Trends for light and heavy-duty vehicles

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Summary

Introduction
This report on trends in the fleet of light and heavy-duty vehicles is written by TNO for the Dutch Ministry of Infrastructure and Water Management. The analysis is based on the data obtained from the RDW[1] and Emission Registration (in Dutch, emissieregistratie)[2]. This includes how the age and size of the fleet is developing over time. The report also covers trends in the ownership of light vehicles. Another topic covered in the report is the contribution of the fleet of Euro 5 and older vehicles in polluting emissions. These vehicles have a reputation of being very polluting. Their disproportional effects in the entire fleet are presented in this work.

Data
The data for the analysis in this work is obtained from the RDW which has compiled the data for all vehicles in the Netherlands. For the sake of this report, the data analyzed is from 2014 until 2021. For the part on ownership, the analysis was extended to include the household information. This way the ownership trends could be understood and relevant conclusions could be made. Since the latter was limited to data up until mid-2019, the newer trends in terms of more EV vehicles and the shift to heavier vehicles was not fully captured. This is a reason why newer data in this regard could help strengthen the understanding of vehicle ownership and how specific policies can help guide the transition towards cleaner vehicle fleet. For the kilometers and emissions analysis, data from the emission registration was used. This gave us insight into the mileage of the fleet and how much do they emit in term of CO_2, NO_x and PM_{10}. The vehicles could also be segregated into euro-classes to understand if there are some euro-classes contribute in emissions more than the others.

Results
The main results from the trend analyses on fleet age and size is the that the vehicle fleet in the Netherlands is increasing in number and is getting older. On average vehicles remain longer in the fleet before they are exported or scrapped.
The increase in the van fleet is almost twice as high as compared to the passenger car fleet in terms of percentage increase. This also comes at the cost that vans, on average, are more polluting than passenger cars which justifies the new policies that are targeted at vans.

For the heavy-duty vehicle fleet, there is an observable shift to either the medium-heavy light rigid trucks or the heavy tractor semi-trailers. This, in turn, comes at the expense of a decreasing medium-heavy-duty fleet.

In recent years the share of imported vehicles in the total new registrations has increased to close to 50% of the total new registrations for passenger cars and 30% for vans in 2021. This entails that imported vehicles come at the expense of new vehicles. This, along with the exported vehicles getting exported at an older age than before contribute to the vehicles fleet getting older and dirtier than before.

[1] The RDW is a Dutch organisation that handles the type-approval and registration of motorized vehicles in the Netherlands.
[2] Emissieregistratie registers the emissions from all relevant Dutch sources every year.

From the analysis of Euro 5 and older vehicles, it appears that certain groups disproportionally contribute to the total polluting emissions from light and heavy-duty vehicles. Especially Euro 4 (and older) and Euro 5 diesel vans stood out substantially as they have a large share in the NO_x emissions of light-duty vehicles. In 2021, this group accounted to about 6.5% of the light-duty vehicle fleet, drove about 8% kilometres and contributed close to 30% of the total NO_x emissions from light-duty vehicles. A similar group in Euro 4 (and older) diesel vans was identified that contribute significantly to the total PM_{10} emissions of light-duty vehicles. This small group, which accounted to about 3.5% of the total light-duty fleet and drove a similar share of kilometres contributed to about 41% of the total exhaust-PM emissions of light-duty vehicles. A similar observation was made for passenger cars. Euro 4 (and older) diesel passenger cars are notoriously high emitting vehicles for exhaust-PM. In 2021, about 3% of the light-duty fleet was diesel Euro 4 (and older) passenger cars, drove about the same share of kilometres but contributed to about 20% of the total exhaust-PM emissions of light-duty vehicles. For NO_x, Euro 5 diesel passenger cars were seen standing out. This group constituted of 4% of the total light-duty vehicle fleet in 2021, drove about 7% of the kilometres but contributed to 14% of the total NO_x emissions from light-duty vehicles. These small groups of vehicles contribute extremely highly to the total NO_x and exhaust-PM of light-duty vehicles. The trends of passenger car and van ownership also resulted in some important insights. Parameters like age of the vehicles, mass of the vehicles, brand-loyalty and fuel-loyalty were studied in this work. But due to the availability of data until only mid-2019, this work could be strengthened a lot in terms of understanding the impacts of the growing EV fleet and the growing SUV (or other heavier) vehicle group.

Samenvatting

Introduction
Dit rapport over trends in de Nederlandse vloot lichte en zware voertuigen is geschreven door TNO in opdracht van het Ministerie van Infrastructuur en Waterstaat. De analyse is gebaseerd op de gegevens van de RDW en Emissieregistratie om inzicht te geven in deze trends. Daarbij gaat het onder meer om hoe de leeftijd en omvang van het wagenpark zich in de loop der jaren heeft ontwikkeld. Het rapport gaat ook in op trends in het bezit van lichte voertuigen. Een ander onderwerp dat aan bod komt, is de bijdrage van Euro 5 en oudere voertuigen aan de vervuilende emissies.

Data
De data voor de analyse zijn afkomstig van de RDW, die gegevens van alle voertuigen in Nederland verzameld. In het kader van dit rapport worden de gegevens van 2014 tot 2021 geanalyseerd. Voor het deel over eigendom is de analyse uitgebreid met informatie over huishoudens. Op deze manier konden de trends in bezit worden geanalyseerd. Aangezien deze dataset beperkt was tot medio 2019, kunnen de nieuwere trends in termen van meer EV-voertuigen en de verschuiving naar zwaardere voertuigen niet volledig in beeld gebracht worden. Dit is een reden waarom nieuwere data kunnen bijdragen tot een beter begrip van het voertuigbezit en van de manier waarop specifiek beleid de overgang naar een schoner wagenpark kan helpen sturen. Voor de kilometer- en emissieanalyse is gebruik gemaakt van gegevens uit de emissieregistratie. Dit geeft inzicht in het aantal kilometers van het wagenpark en hoeveel de voertuigen uitstoten in termen van CO_2, NO_x en PM_{10}.

Resultaten
De belangrijkste resultaten van de trendanalyse van de leeftijd en omvang van het wagenpark zijn dat het wagenpark in Nederland in aantal toeneemt en ouder wordt. Gemiddeld blijven voertuigen langer in het wagenpark voordat ze worden geëxporteerd of gesloopt.

De toename van het bestelwagenpark is procentueel bijna tweemaal zo groot als die van het personenwagenpark. Dit gaat ook ten koste van het feit dat bestelwagens gemiddeld vervuilender zijn dan personenauto's, wat het op bestelwagens gerichte beleid rechtvaardigt.

Wat het wagenpark van zware voertuigen betreft, is er een verschuiving naar lichte vrachtwagens en zware trekker-opleggers. Dit gaat dan weer ten koste van een afnemend middelzwaar wagenpark.

De laatste jaren is het aandeel van geïmporteerde voertuigen in het totale aantal nieuwe registraties gestegen tot bijna 50% van het totale aantal nieuwe registraties voor personenauto's en 30% voor bestelwagens in 2021. Dit betekent dat geïmporteerde voertuigen ten koste gaan van nieuwe voertuigen. Dit, samen met het feit dat de geëxporteerde voertuigen ouder worden dan voorheen, draagt ertoe bij dat het wagenpark ouder en vuiler wordt dan voorheen.

Uit de analyse van Euro 5- en oudere voertuigen blijkt dat bepaalde groepen onevenredig bijdragen aan de totale verontreinigende emissies van lichte en zware bedrijfsvoertuigen. Vooral Euro 4- (en oudere) en Euro 5-dieselbusjes vallen op, omdat zij een groot aandeel hebben in de NO_x -uitstoot van lichte voertuigen. In 2021 was deze groep goed voor ongeveer 6,5% van het lichte voertuigenpark, reden ze ongeveer 8% kilometers en droegen ze bijna 30% van de totale NO_x -emissies van lichte voertuigen bij. Een soortgelijke groep in Euro 4 (en oudere) bestelwagens met dieselmotor werd geïdentificeerd die aanzienlijk bijdraagt tot de totale PM uitlaat emissies van lichte voertuigen. Deze groep, die ongeveer 3,5% van het totale lichte wagenpark uitmaakt en een vergelijkbaar aandeel in het aantal kilometers aflegt, draagt voor ongeveer 41% bij aan de totale PM uitlaat emissies van lichte voertuigen. Een soortgelijke vaststelling werd gedaan voor personenauto's. Euro 4 (en oudere) dieselpersonenauto's zijn voertuigen met een hoge PM uitstoot aan de uit. In 2021 bestond ongeveer 3% van het lichte wagenpark uit diesel Euro 4 (en oudere) personenauto's, reed ongeveer hetzelfde aandeel kilometers maar droeg bij aan ongeveer 20% van de totale PM uitlaatemissies van lichte voertuigen. Voor NO_x vielen Euro 5-dieselpersonenauto's op. Deze groep vertegenwoordigde 4% van het totale lichte voertuigenpark in 2021, reed ongeveer 7% van de kilometers, maar droeg bij tot 14% van de totale NO_x -emissies van lichte voertuigen. Deze kleine groepen voertuigen hebben een enorm grote bijdrage aan de totale NO_x en PM uitlaat emissies van lichte wegvoertuigen. Ook de trends in het bezit van personenauto's en bestelwagens leverden belangrijke inzichten op. Parameters zoals leeftijd van de voertuigen, massa van de voertuigen, merkentrouw en brandstoftrouw zijn geanalyseerd. Maar omdat er alleen data beschikbaar is tot medio 2019 zou dit kunnen worden versterkt met recentere inzichten op basis van nieuwe data.

Contents

1 Introduction

1.1 Study background

Since 1990 the environmental impact of road traffic has reduced significantly[3], despite the increasing demand, fleet size and with that climate impact. The reduction in environmental impact is due to vehicle emission legislation and the attention for environmental impact in national policies. Contrary to other European countries, that promoted diesel cars for [believed] climate benefits, the Netherlands did not have a large increase diesel passenger cars around 2010-2015.

As far as the climate impact of road vehicles is concerned the emissions in gram per kilometre has seen a decreasing trend over the past decade but due to an increase in fleet size and kilometres driven this decrease has been undone to a large extend.
This report is one in a series[4] of many linking fleet developments with technologies, legislation, and their effect on emissions, environment, and climate.

1.2 Goal of this study

The goal of this study is foremost to present trends in the fleet age, size and ownership for passenger cars, vans and heavy-duty vehicles. These trends are to be used to provide input for future policy aimed at reducing the climate and environmental impact of road vehicles by influencing the composition of the Dutch road vehicles fleet. The focus is on changes in the trends that deviate from the very successful reduction in emissions in the last decade due to fleet renewal, and the possible trends in the CO_2, NO_x and PM_{10} reduction by changes in the fleet. These results highlight strength, but also possible risks and shortcomings in policy aimed at the Dutch passenger car, vans and heavy-duty fleet. Additionally, target groups for future policy are identified. This can be used as input for effective policy action in the future.

1.3 Data

The results presented in this report are based on analysis of RDW data and the emission registration data (in Dutch, Emissieregistratie). RDW data is used to analyse vehicle purchases, import, export and scrappage as well as fleet size and age. The emission registration data is used for kilometre and emission factor data. Results presented here may differ from numbers as presented by CBS these differences are expected to be mainly due to the fact that CBS includes all vehicles that have been active during a given year while in our analysis only the vehicles active at the last day of a given year are included[5].

The analysis focuses on road vehicles and includes cars, vans and heavy-duty vehicles, but does not include L-cat[6] vehicles, busses and coaches.

[3] Effects of European emission reductions on air quality in the Netherlands and the associated health effects, G.J.M. Velders et al, 2020, Atmospheric Environment, 221, 1-17.
[4] Nederlands wagenpark onderhevig aan veranderingen | TNO (webpage with the 11 TNO reports so far collected).
[5] See the table explanation at (cbs.nl)
[6] L-cat vehicles are light (utility) vehicles such as golf carts, micro cars and Goupil's and also includes two wheelers

1.4 Structure of the report

The report is structured based on different categories of road vehicles.

The following are the chapters in the report:

1. Introduction to the topic including the scope of the research and the layout of the report.
2. Analysis of the passenger car fleet in the Netherlands. This includes the change in the fleet, age development of the fleet, trends in the higher emitting groups of passenger cars, trends in ownership and climate action points.
3. Analysis of the van fleet in the Netherlands. The structure remains the same as in the case of passenger cars.
4. Analysis of the heavy-duty vehicle fleet in the Netherlands. Trends for medium-heavy-light rigid trucks, medium-heavy rigid trucks, heavy rigid trucks and tractor semi-trailers have been discussed. Analysis has been done on the fleet development, age development and the higher emitting group of heavy-duty vehicles.
5. Chapter five presents three topics. At first an overview is presented of the CO_2 performance standards for trucks as is currently the case. Secondly the current uptake of zero emission heavy-duty vehicles in new sales and in the fleet is analysed and at last an overview is given of the potential CO_2 reduction with the use of (super) Eco combi's.

2 Passenger cars

With passenger cars lasting about 19 years, it is expected that about 5% of the fleet is renewed every year. But this is based on the assumption that the total fleet remains the same size, and every new vehicle replaces an older one that is scrapped or exported. This is not really the case. The fleet, i.e., the number of vehicles registered in the Netherlands, increases in size and older vehicles remain longer in the fleet than before. The majority of these vehicles are passenger cars, but vans are also substantial in numbers. This increase in vehicles is faster than the population growth. The Dutch, on average, have grown to own more vehicles and drive longer distances[7].

The net change in the total LDV (Light-duty Vehicles) fleet is defined as the total change in number of LDV's in the country. It is calculated by taking into account the number of new vehicles purchased, imports, and number of exports and scrappage per year. The total change in the last years has been 1.5% to 2% per year, see Figure 1.

