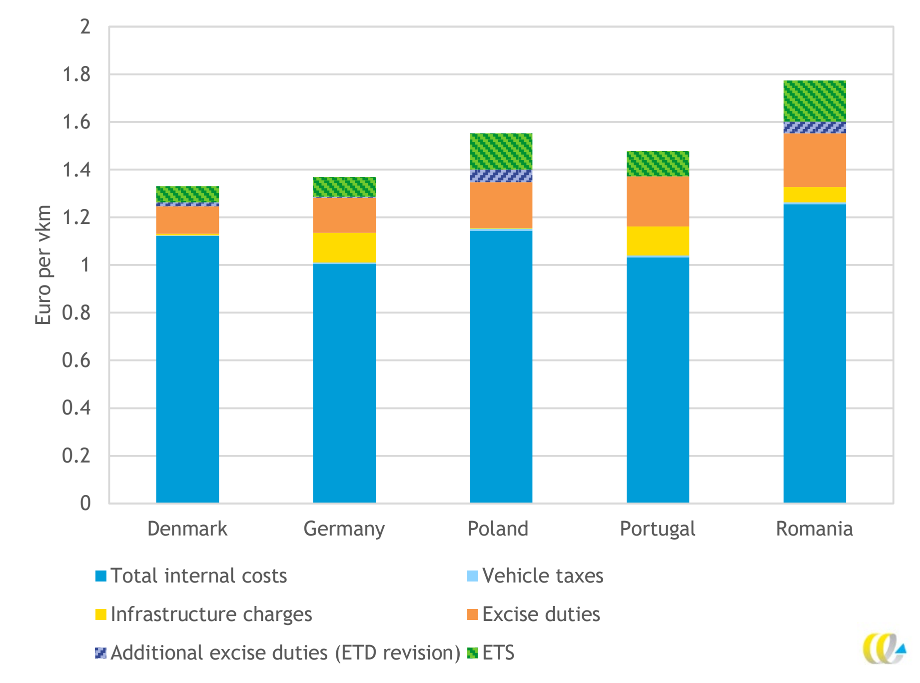


Note: internal costs consist of costs of depreciation, maintenance, energy, insurance.
Sources: Own analysis based on CE Delft et al. (2017), ACEA (2021) and CE Delft et al. (2019b)

For HGVs, transport taxes/charges constitute, in general, 15% to 25% of the total transport costs (see Figure 12), The only exception is Denmark, where transport taxes only contribute for 10% to the total costs, as taxes/charges on HGVs are relatively low in Denmark. The possible contribution of the ETS price (assuming a price of EUR 50 per tonne) and the higher diesel tax rates due to the revision of the ETD is also shown in Figure 12. It is expected that in Denmark, Germany and Portugal these policy instruments would lead to a cost increase of 4%. For Poland and Romania, a cost increase of about 9%-10% is estimated. This larger increase is due to the fact that in these countries the diesel tax rates have to be increased significantly to meet the new minimum rates set by the revised ETD. Considering a higher ETS price (EUR 100 per tonne) would result in a cost increase of about 8% in Denmark, Germany and Portugal and 14%-15% in Poland and Romania.

The figures 11 and 12 show that the costs for passenger cars and HGVs for a large extent exist out of internal costs. This will be the case for LCVs as well, since internal costs are comparable with passenger cars. As LCVs are, in general, eligible to fewer taxes compared to passenger cars, the share of taxes and charges on overall transport costs is expected to be lower than for passenger cars (and probably more in line with the situation for HGVs).

Figure 12: Impact transport taxes/charges on transport prices for HGVs (PPP corrected)



Note: internal costs consist of costs of the driver, depreciation, maintenance, energy, insurance.
Sources: Own analysis based on CE Delft et al. (2017), ACEA (2021) and CE Delft et al. (2019b).