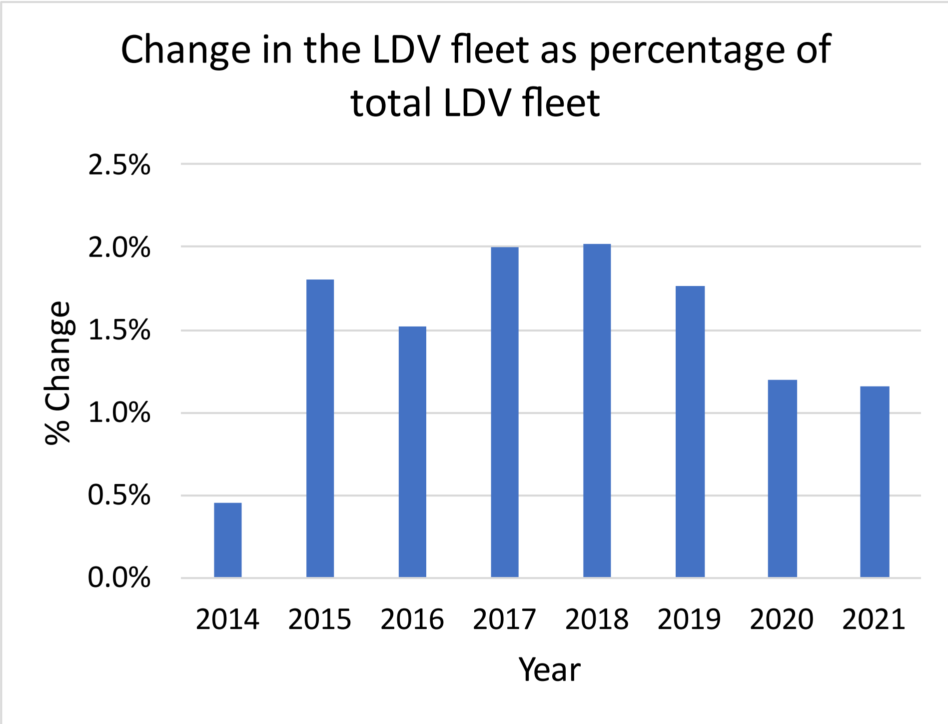


Figure 1: Change as a percentage of the total LDV fleet in that year.

The Netherlands has about 1.5% - 2% increase in number of vehicles every year in comparison to its fleet size. In 2019, for instance, 177,000 vehicles have been added to the existing fleet size of 10 million, passenger cars and vans combined.

[7] Opnieuw record personenautokilometers in 2019 (cbs.nl) Opnieuw record personenautokilometers in 2019 (cbs.nl)

2.1 Fleet size change

The change in the passenger car fleet is slightly lower than the change in the LDV fleet, indicating a possible shift to vans. Given the large size of the passenger fleet the effect is limited, yet significant. Only in 2015, the net change of passenger cars was in line with the average growth of the fleet. See Figure 2.

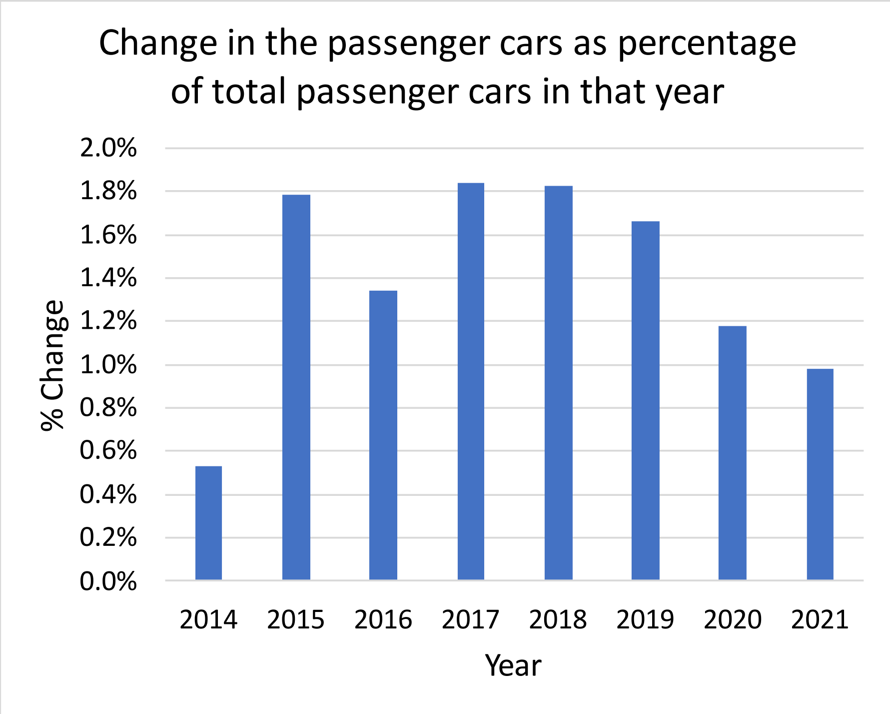


Figure 2: Net change in passenger car fleet as a percentage of the total passenger cars in that year.

The passenger car fleet in the Netherlands sees a positive change of about 1.2%- 1.8% per year. In Figure 3 the net change in passenger cars is broken down in a fuel-type specific net change. The net change of petrol vehicles is increasing from 2014 only to level out in 2019 and a lower rate of change in 2020 and 2021 which might be caused by COVID-19 and global chip shortages that caused delays for new vehicles. Despite COVID-19 the rate of change of full electric vehicles still increased in 2020 and stayed about the same in 2021.

Whereas both petrol and full electric vehicles have a positive net change, diesel passenger cars have a negative net change since 2016 and the decrease is stronger each year. This means that the diesel passenger car fleet is shrinking at a yearly increasing rate. This increasing trend is broken in 2021 as it seems to stabilize in 2021 as the decrease is a little less than in 2020.

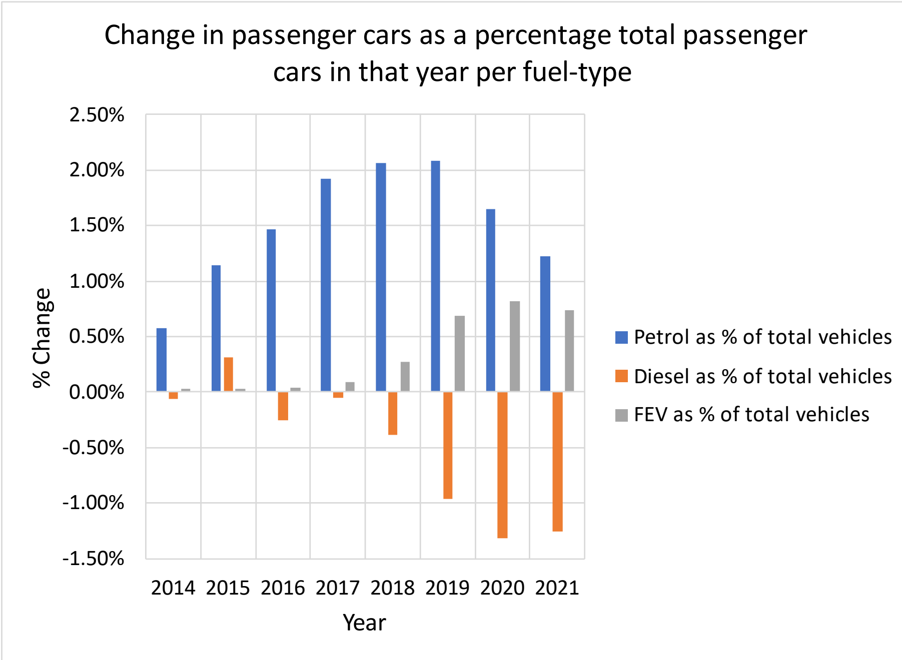


Figure 3: Net change in passenger cars per fuel-type as a percentage of the total passenger car fleet in that year.

Breaking down the change in the passenger car fleet, the influx is a combination of new sales in the Netherlands and import of second-hand vehicles. There is a clear trend in the contribution of both. A large and increasing part of the new vehicles registered in the country are imported vehicles. This number has also been steadily increasing. Its share in new registrations has risen from about 20% in 2014 to more than 40% in 2021, see Figure 5. This is alarming because the purchase tax policy (BPM) is aimed at introducing more fuel- efficient new vehicles in the fleet while in fact it seems to have an opposite effect. Instead of an increase in more fuel efficient newly purchased cars there is an increase in imported vehicles that usually have higher CO_2 emissions.

For passenger cars the BPM is differentiated based on CO_2, causing cars with high CO_2 emissions to have a higher BPM. Both new sales and imported vehicles must pay the purchase tax, however, the BPM for imported vehicles usually is much lower compared to new sales. This is mainly due to the high depreciation rates in the BPM causing older vehicles to have a lower BPM[8].

[8] The BPM of a 2,5 year old imported vehicle is less than 50% of the original BPM. For Vehicles sold new in the Netherlands the BPM is assumed to scale with the list price of the vehicle. Usually a 50% resale value is reached around a vehicle age of 5 years.

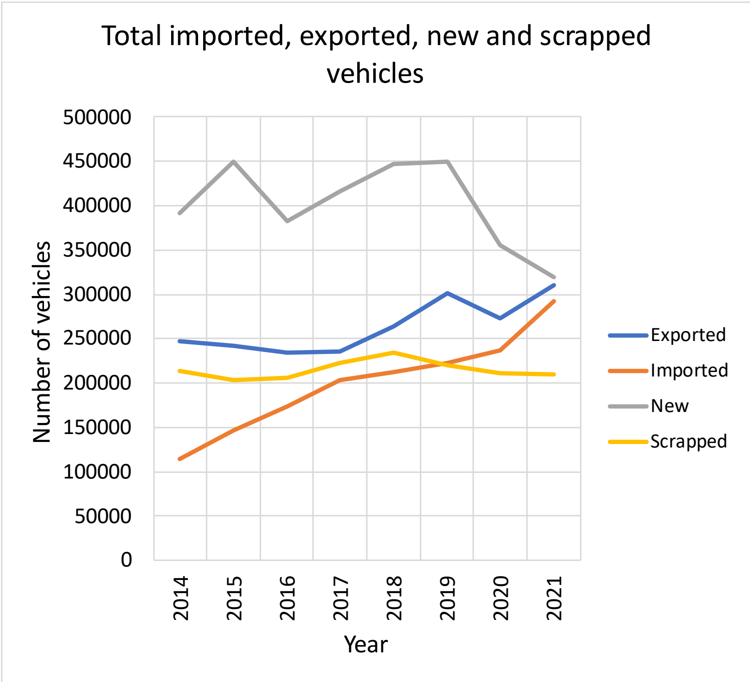


Figure 4: Total imported, exported, new and scrapped passenger vehicles per year

While import is increasing, the share of newly purchased cars is decreasing. Nevertheless, its absolute number remains fairly constant – except for 2020 and 2021 when COVID-19 caused the sales to fall - at around 400,000 sales per year in the recent years, see Figure 4. This implies a shift in consumers preferences to imported vehicles[9]. Previous research has shown that a significant part of the imports are young vehicles with high CO_2 emissions and a relative low BPM[10]. Apparently, the current policy to stimulate the sales of passenger cars with low CO_2 emissions has the negative side effect that people opt for cheaper imported vehicles with higher CO_2 emissions. Additional policy measures are necessary in order to address this.

The low number of sales in 2020 and 2021 may partly be due to COVID-19 and a global chip shortage. These events are likely to give an impulse to the trend towards imported vehicles, though it is unlikely that without them the trends would be very different.

[9] This is studied in more detail in chapter 2.5
[10] Schoon wagenpark vraagt om meer naast stekkersubsidie. Milieu en klimaat zijn gebaat bij doelgerichte autobelastingen voor het gehele wagenpark, TNO Whitepaper 2021

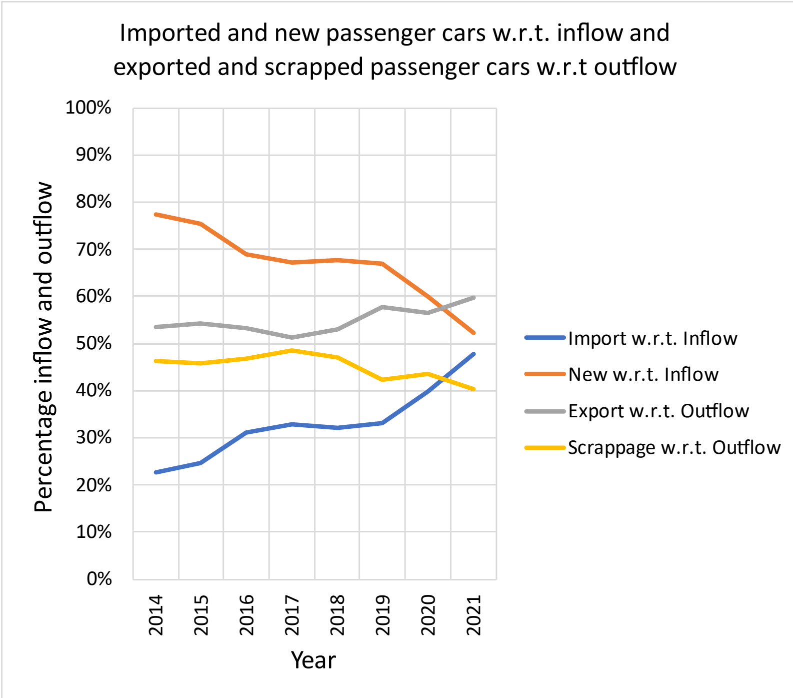


Figure 5: Percentage of imported and new passenger cars as a share of the total inflow and the percentage of exported and scrapped passenger cars as a share of the total outflow.

The ratio of imports to total new registrations highest for diesel passenger vehicles per 2015 where it was close to 30% and has since risen to over 80% in 2021, See Figure 6. This can be attributed to the fact that the number of new sales of diesel passenger cars has been falling, especially since 2018, as shown in Figure 3. The imports of diesel passenger cars is roughly stable since mid-2018.

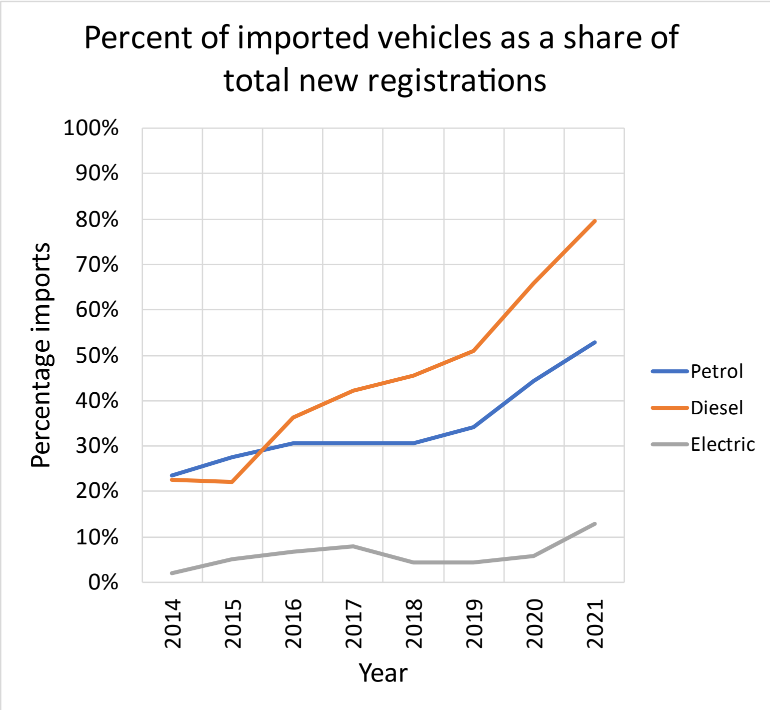


Figure 6: Percentage of imported passenger vehicles as a share of total new registrations per fuel type in that year. About 80% of the diesel vehicles coming into the fleet are imported vehicles in 2021 while about 50% of petrol vehicles are imported vehicles in 2021, both on a steady rise year-on-year.

The increase in import of electric vehicles is likely related to the change in taxes for company cars (i.e., “bijtelling”), which is more favourable for older electric cars, see Figure 6. However, the discount in the tax for company cars is limited to 60 months after first registration.

In Figure 7 the number of privately owned passenger cars per adult inhabitant has been visualized for the four biggest cities. It appears for most of them that this number is relatively constant except for the last couple years. In Rotterdam also in earlier years there has been an increase in the number of passenger cars owned by natural persons per adult inhabitant. While the number of cars per adult inhabitant of all four cities is lower compared to other areas in the Netherlands the figure shows that in Amsterdam the number of cars per inhabitant is lower compared to the other three cities and Rotterdam has a relative high car ownership per adult inhabitant. However, it is important to note that this figure presents the passenger car ownership of privately owned passenger cars per adult inhabitant only. The company car fleet is often registered at the address of the lease company and not at the address of the driver which means that the results may be different from reality. Inclusion of business owned passenger cars at the drivers’ address might give different results. Also it might be possible that the share of company cars in Amsterdam is higher compared to Rotterdam which would bring both cities closer together as is currently the case.

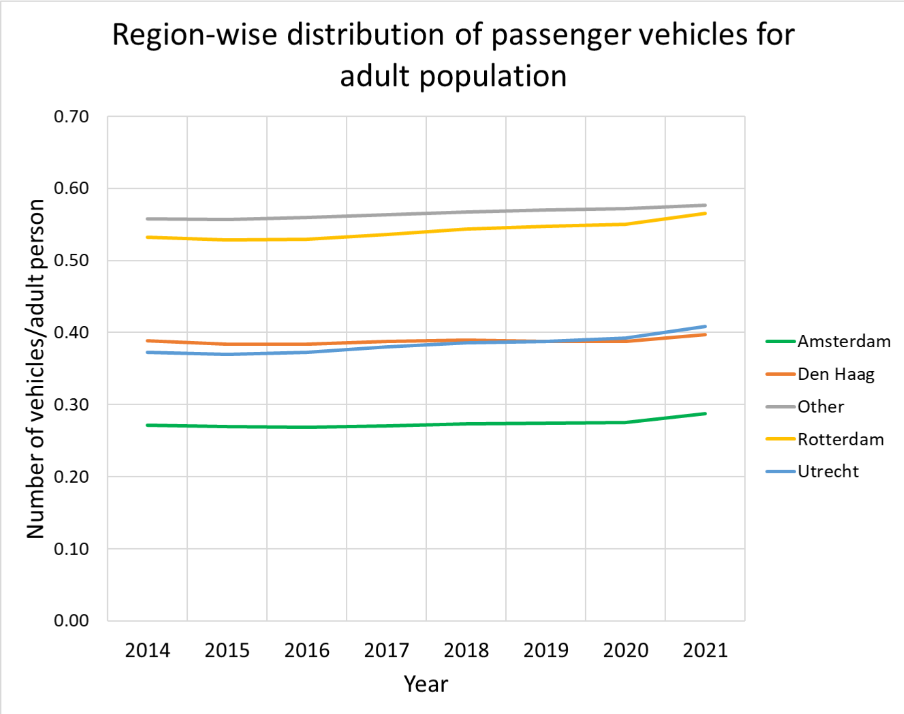


Figure 7: Regional distribution of passenger vehicles per adult population. This includes only vehicles owned by natural persons.

2.2 Average age of passenger cars

The average age of passenger cars in the Netherlands has been increasing over time. The average age of a passenger car in 2014 was about 10.2 years and in 2021 it is about 11.4 years. The fleet growing older entails that it takes longer for policies targeted at new sales to come into effect in the whole fleet.

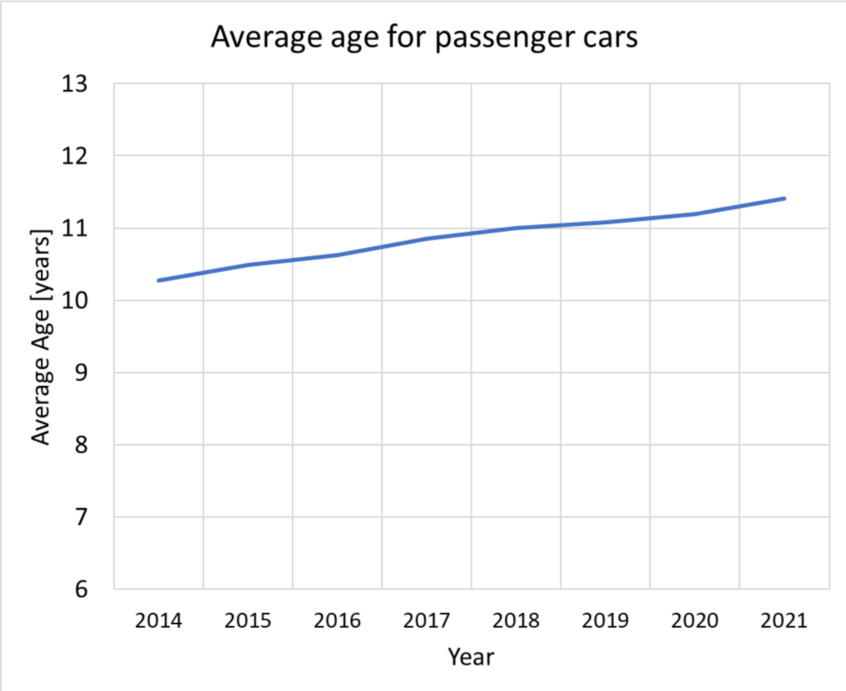


Figure 8: Average age of passenger cars

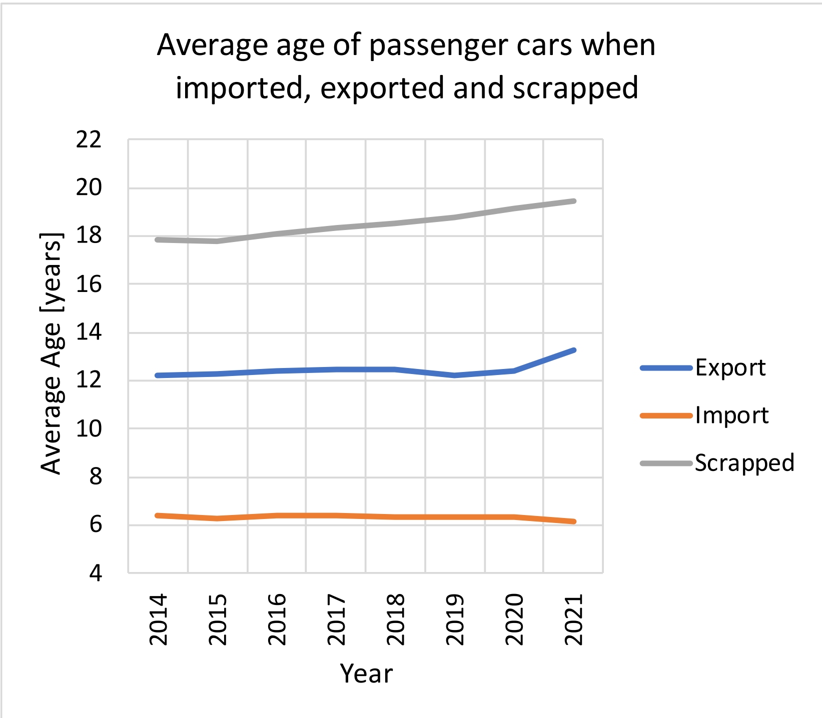


Figure 9: Average age of passenger vehicles when imported, exported and scrapped.

The increase in average age of passenger cars can be attributed to the following factors:

1. Total inflow has been increasing while at the same time the share of imports in the inflow has been increasing as well which entails that to some extend imports are increasing at the expense of newer vehicles. Also this means that the average age of inflow increases, which results in a higher average fleet age and reduces the effect of the higher inflow.
2. The number of exported vehicles has been on the rise since 2014 while the age has remained more or less constant and only increases per 2020. This leads to a decreasing effect on average fleet age.
3. Another reason for increase in the age of the fleet of passenger cars is the increase in the average age of scrappage of vehicles. Passenger vehicles remain in the fleet for longer which in turn also causes the average age of the fleet to increase.
   See Figure 9.

The increase in age of the passenger car fleet shows that there is a market for older passenger cars in the Netherlands and that it is growing. Since 2021 there is a particulate matter premium on old diesel cars, but there are no policies targeted at older petrol vehicles with relative high CO_2 emissions. Further analysis into the fleet age developments of the passenger car fleet can show where the highest growth has taken place and whether additional policy measures are necessary.

Fuel specific average age of passenger cars

Figure 10 shows the fuel specific average age of passenger cars in the Netherlands.
The average age of diesel cars has also been increasing after remaining constant until 2017. This can be attributed in part to the fact that the number of new diesel registration have been falling from 2018 onwards, see Figure 3. For petrol cars, the average age has increased with about one year since 2014.

The increase in age of diesel passenger cars and the low influx of newer diesel cars entails that on average the older diesel car is more polluting as the diesel fleet as a whole does not keep getting cleaner. However due to a shift away from diesel the total impact of diesel passenger cars is shrinking.

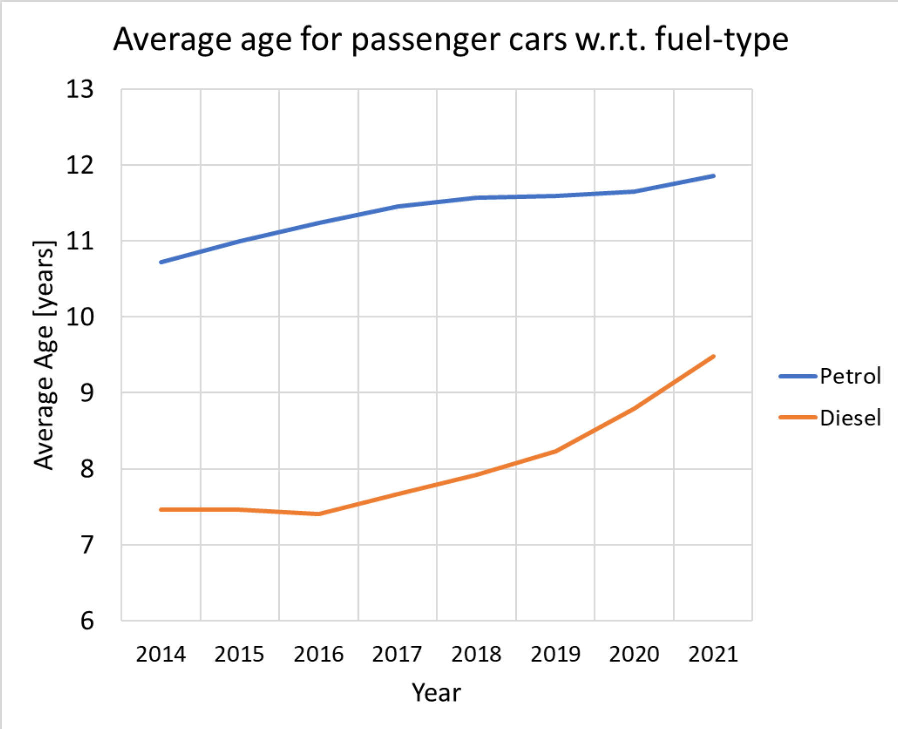


Figure 10: Average age of passenger cars for diesel and petrol passenger cars, showing a substantial increase of the age of diesel vehicles since 2016 of about four months per year.