4.4. Broader economic impacts

4.4.1. Distributional impacts

The use of pricing instruments could potentially result in some distributional impacts, as these instruments imply changes to the costs of transport. In this respect, particularly pricing instruments affecting the costs of passenger transport are relevant. Theoretically, changes in freight prices may also affect consumers via higher prices for final products. However, as transport costs have, in general, a limited share in the prices of final products, this impact is expected to be (very) limited.

The distributional consequences from transport taxes heavily depend on the type of instrument and its design. Therefore, it is not feasible to discuss the distributional impacts of all pricing instruments within this briefing. Instead, we focus on CO_2 related taxes (mainly fuel taxes and ETS), which is in line with the overall objective of this briefing (see Section 1.2).

Distributional impacts may be relevant within countries, e.g. between different income classes. The following effects are relevant in that perspective:

- There are large differences in the share of household spending going towards transport costs between income levels. In general, high income households spend more on transport in absolute terms, as they own more cars and drive more (Bureau, 2010). Low-income households, on the other hand, spend a higher share of their income on transport (EC, 2021f). Actually, the share of income spending on transport fuel is decreasing with income level (Eliasson, 2019), implying that a fuel tax or ETS price will be regressive (Cambridge Econometrics, 2021b) (CE Delft, 2021).

- Low-income households have, in general, less mitigation options for higher fuel prices (due to the impact of pricing instruments). They often lack the capital to invest in low-carbon technologies, like electric vehicles (EC, 2021c). Additionally, low-income households have fewer options to reduce their transport demand as well, as the share of non-essential trips in their total number of trips is lower than for high-income households (Cambridge Econometrics, 2021b). Because of the fewer mitigation options available to low-income households, the impact of CO2 pricing instruments on their disposable income are expected to be more significant (in relative terms) than for high-income households.
- Access to substitutes for car use (e.g. public transport) and average commuting distances are important drivers of the impact of CO2 pricing instruments on disposable incomes of households. These drivers are closely linked to geographical factors. In rural areas and to a smaller extent suburbs there is, due to a higher car dependency and longer average trip distances, a higher burden of car taxation compared to cities (Eliasson et al., 2018) (Eliasson, 2019).

Based on these effects, it can be concluded that CO_2 pricing instruments in the road transport sector are expected to affect low-income households more significantly than high-income households, having a regressive impact. Furthermore, it may be expected that at the same time, households that are more dependent on car use (e.g. people living in rural areas) are more heavily affected than households for whom alternative transport options are available.

The distributional effects between Member States of cross boundary pricing instruments (e.g. and ETS for road transport or EU-wide minimum fuel tax rates) show patterns comparable to the distributional effects within countries:

- Impacts on disposable income are higher in countries with relatively low-income levels. This is illustrated by the assessments carried out in Section 4.3, where it was shown that similar price incentives have larger relative impacts in countries with lower income-levels.
- Mitigation alternatives, like electrification of transport, are more accessible and affordable in high income Member States. Therefore, the latter countries have more options to mitigate the impact of pricing instruments on disposable incomes.
- Member States with a higher population density and high use of public transport will, on average, be less affected by CO2 pricing instruments, as less transport movements are affected.

In the above mentioned discussion we did not yet consider the role of the recycling of revenues from pricing instruments. Several studies show that such revenues can be used to (partly) neutralise the distributional impacts of pricing instruments (Cambridge Econometrics, 2021b) (Landsi et al, 2021). This can be done both within countries and between countries. For the latter, an EU-wide instrument is required, like the Social Climate Fund proposed as part of the extension of ETS to road transport. Furthermore, the effectiveness of revenue recycling depends heavily on its design and therefore the development of such schemes should be carefully weighted.