2.3 Trends in Euro 5 and before vehicle groups and their impact on total emissions

All vehicles with a combustion engine contribute to the CO_2 emissions of transport and hence to the climate problem. There is an improvement in energy efficiency of about 2%-3% per year, but this is largely counteracted by the increase in weight of vehicles [11]. Hence with a shift to substantially larger and heavier vehicles the CO_2 emissions will increase substantially. For environmental and health benefits there are larger differences. Diesel vehicles without a particle filter are the main contributors to ultrafine particles in the air, which are known to cause cancer. For diesel passenger cars this is roughly before 2008, for vans it is before 2011, and form trucks and tractors this is before 2014. Diesel vehicles are also the main contributors of NO_x emissions. The legislation to reduce NO_x emissions is later, and the effects are less significant than for particle emission. Basically, around 2016 lower NO_x emissions were measured in real-world conditions, and from 2019 diesel passenger cars and vans were significantly cleaner than the previous generations due to the introduction of RDE regulations.

Hence, the development of these high emission vehicle categories in the fleet is important to follow, as they dominate the environmental and health impact.

[11] TNO, 2021. Trend in Energy efficiency of conventional petrol and diesel passenger cars. R11642

The methodology used to calculate the total NO_x, CO_2 and PM is based on the emissions factor per VERSIT class[12] and the kilometres driven by same VERSIT class based on emissieregistratie[13]. This helps quantify the effects of the different Euro-classes on the total emissions. It is known that older vehicles may contribute less to the total mileage, but diesel vehicles typically drive more than petrol vehicles.

Figure 11 through Figure 13 show the share that diesel passenger vehicles have on the total NO_x, CO_2 and exhaust-PM of light-duty vehicles. The trend in CO_2 is very similar to the trend in the fleet but it is not the same with the other pollutants. NO_x on the other hand, does not follow the same trend. Vehicles in the category of Euro 4 and older and Euro 5 contribute a lot more. For instance, Euro 4 (and older) and Euro 5 passenger vehicles together were about 15% of the total LDV fleet (including passenger cars and vans) in 2014 and contributed to about 38% of total NO_x. This changed to the group accounting to about 8% of the total LDV fleet and contributing to about 20% NO_x in 2021. Especially the contribution of Euro 5 vehicles stands out where about 4% of the vehicles contribute to about 14% of the total NO_x of the LDV fleet in 2021. A worse trend is the case for exhaust-PM emissions. Here, the group Euro 4 (and older) are dominant. This group contributed to about 38% of the total LDV exhaust-PM emissions in 2014 and still are responsible for 20% in 2021. Because the rest of the fleet is getting cleaner, these vehicles, albeit a small group, remain dominant in the emissions. The staggering effect of this small group of vehicles on the total exhaust-PM emissions is quite detrimental to health. On the other hand, the noticeable improvements from Euro-6a to Euro-6d can be seen clearly. Euro-6d contributes very little to the total NO_x even though it drives much more kilometres.

As can be seen in Figure 12, Euro-6d passenger cars drive 1.6% of all LDV kilometres but contribute to only 0.1% of all NO_x emissions. This is also an improvement from Euro-6a (until Euro-6c) passenger cars which drive 6.6% of the total LDV kilometres and contribute to about 8% of the NO_x emissions, clearly showcasing the improvements in the technology to prevent excessive NO_x emissions.

[12] VERSIT classes are classes of vehicles that are grouped based on emission relevant technical vehicle attributes
[13] Emissieregistratie calculates all relevant emissions in the Netherlands. More information can be found on Alle emissiegegevens op één plek | Emissieregistratie More information can be found on Alle emissiegegevens op één plek | Emissieregistratie

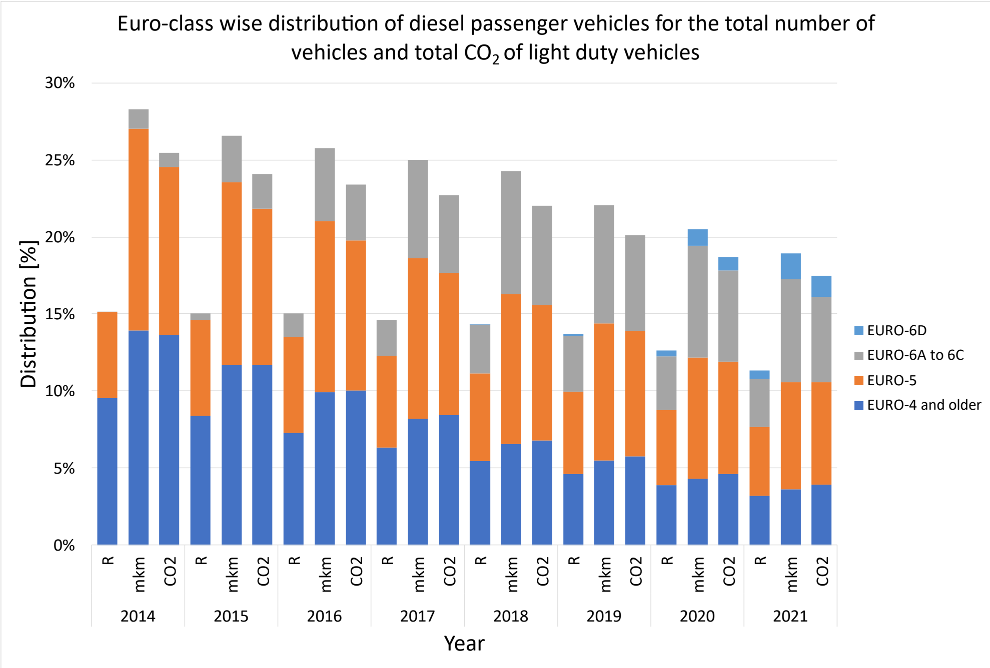


Figure 11: Distribution of diesel passenger vehicles per Euro-class for the total number of vehicles (represented by R), the total kilometers driven and total CO_2 based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

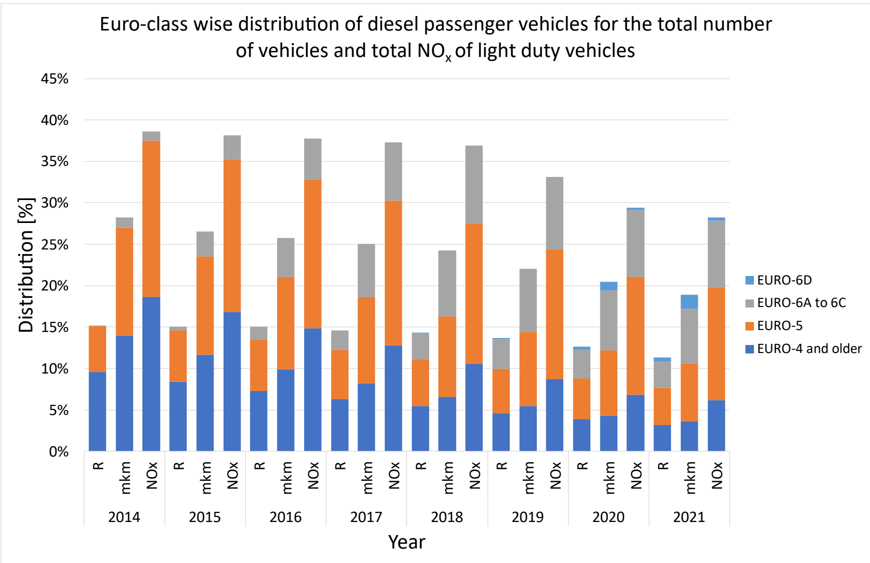


Figure 12: Distribution of diesel passenger vehicles per Euro-class for the total number of vehicles (represented by R), the total kiloemters driven and total NO_x based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

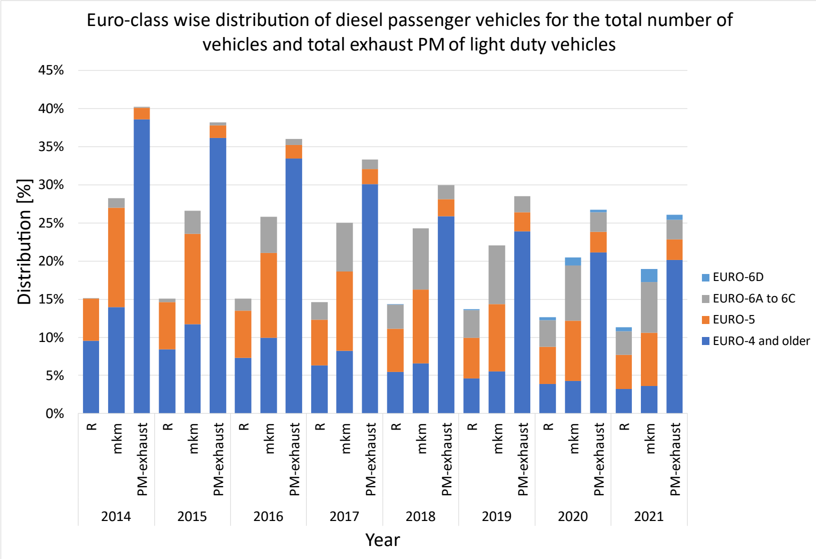


Figure 13: Distribution of diesel passenger vehicles per Euro-class for the total number of vehicles (represented by R), the total kilometers driven and total exhaust-PM based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

Following the analysis of the Euro 4 and Euro 5 diesel vehicles, it is also important to shed some light on the high emitter category of vehicles[15]. The introduction of the three-way catalyst and the soot-filter have been of primary importance in reducing the emissions of both NO_x and PM_{10}. The table below (Table 1) shows the share of such high emitting passenger cars and how much they contribute to the total NO_x and PM_{10} along with a projection of how the fleet evolved over time. It is quite alarming to see the contribution of these high emitting vehicles on NO_x. In 2021, 12% of the vehicles accounted for about 36% of the total NO_x emitted by passenger cars. Although this number is predicted to reduce in the future, the disproportional share is to be noted. The case for PM is also similar but on a smaller scale. For PM_{10} emissions, in 2021, 2% of the vehicles account for about 8% of the PM_{10} emissions of passenger cars. This is over a three-fold higher contribution by this category of vehicles to the PM_{10} emissions. It is important to note that the absolute numbers for 2022, 2025 and 2030 are derived from the KEV2021VV. Although these numbers might not be entirely true the shares of older vehicles (high NO_x and high PM_{10} vehicles) still is expected to be quite accurate.

Table 1: Share of passenger vehicles per fuel-type along with the share of emissions (NO_x and PM_{10}) of high emitting passenger vehicles in the passenger car fleet. The data also represents the projections for the years 2022, 2025 and 20230 based on KEV21VV. Absolute numbers are rounded to thousands.

	2019	2020	2021	2022	2025	2030
Total fleet of passenger vehicles	8,992,000	9,118,000	9,215,000	8,843,000	9,116,000	9,519,000
Share of fully electric vehicles	1%	1%	2%	3%	5%	10%
Share of Petrol and Gas vehicles	84%	85%	85%	86%	86%	86%
Share of Diesel vehicles	15%	14%	13%	11%	8%	4%
Number of high NO_x emitting vehicles	1,311,000	1,203,000	1,097,000	861,000	436,000	424,000
Share of high NO_x emitting vehicles	15%	13%	12%	10%	5%	4%
Share of NO_x of high emitters compared to total NO_x of passenger vehicles	39%	36%	36%	33%	25%	17%
Number of high PM_{10} emitting vehicles	298,000	254,000	211,000	173,000	91,000	59,000
Share of high PM_{10} emitting vehicles	3%	3%	2%	2%	1%	1%
Share of PM_{10} of high emitters compared to total PM_{10} of passenger vehicles	11%	9%	8%	7%	3%	2%

2.4 Particulate matter tax[14]

As stated earlier, as of 2021 a new regulation is in force which requires older diesel vehicles to pay a particulate matter premium.

This tax needs to be paid for by passenger car based on the following conditions:

1. For a diesel passenger car with an approval according to the LD regime, the particular matter emission is higher than 0.005 gram/km
2. For a diesel passenger car with an approval according to the HD regime, the particular matter emission is higher than 0.01 gram/kWh.
3. If the date of first registration if before 1 September 2009 and the particulate matter emissions have not been recorded in the vehicle registration of the RDW.
4. When the particulate matter filter[15] has been removed.

The method of approving light-duty vehicles is not always straightforward. Most passenger cars are approved following a LD approval regime and only a limited number of passenger cars are approved according to the HD regime. Table 2 shows that from all vehicles of which the type approval is known more than 99.8% of the vehicles are approved according to a LD regime. However, the data quality of this field is expected to be rather low which makes that this number is to be interpreted with precaution.

[14] In Dutch, fijnstoftoeslag
[15] In Dutch, roetfilter

Table 2: Type approval according to the light and heavy-duty regime for passenger cars

Vehicle Type	No Approval	Light-duty regime	Light and Heavy-Duty regime	Heavy-Duty regime	Total
M1	1101278	8382242	343	11331	9495194
M1	11.6%	88.3%	0.0%	0.1%	100.0%

For years the government subsidized the retrofitting of diesel vehicles with soot filters. With the introduction of Euro 5 (2009) soot filter were mandatory. As part of the APK these filters were only visually inspected. As of 2023 the APK test prescribes a particle counter test in order to inspect the performance of the soot filter.