4.4.2. Competitiveness

The implementation of pricing instruments may affect competitiveness as well. The competitiveness of the road haulage sector may be influenced in several ways:

- Pricing instruments will result in higher unit costs for road transport. EU-wide instruments (like an ETS for road transport), however, result in comparable price increases for operators in all countries, such that competition between road operators from different Member States will not be significantly affected. Moreover, national taxes/charges that have to be paid by both domestic as foreign operators (i.e. fuel tax, road infrastructure charge) do not significantly affect the competitiveness of individual operators. National vehicle taxes, on the other hand, may affect competitiveness between transport operators from different counties, which probably is the reason these are quite similar in most Member States (see Section 2.1.2).

- Operators who improve their efficiency as reaction to the implementation of a pricing instrument may gain a competitive advantage (Ricardo et al., 2017). At the same time, this will contribute to the overall competitiveness of the EU economy.
- With respect to CO_2 pricing instruments, operators that invest in fuel efficient vehicles or make use of alternative fuels or powertrains may gain a competitive advantage (CE Delft, 2021). Simultaneously, CO_2 pricing instruments provide a competitive penalty for operators that are operating less efficient fuel.
- Pricing instruments for the road transport sector does impact the competitiveness of the road freight sector compared to other modes of transport. The risk of loss in transport volumes is, however, small due to the low substitution possibilities for most types of goods (CE Delft, 2021).

Based on these arguments, it is expected that the use of pricing instruments in road transport will not have a big impact on the competitiveness of the road haulage sector. However, it may affect the competitiveness of individual operators, particularly in favour of operators offering high transport efficiency and/or low CO_2 intensity of transport.

The increase of freight transport costs due to pricing instruments may theoretically affect the competitiveness of the European production sector, as total production costs of goods will increase. This effect is most dominant for services and products where road transport costs take upon an important part of total production costs and for which substitutes outside the EU are available. However, Arcadis (2019) shows that as road transport is often used for final distribution only, the share in total transport costs is limited. As a result, the competitive loss due to pricing instruments in the road sector is expected to be small.

4.4.3. Employment

As discussed in section 4.4.2, no significant loss of competitiveness of the road transport sector is expected from the implementation of pricing instruments. As a consequence, small reductions in output and employment are expected (Cambridge Econometrics, 2021a) within the road transport sector. Particularly, as the true effects of pricing instruments on the labour market are far more complex than a simple accounting procedure, jobs tend to be reallocated rather than lost entirely. This is also confirmed by EC (2020a) for the inclusion of road and building under ETS. A relatively small negative effect on aggregate employment (0.26%) is found by 2030, when no carbon revenues are to be used for compensating the labour market. However, if carbon revenues are used to reduce labour taxation, a limited positive impact on aggregate employment is found. The effects are more prominent in low-income countries. This is due to both higher tax rates increase (relative to the baseline) and higher shares of transportation in overall consumption (EC, 2021f).

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1. Main conclusions

5.1.1. Wide differences in CO_2 based pricing of road transport between EU countries

Pricing instruments on CO_2 emissions of road transport are currently widely applied in Europe. All Member States apply fuel taxes and in a selection of countries registration taxes and/or ownership taxes for passenger cars are CO_2 based. Additionally, non-CO_2 based vehicle taxes and infrastructure charges are applied, which indirectly also affect the level of CO_2 emissions of road transport to some extent[29]. In general, CO_2 emissions of passenger cars are more heavily charged than emissions of LCVs and HGVs, mainly because of higher petrol taxes compared to diesel taxes and the fact that CO_2 based vehicle taxes are applied more often for passenger cars.

Although pricing instruments on CO_2 emissions are applied in all EU Member States, there are large differences between countries with respect to the type of instruments applied, the tax/charge levels set, and the CO_2 mitigation potential of the differentiations used. Therefore, the level of CO_2 based pricing of road transport differs widely between countries. More broadly, Member States also differ to the level by which their road transport sectors meet the 'polluter-pays' and 'user-pays' principles. Although in almost none of the EU countries external and infrastructure costs of road transport are fully covered by taxes and charges, some countries have made much more progress in this respect than others.