In some circumstances (e.g., a broken soot filter) it is allowed to remove the soot filter. Roughly half of the diesel vehicles with year of construction 2007 have a soot filter installed. As of 2009 with the introduction of Euro 5 all diesel passenger cars are assumed to have factory fitted soot filters. At the upper end only vehicles with a registration date before 01-01-2017 are allowed to remove the soot filter[16].

As of 2022 about 14.000 passenger cars qualify for a particulate matter surcharge based on the fact that they have had their particulate filter removed, see Figure 14. Potentially the number of diesel vehicles that have not yet removed their soot filter but could do so given de above year range amounts to a potential of more than 600.000 vehicles.

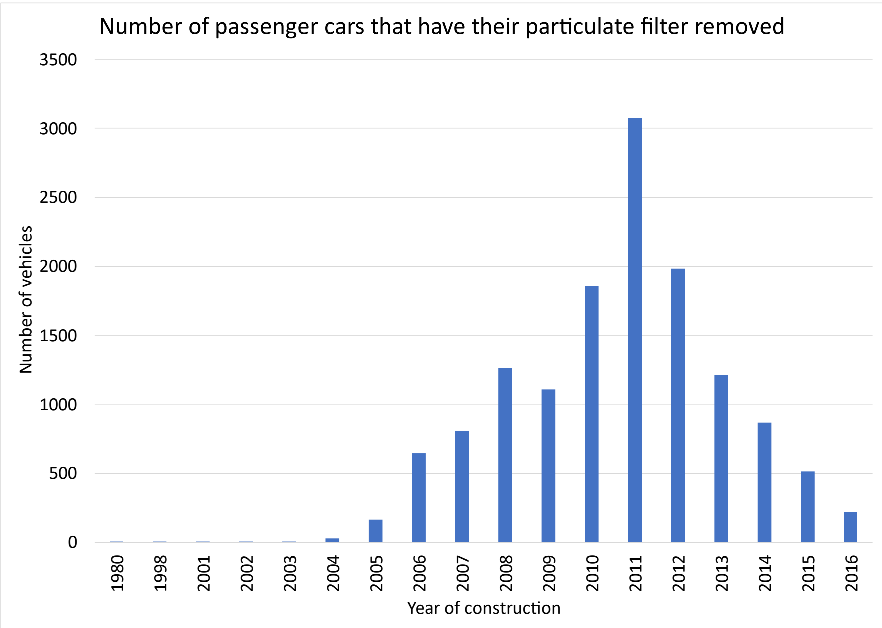


Figure 14: Number of passenger cars of which the particulate filter has been removed.

According to conditions 1, 2, and 3 there are about 132,000 passenger cars that qualify for the particulate matter surcharge in the active fleet as on January 1, 2022 (Figure 15).

[16] Uitstoot dieselauto's RDW | RDW

Including also the vehicles that have their soot filter removed results in a total of 146,000 vehicles. It is important to note that none of the vehicles that have been classified to pay the particulate matter surcharge are vehicles which are registered as vehicles that have their particulate filter removed.

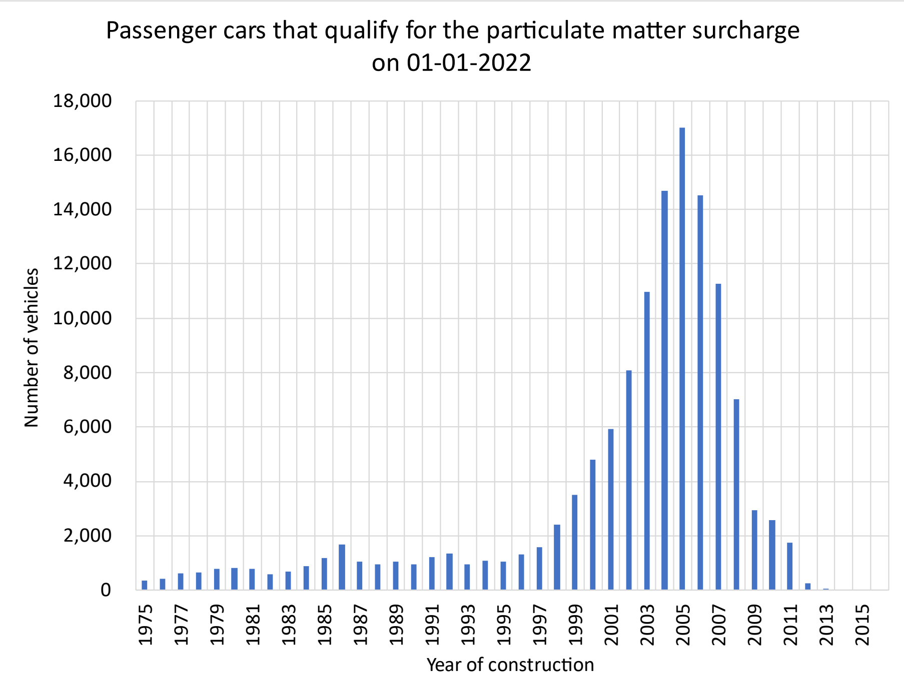


Figure 15: Number of passenger cars that qualify for the particulate matter tax based on their emission value - as described in condition 1, 2, and 3 above.

Based on KEV 2022 data an estimate is made for the number of vehicles eligible for the particulate matter surcharge in 2025 and 2030. In the analysis it is assumed that the share of vehicles that are eligible for the surcharge per year of construction remains constant. Based on our estimate in 2025 more than 90.000 vehicles will be eligible and potentially another almost 450.000 vehicles could potentially remove their soot filter. For 2030 this is more than 50.000 vehicles that are expected to have to pay the surcharge and another 130.000 could be eligible if these vehicles have their soot filter removed.

2.5 Trends in ownership of passenger cars

This section is based on the mutation data until 2019 and addresses the ownership of vehicles. The data shows how the fleet changes and how households change their vehicles. Since this section is based off of data until mid-2019, further research into this with more recent data would lead to further in-depth understanding of ownership of vehicles and how it changes over the life of the vehicle. The mutations considered for the analysis in this section highlights all the household transactions of vehicles between 2016 and 2019, i.e., all vehicles sold between 2016 and 2018 and all vehicles bought between 2016 and 2019. The year-on-year changes are limited and do not provide a clear trend hence a cumulative effect for these years are presented in this section. The number of transactions that were analysed using this data was roughly 2.3 million for passenger cars and 53 thousand for vans.

The trends in this section are based on how vehicles are changed within a household. A vehicle is defined as a new (or next) vehicle if it has replaced a previously owned vehicle in a household. This gives insight into what kind of vehicle follows in preference for a household looking to change their old vehicle. This is quite crucial for the understanding of buying behaviour of people and what factors play a role in deciding the new (or next) vehicle. The ownership trends are analysed for privately owned vehicles and do not include leased or business-owned vehicles. The reason of which is that lease vehicles are most often registered at the address of the lease company which entails that a shift towards a new vehicle cannot be analysed at the driver level. This is a limitation of the current analysis.

2.5.1 Vehicle age

When looking at the age of the vehicles and how it influences the choice of the next vehicle, it can be seen from Figure 16 that the households that sell their older car from ages 1 until 9 years usually end up buying a newer vehicle aged 0 to 1. There is a middle group that sells their car aged 6 to 15 years and replace it with a newer 2 to 10 year old car. A third group that can be identified from the figure is the group that sells their older vehicle aged 13 to 18 years old and buys a next car aged 10 to 17 years old to also buy the next car which is also quite old – selling the older car aged 13 to 18 and buying the next car aged 10 to 17 years. This last group of people is the group that is generally interested in buying older vehicles. More research is needed to find out what drives vehicle choice for this group in order to understand how this group can be influenced to choose cleaner and more fuel-efficient vehicles.

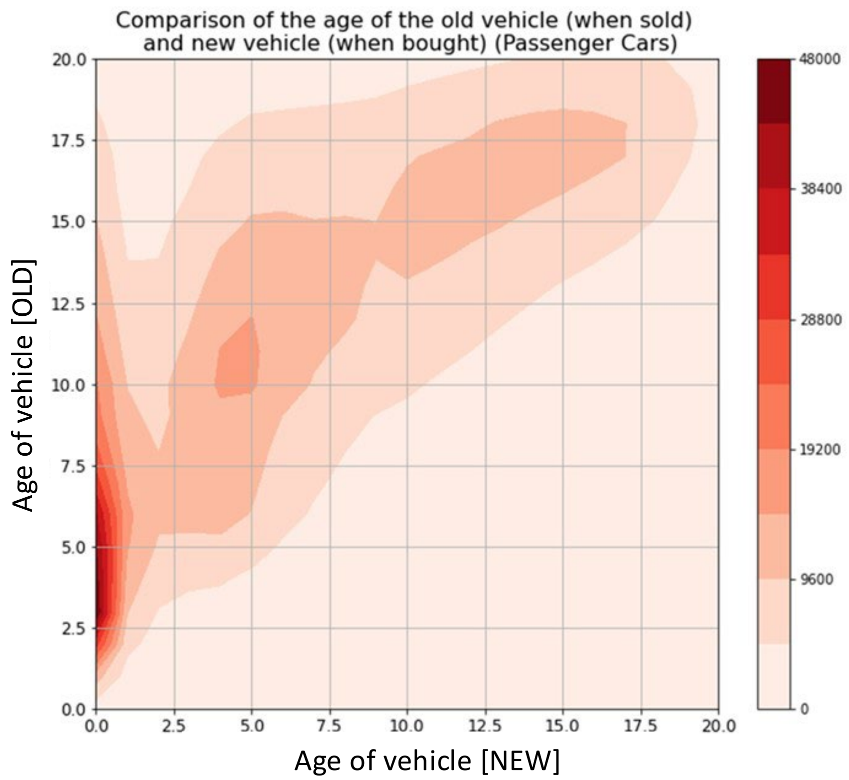


Figure 16: The age distribution of passenger vehicles when they change an owner, i.e., what is the age of a passenger car when it is sold and the age at which a passenger car is bought. The figure shows the cumulative effect between 2016 and 2019.

2.5.2 Vehicle mass

The next variable that is also interesting to look at is the mass of the old and the new replaced vehicle. As can be seen in Figure 17, households buy heavier vehicles when they replace their older vehicle. This can be attributed to either vehicles becoming bigger in general or people having a preference for heavier vehicles or having more features in it thereby making it heavier. Two developments are expected to be the main driver of the increase in vehicle weight. These are the shift to heavier SUV's and crossovers and a shift to (hybrid) electric vehicles. According to the BOVAG/RAI the share of SUV's in the new vehicle sales has increased from 19% in 2016 to 28% in 2019[17]. Since the analysis is limited to data until mid-2019 and the uptake of electric vehicles at this stage was rather limited, the main reason is expected to be the shift towards SUV's.

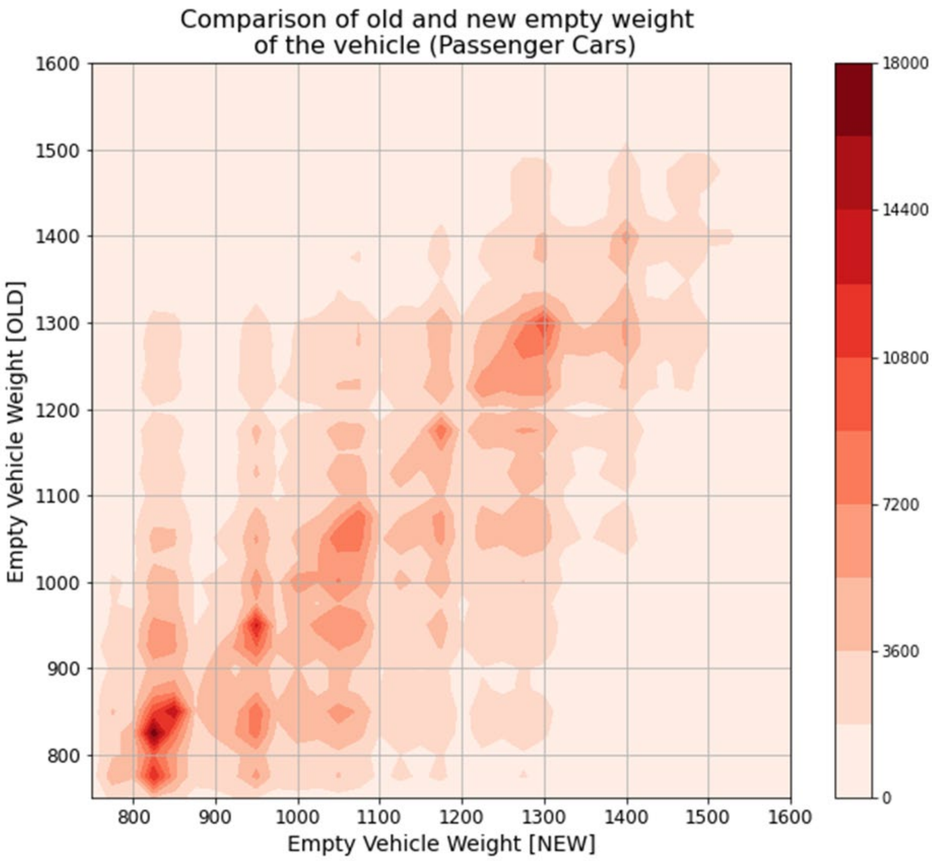


Figure 17: The mass distribution of passenger cars when they change an owner, i.e., how does the mass of the older car compare with the next vehicle bought by a household. The figure shows the cumulative effect between 2016 and 2019.

2.5.3 Brand loyalty

The question of brand loyalty is also addressed in Figure 18. Each horizontal row in the plot adds up to 1. The figure shows the top 10 brands based on number of transactions available in the dataset. As can be seen until 2019, the brand was also a major factor influencing the choice of the next vehicle for households. From the figure it appears that the brand loyalty is strongest for Toyota with a retention of 60%. For the top 10 of brands sold the lowest loyalty is found for Fiat where only 28% of households who owned a Fiat again buys a Fiat.

[17] Mobiliteit-in-Cijfers-Auto-2022-click.pdf (bovag.nl). see page 19.

People have a tendency to stick to the brand they had previously or at least have a heavy preference for it. They are not very likely to change the brand of the vehicle when they buy their next vehicle. There is a possibility that this trend is no longer valid in the recent years as certain other brands have made good progress in their electric fleet but this can be analysed only with newer data.

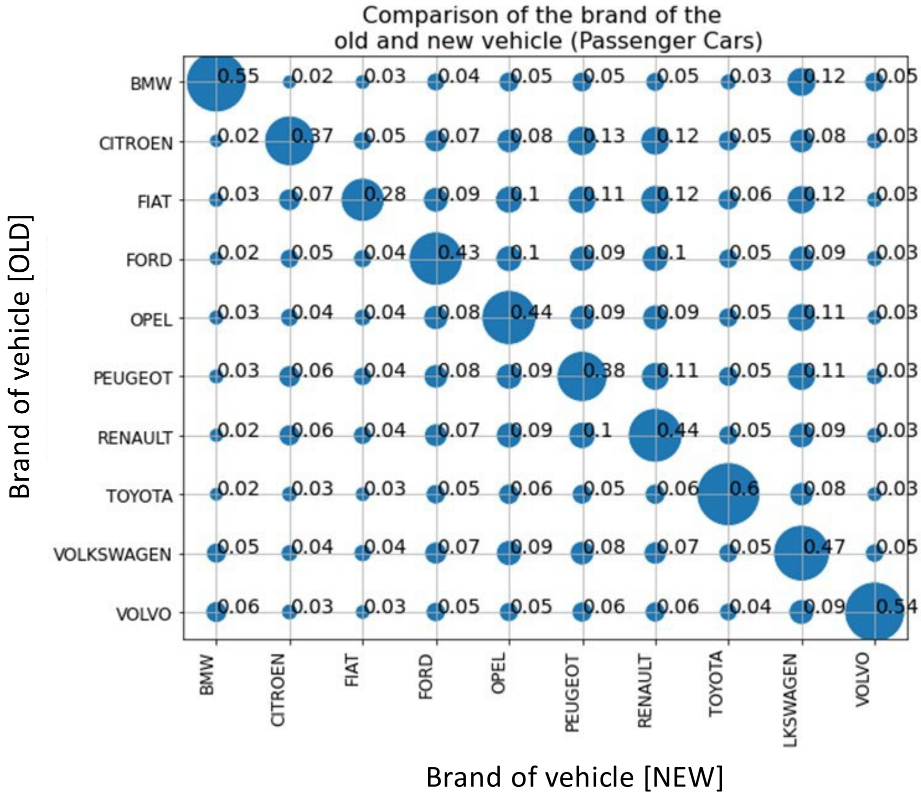


Figure 18: The brand loyalty of passenger cars when they change an owner, i.e., how does the brand of the older car compare with the next vehicle bought by a household. The figure shows a share of older vehicles and how likely are they to have the same or different brand to the next vehicle. The figure shows the cumulative effect between 2016 and 2019 based on the top 10 brands traded.

2.5.4 Vehicle fuel-type

The fuel-type of the vehicle is another factor that is largely important. Figure 19 gives further information on how an old vehicle is replaced by the next vehicle in a household based on the fuel-type. The figure shows the share of replacement of the old vehicle. Each row in the scatter plot adds to 1 (if not, it is a rounding error) thereby implying how likely it is for a particular fuel-type car to be replaced by the same fuel-type or be changed to some other fuel-type for the next vehicle. It is to be noted that this is based on analysis of data until 2019 and can be further enriched with newer data. The fact that the preference for petrol vehicles still dominates the choice of fuel-type of the vehicle is notable. The majority of households replace their older car with a petrol vehicle. 91% of the petrol cars are again replaced by a petrol vehicle. 56% of the households which had a diesel vehicle end up replacing it with a petrol vehicle while 42% of them buy a diesel vehicle again. Another interesting trend is the households that had an electric vehicle. Only 41% replace it with another electric vehicle while 40% of them change it for a petrol vehicle. This implies that this group of people somehow were not completely satisfied with their electric vehicle.

However, one should be cautious with interpreting this number since this is based on data until mid 2019 and the electric vehicles that are bought and traded again in this period are expected to be first generation electric vehicles which are different from today's electric vehicles.

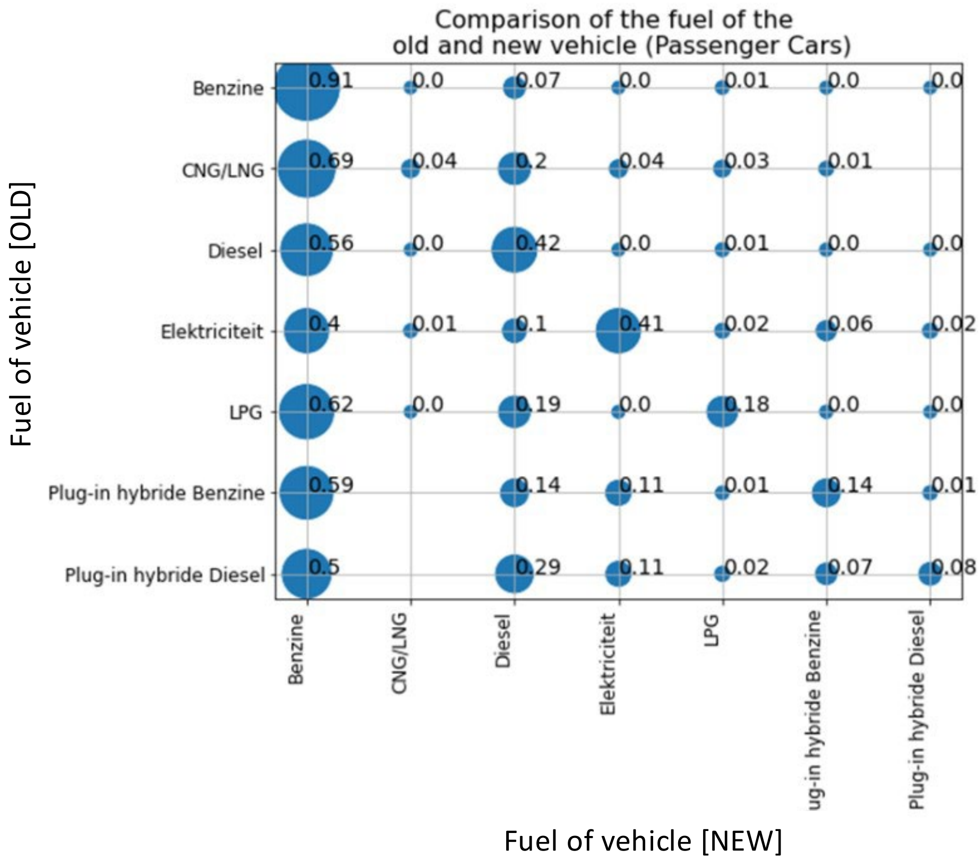


Figure 19: The fuel-type of passenger cars when they change an owner, i.e., how does the fuel-type of the older car compare with the next vehicle bought by a household. The figure shows a share of older vehicles and how likely are they to have the same or different fuel to the next vehicle. The figure shows the cumulative effect between 2016 and 2019.

2.5.5 Ownership status

The ownership status of vehicles is another interesting thing to analyse. Figure 20 shows how likely it is that people replace their current vehicle with a used vehicle or a new vehicle. Each row in the scatter plot adds to 1 (if not, it is a rounding error) thereby implying how likely is it for a particular ownership-type of a car to be replaced by the same ownership-type or be changed to some other ownership-type for the next vehicle. 4 different types of ownership have been defined for the sake of analysis. A vehicle could be new, which means it was first registered in the Netherlands as a new vehicle. It could be a used vehicle which is a vehicle that has been registered at some other address (inside the Netherlands) before it is registered at the current address. It could be a first owned imported car in the Netherlands, i.e., the vehicle had a previous owner outside the Netherlands but it is registered under its first owner in the Netherlands. The last is the used imported vehicle which is an imported vehicle but has been registered with one (or more) owners in the Netherlands before its current address of registration. From the analysis it appears that only 50% of the people who had a new vehicle again buys a new vehicle. The other 50% opts for some kind of used vehicle.

This also is an explanation of why the (privately owned) new sales are diminishing (Figure 4 and Figure 5). In part this can also be due to a shift from privately owned new vehicles to private lease new vehicles which at least in part are registered as business vehicles. Also it is quite interesting to see that people have a big preference for a used car thereby implying that the second-hand market in the Netherlands is quite big and plays a major role in deciding how the fleet in the country is evolving. 93% of the people having an older vehicle (used vehicle) end up buying a used vehicle as well.

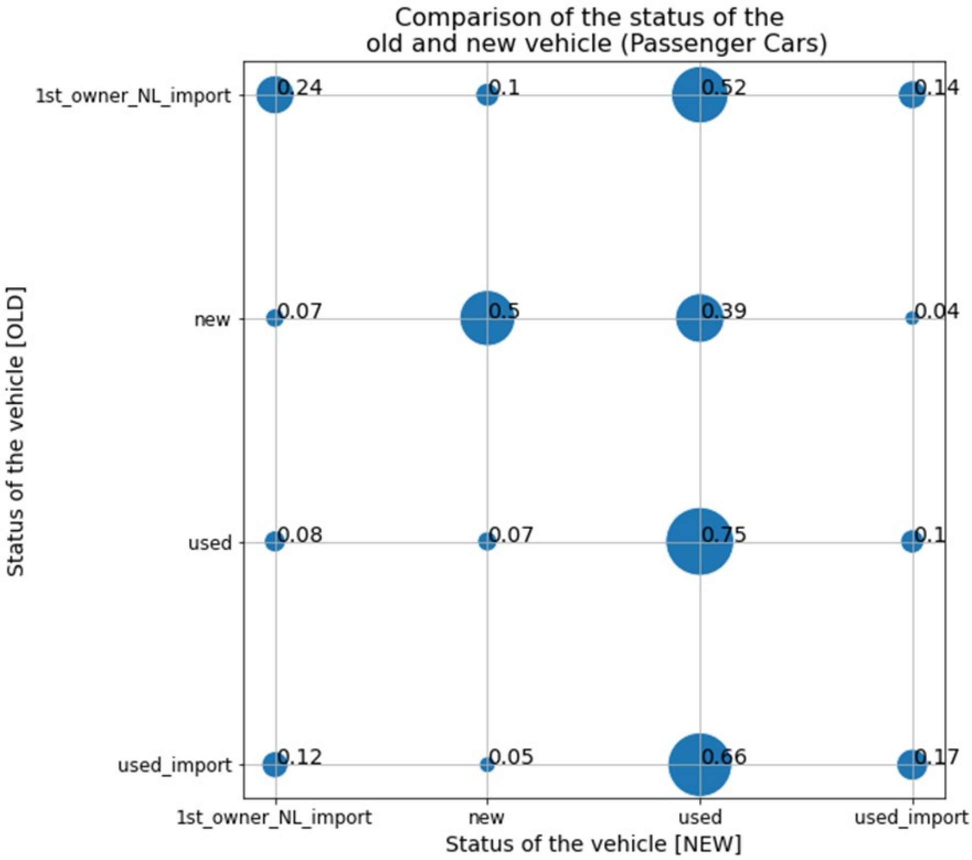


Figure 20: The type of ownership of passenger cars when they change an owner, i.e., how does the type of ownership of the older car compare with the next vehicle bought by a household. The figure shows a share of older vehicles and how likely are they to have the same or different ownership-type to the next vehicle. The figure shows the cumulative effect between 2016 and 2019.

2.6 Climate Actions

2.6.1 Comparing the effect of Plug-in Hybrid vehicles with the average passenger vehicle

Plug-in hybrid electric vehicles (PHEVs) aim at reducing the total CO_2 emissions. That was indeed the case soon after they were introduced but the real-world emissions of Plug-in Hybrid vehicles have been on the rise since until 2018 where its real-world emissions are about the same as the real-world emissions for passenger cars with internal combustion engines.

From 2018 onwards the real-world CO_2 emissions of PHEVs are about the same as for ICE vehicles and in 2021 it was observed to be even higher than the ICE vehicles. Partly this is due to the fact that the average Plug-in Hybrid vehicle sold in the Netherlands is bigger and heavier compared to the average sold internal combustion engine (ICE) vehicle. Also, while real world CO_2 emissions of both ICE and PHEV vehicles are influenced by variables such as driving behaviour and ambient temperature, for PHEVs this is also influenced by charging behaviour. A recent study found that around 12-34% of PHEV kilometres are driven electric[18] while in the WLTP test the share of electric kilometres is assumed to be much higher. As a result, PHEVs may seem as a novel strategy to reduce CO_2 emissions while reality shows otherwise. A thorough review of the WLTP type approval for PHEV's might be necessary to address this issue.