5.1.2. Key role for pricing instruments in EU climate policy for road transport

In order to increase the pricing of CO_2 emissions of road transport, the European Commission has proposed to implement an emission trading system for road transport (and buildings). Also the revision of the ETD may strengthen the effectiveness of carbon pricing in Europe, e.g. by removing disadvantages for clean technologies and introducing higher levels of taxation for inefficient and polluting fuels. These additional/sharpened pricing instruments on CO_2 emissions may strengthen the climate policy for road transport in the EU. At the same time, it may contribute to the EU's ambition to meet the 'polluter-pays' and 'user-pays' principles to a larger extent.

5.1.3. Impacts of pricing instruments

Pricing instruments are effective in reducing CO_2 emissions in the road transport sector. Fuel taxes and ETS can be considered as the first best instruments, as they stimulate the uptake of all relevant CO_2 reduction options, but at the same time leave the actual choice on how to reduce CO_2 emissions to the market. CO_2 based purchase taxes have an important additional value in incentivising the acquisition of low- and zero-emission vehicles. Road infrastructure charges can contribute to CO_2 reduction as well, but are in general less efficient than fuel taxes and/or ETS. However, as this instrument may also contribute to the reduction of other externalities of transport, it may be an interesting element of an overall transport policy.

Transport taxes and charges are also an important source of income for national governments. On average, transport taxes contribute 5% to 10% to the total tax revenue in the EU countries. Rising market shares of low- and zero emission vehicles may lower the income from fuel taxes and CO_2 based

[29] By limiting the size of the vehicle fleet, improve transport efficiency and curbing overall transport demand.

vehicle taxes. Keeping income from transport taxes at a stable level may become an important challenge for EU countries in the next decade.

A key issue with respect to the political and social acceptance of pricing instruments is their distributional impacts. In general, CO_2 based pricing is regressive, meaning that the financial burden for low-income households is relatively higher than for high-income households. There may also be large differences in impacts on disposable income between people living in rural or urban areas. These distributional impacts may, however, be (partly) neutralised by recycling the revenues from pricing instruments in a smart way.

5.2. Policy recommendations

Pricing instruments may have an important role in decarbonising the road transport sector. In order to use pricing instruments in an effective and efficient way, it is key to:

- *Develop a balanced mix of pricing instruments*. Fuel taxes and/or ETS are the key pricing instruments to reduce CO_2 emissions in the road transport sector. However, CO_2 based vehicle taxes (and in particular purchase taxes) may provide an important additional incentive in stimulating the uptake of low- and zero emission vehicles.
- *Integrate pricing instruments in a broader package of CO_2 reduction policies*. Pricing instruments are largely complementary to other climate policies, like CO2 vehicle standards and fuel standards, and may therefore be best combined in an overall policy package. In this way all different market barriers for CO_2 mitigation may be addressed and all relevant reduction options may be optimally incentivised.
- *Consider political and social acceptance of pricing instruments*. The generally regressive impact of CO_2 based pricing instruments may negatively affect the political and social acceptance of these instruments. Therefore, designing mitigation options for unwanted distributional impacts is key, e.g. by developing effective recycling channels for the revenues of pricing instruments.
- *Regularly re-adjust the pricing instruments*. In order to keep pricing instruments effective and revenues stable, it is key to regularly update the design of (CO_2 based) taxes and charges, taking into account trends in the car industry (e.g. decreasing average CO_2 emissions of new vehicles) and consumer preferences (e.g. increased preferences for zero-emission vehicles).
- *Consider other transport externalities as well*. Next to CO_2 emissions, air pollutant emissions, noise, accidents and congestion are important external costs of transport as well. Therefore, an overall transport policy for the road sector should take these externalities in account as well. Distance-based road charging schemes differentiated to time of day, location and Euro emission standards may play an important role in such an overall policy package.

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This briefing provides an overview of pricing instruments on road transport CO_2 emissions. It presents the current use of these instruments in the EU, the main EU legal framework in this field including the expected developments, and the impacts these instruments may have on the road transport sector and society in general.

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