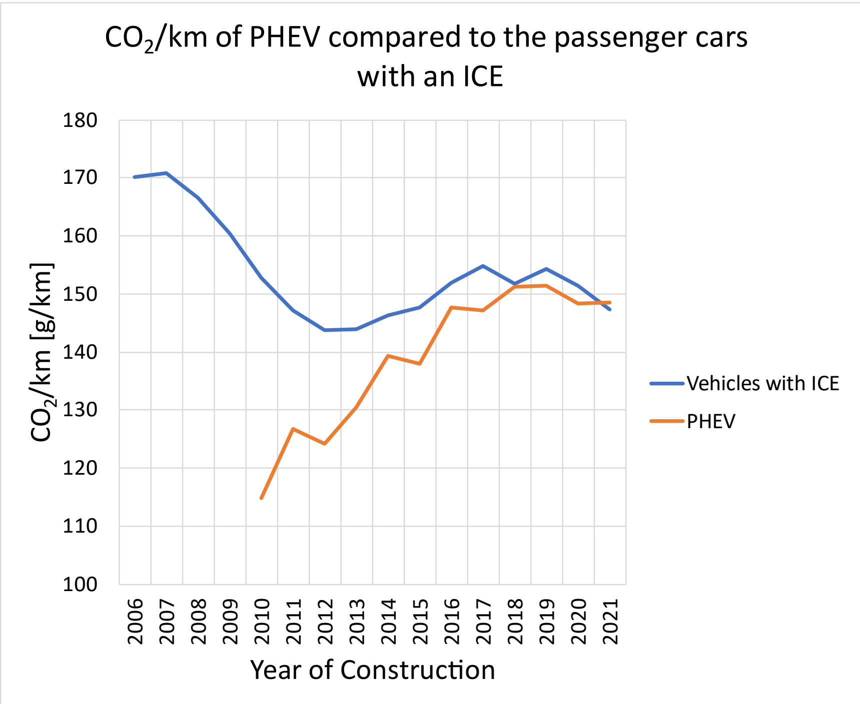


Figure 21: Real-world CO_2/km of Plug-in Hybrid vehicles compared to the total passenger vehicles

Since the mass of PHEVs is known to be higher than the mass of an average ICE vehicle, also the real-world CO_2 emissions per kilogram of vehicle mass has been studied. From Figure 22, it can be seen that the CO_2/kg of PHEV vehicles is indeed less than that of vehicles with an ICE. This does imply that the PHEVs are with regard to their mass cleaner than a comparable conventional car but it does not change the fact that they are more polluting in terms of CO_2 emissions when compared to an average conventional passenger car. It can also be seen that there have been improvements in the CO_2 emissions per kilogram of vehicle mass of ICE vehicles over time whereas the CO_2 emissions per kilogram of vehicle mass of PHEVs has remained the same.

[18] Real-world fuel consumption and electricity consumption of passenger cars and light commercial vehicles – TNO report 2022 R10409

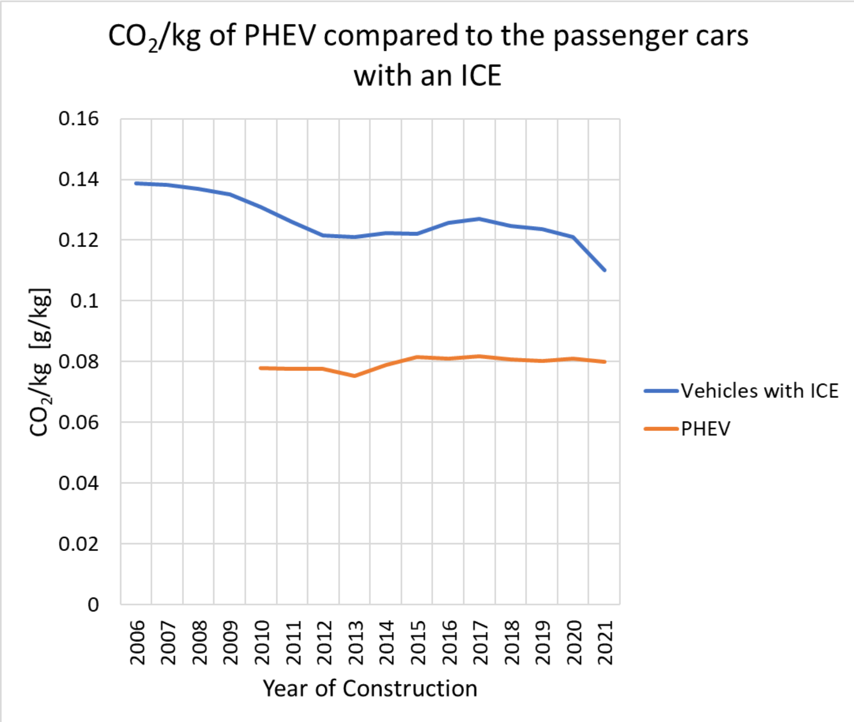


Figure 22: Real-world CO_2/kg of Plug-in Hybrid vehicles compared to the total passenger vehicles

2.6.2 Comparing the effect of import, export and new passenger vehicle

An interesting phenomenon in the export of lease vehicles can be seen. There is a big outflux of vehicles in the 3-6-year age[19]. To quantify this, this group was represented separately from the export group. Figure 23 shows that during the period 2013-2018 the average CO_2 emission of 3-6-year-old exported vehicles are lower than the exported group and in more recent years this gap has increased. It is noticed that the export of 3 to 6 years old in the period 2013-2018 also has lower CO_2 emissions than the average new sales of the year considered. Which means that the vehicles with lower CO_2 emission than average are exported. For 2014 up until 2017 this also applies to the average CO_2 emissions of all exports. The analysis shows that for a given the vehicles with lower CO_2 emissions than average are exported rather quickly. This is most likely due to a mismatch between the company car fleet and the private car fleet, which emphasises the need for policies for company cars to be directed at cars that are in demand in the private car market.

In Figure 23 also the average CO_2 emissions of the imported vehicles is shown. It shows that imported vehicles are quite less fuel efficient and have always been more fuel consuming than all the other groups but seem to be getting more fuel efficient in the recent years.

[19] See Figure 1. of Schoon wagenpark vraagt om meer naast stekkersubsidie. Milieu en klimaat zijn gebaat bij doelgerichte autobelastingen voor het gehele wagenpark, TNO Whitepaper 2021

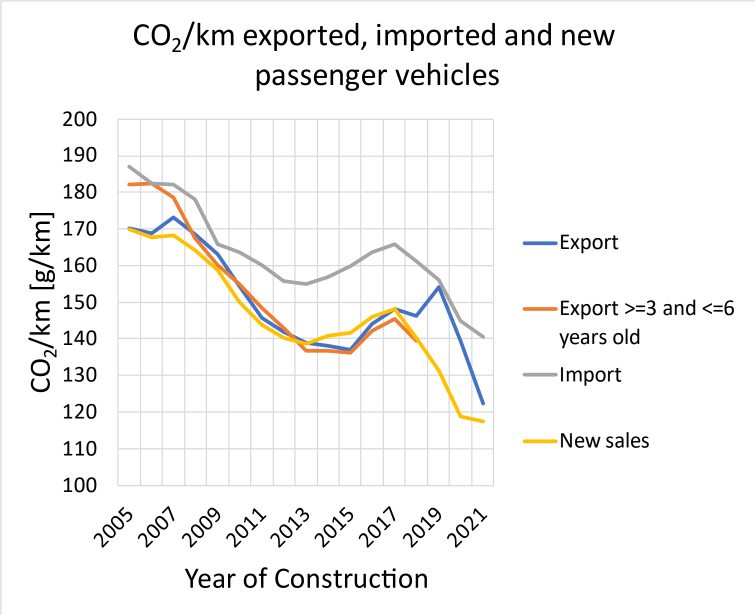


Figure 23: Real-world CO_2/km comparison between imported, exported and new passenger vehicles. The group of vehicles exported in the 3-6 years have been represented separately because of the large number of exports in that age group.

When looking at the environmental impact, the NO_x emissions tell a different story. The group of vehicles that are exported in the 3 to 6 year old age group appear to be contributing a lot more to the NO_x emissions. As can be seen in Figure 24, exported vehicles in general contribute a lot more to the NO_x emissions as compared to the other groups, this is most likely due to a large share of diesel vehicles in exported vehicles. The NO_x emissions of exports has been decreasing from 2013 but has been substantially higher. Therefore, although the CO_2 emissions of exports and more specifically of the exports with age from three to six years are lower than average sales in the period 2013-2018, their NO_x contributions are higher.

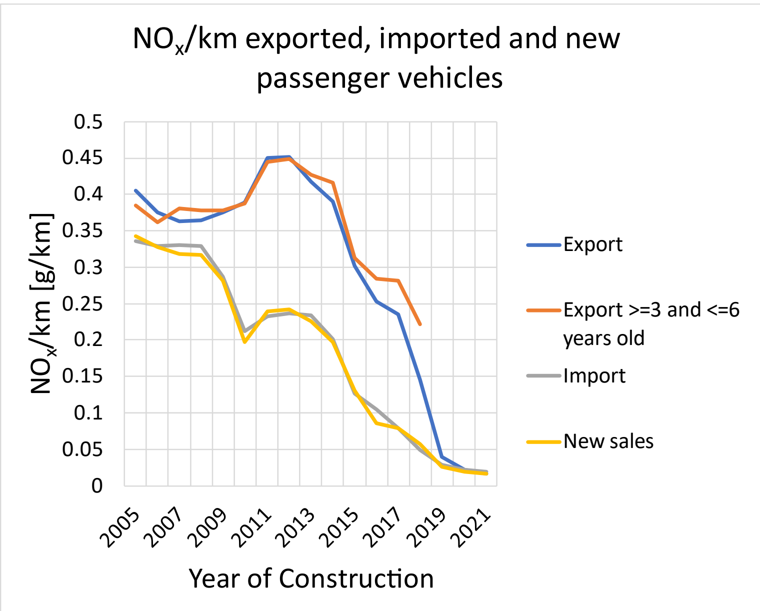


Figure 24: NO_x/km comparison between imported, exported and new passenger vehicles.

2.6.3 Comparison of the Netherlands with Europe

From the European Environment Agency (EEA) dataset, a comparison could be drawn for the CO_2/km of passenger cars in Europe and the Netherlands. It can be seen that the cars sold in the Netherlands have lower NEDC type approval emissions compared to passenger cars sold in other European countries, see Figure 25. The low 2015 type approval emissions of the Netherlands shows the end of discounts in the tax for company cars for conventional vehicles and Plug-in Hybrids with low CO_2 emissions. Resulting in increasing type approval emissions in 2016 and 2017. The lower type approval emissions from 2017 onwards are in part attributed to an increasing share of zero emissions vehicles in Dutch new sales. The real-world difference in CO_2 emissions is unknown due to the scarcity of data on the EU-level.

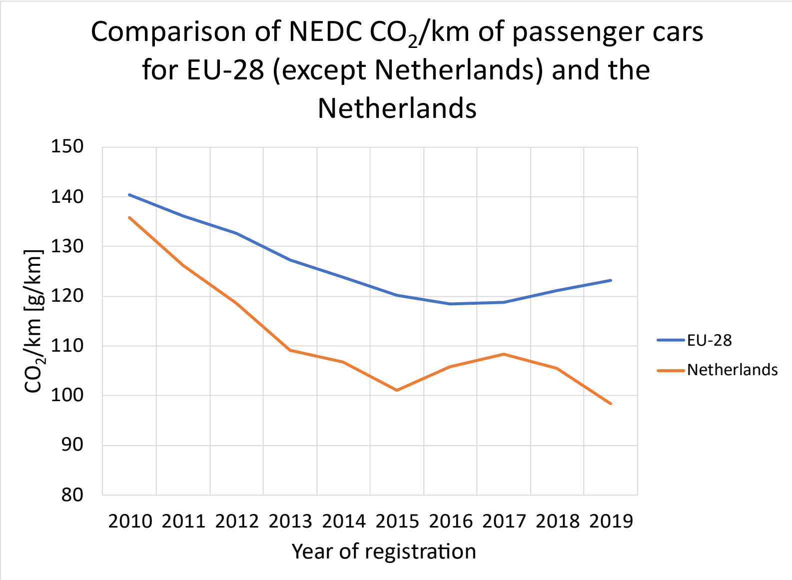


Figure 25 : Comparison of the CO_2/km of passenger cars for EU-28 (excluding the Netherlands) and the Netherlands. Note: UK was still included in this analysis and is considered part of the EU-28.

3 Vans

3.1 Fleet size change

Given the increase in passenger cars per year (Figure 2) is less than the average increase in the LDV fleet (Figure 1), the extra increase lies elsewhere. The van fleet has increased in size more than average, see Figure 26. The increase is almost double the LDV fleet increase. Given the fact that vans are mainly diesel, and substantially larger than passenger cars, the increase in this fleet has negative effects on both the pollutant and the CO_2 emissions. In particular, prior to 2017 diesel vans had very high NO_x emissions and prior to 2011 they had very high particulate matter emissions. Therefore, if the increase of the fleet size is partially due to import of vehicles, and not the sales of new vehicles the detrimental effect on environmental policies is even larger.

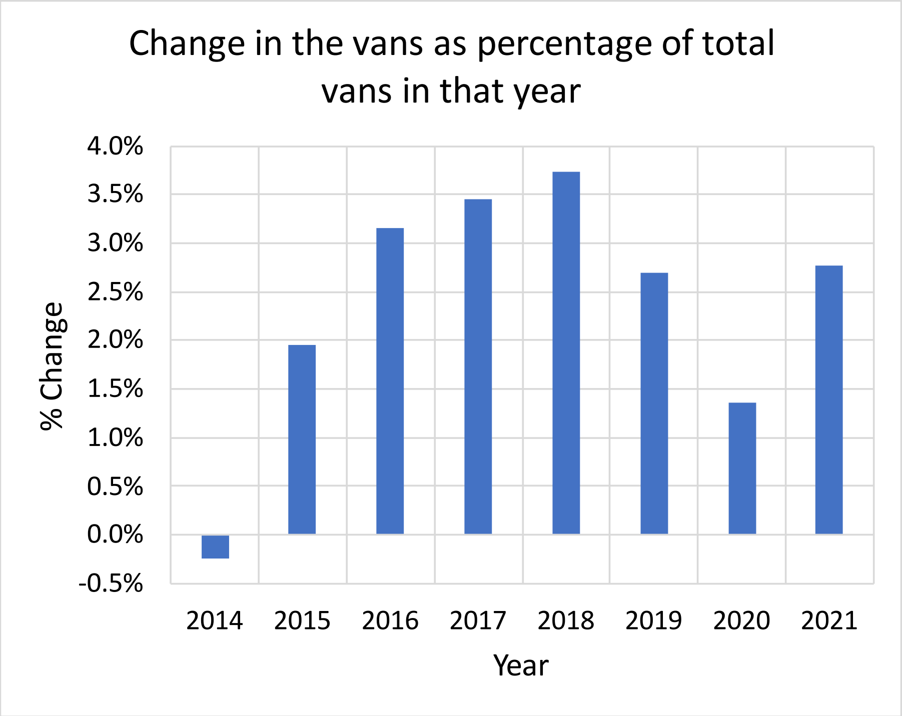


Figure 26: Net change in vans as a percentage of total vans in that year. It shows the change in the van fleet in a particular year as compared to the fleet at the beginning of that year.

Vans see a major increase in terms of the fleet size in the recent past. Until 2019, the vans were steadily increasing at a rate of about 3%-3.5% per year, see Figure 26. Since 2019, there have been over a million vans in the country. The low net change in 2020 can, at least partly, be attributed to COVID-19 and the global chip shortage. 2021 again has a positive increase of about 2.8%, thereby reversing the trend in 2020.

With a growing van fleet, the need for additional measures to stimulate sustainable choices becomes more serious. At this moment vans registered by business owners are exempted from registration tax (BPM).

Annulment of this exemption could help the proposition of, at this point still more expensive, zero emission vans[20]. At the same time this might also lead to an increase in van imports which is expected to have a negative effect on emissions by vans. Also, the ownership tax (MRB) for business owned vans is about 70% lower compared to the MRB tariff of private owners.

The increase in the fleet of vans comes from an increase in both the imported and new vans as can be seen in Figure 27. Although the new vans sees a decrease in 2019 and 2020, mostly due to COVID-19 and the global chip shortages, the increase in imports is unaffected by this. The exports and the scrapped vans, on the other hand, are more or less constant.

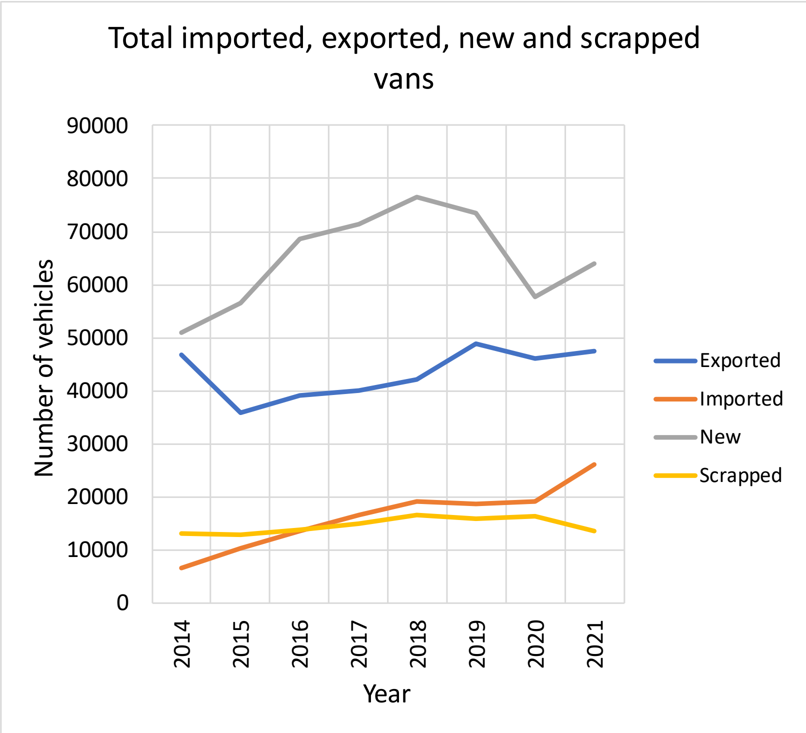


Figure 27: Total imported, exported, new and scrapped vans per year. Increase in the fleet size of the vans is quite evident from the increasing trends in both new and imported vans while the outflow (exports and scrappage) remains almost constant.

Similar to passenger vehicles, vans also see a high share of total new registrations in the form of imports as can be seen in Figure 28. An analysis was performed to analyse this increase in terms of inflow and outflow. Although new vans contribute more to the net inflow, the imports have been constantly increasing. After a steady increase from 2014 where the imports share in the inflow of vans was about 15%, by the end of 2021, this number has risen to about 30%. These are older vehicles with higher emissions when compared to new vans. In 2020 the share of imports in new registrations was about 30% however the dip in new sales might in part be attributed to COVID-19. Compared to 2014 the new sales of vans in 2021 has increased by 25% while imports have quadrupled.

[20] In the “Coalitieakkoord” a phase out of the BPM exemption for business owned vans is announced in the period 2024-2026. See p. 46 of https://www.kabinetsformatie2021.nl/documenten/publicaties/2021/12/15/coalitieakkoord-omzien-naar-elkaar-vooruitkijken-naar-de-toekomst

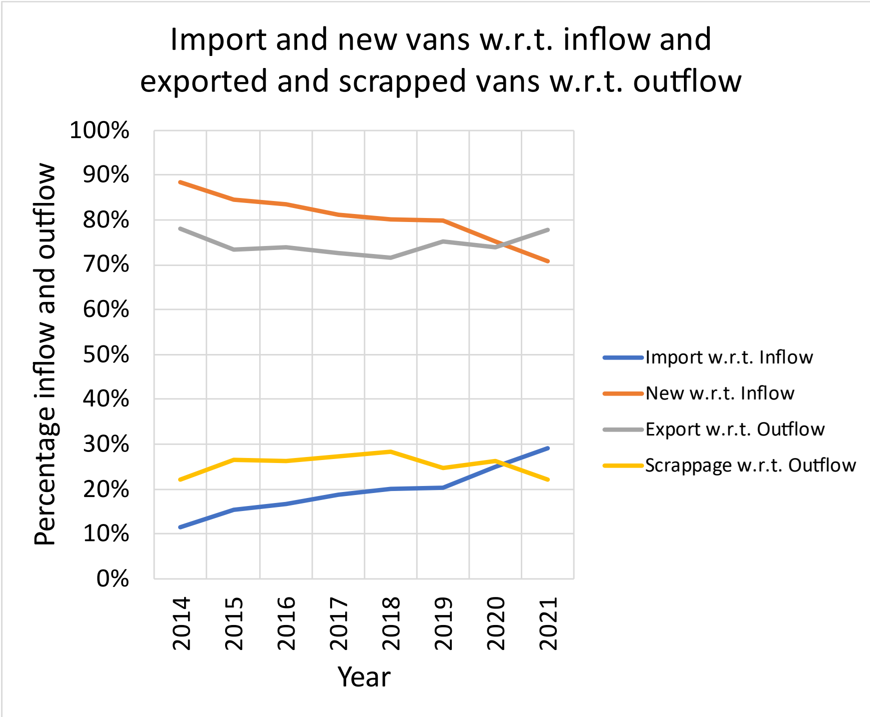


Figure 28: Percentage of imported vans and new vans as a share of total inflow of van registrations in that year and the percentage of exported vans and scrapped vans as a share of the total outflow of van registrations in that year. Total inflow and total outflow both add up to a 100%.

3.2 Average age of vans

Vans are a group that have seen a high growth in the recent years. Along with that, the average age of the van fleet has increased rapidly from 2014 till 2016. From 2016 onwards the average age has remained fairly constant with a minor decrease in 2019 and 2020, see Figure 29. Where the average age of vans in the fleet is 9.6 years in 2014, it has risen to 10.1 years in 2016 and after a short period of rejuvenation the average age has risen to 10.1 years in 2021. Similar to passenger cars, the inflow has been higher than the outflow of vans for years but since the majority of the inflow registrations are still from new vans, the average age of the fleet does not rise as much as is the case with passenger cars. The still increasing share of imported vehicles in the inflow is a factor that might influence the increasing age of the van fleet in the foreseeable future.

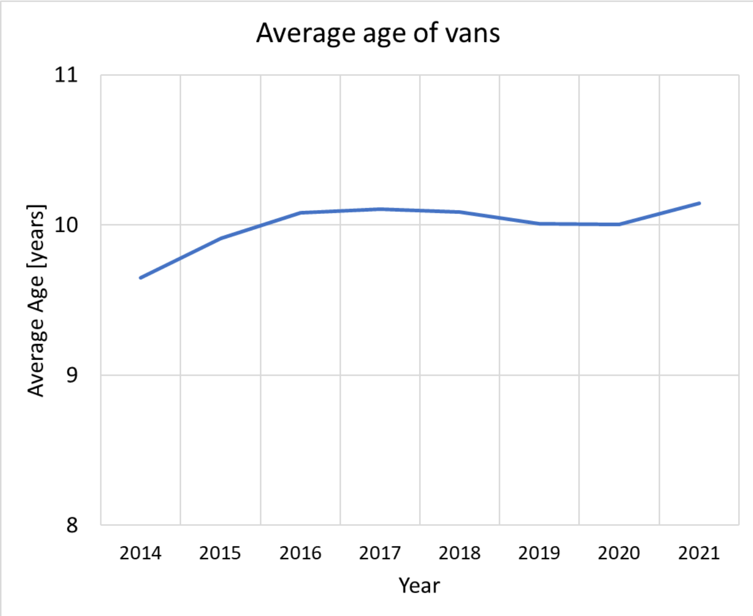


Figure 29. Average age of vans in the Netherlands

Also, from Figure 30 it appears that the average age of van imports is decreasing since 2014, which also contributes to the fact that the average age of vans is fairly constant. It can also be observed that the average age of scrapped vans is increasing year-on-year. This results in an increase of the average age of the fleet by one year over the 2014-2021 timeframe.

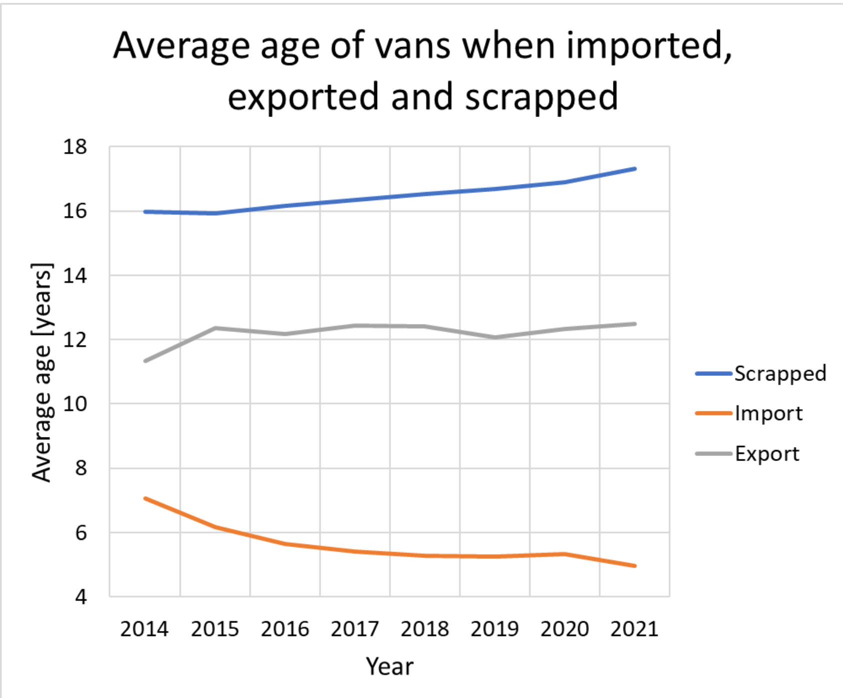


Figure 30. Average age of vans when they are imported, exported and scrapped.

The reasons for the average age of the vans to remain more or less constant can be attributed to the following factors:

1. The inflow is higher than the outflow and it is majorly influenced by the new vans. This makes sure that the average age of the van fleet does not increase. But the increasing imports in the recent years can influence this negatively in the nearby future.
2. The number of scrapped vans in the fleet remains constant (Figure 28) and although they are getting older (Figure 30), they are masked by the newer vans thereby not impacting the average age of the fleet. The flip-side is the fact that this set of vans that stay in the fleet longer are more polluting than a new or a younger imported van and have a major contribution to the overall pollutant emissions from vans. This is further discussed in the next section.
3. The age of imported vans has been decreasing. This also contributes to the effect of the ageing fleet, thereby keeping the average age of the fleet more or less constant.

3.3 Trends in Euro 5 and older vehicle groups and their impact on total emissions

A similar methodology as passenger cars was used for calculating the total real world NO_x, CO_2 and PM_{10} emissions for diesel vans. Van show a similar trend as do passenger cars. Figure 31 through Figure 33 shows the total number of vehicles (represented by R), the total CO_2, total NO_x and total PM_{10}. Every figure shows the share of diesel vans in the total light-duty vehicle fleet and its share in the number of kilometres along with a particular pollutant. This way, it can be inferred what portion of the vans contributes to how much emission in the entire light-duty fleet in the country.

In the case of vans, the trends are more exaggerated than in the case of passenger cars. Euro 4 (and older) and Euro 5 both, stand out for CO_2, NO_x and PM_{10} emissions. It is known that diesel vans drive quite a lot of kilometres hence they contribute a lot of the CO_2. As can be seen in Figure 31, each group contributed CO_2 in the same proportion as the number of kilometres driven But the NO_x and PM_{10} are contributed to in disproportional amounts.

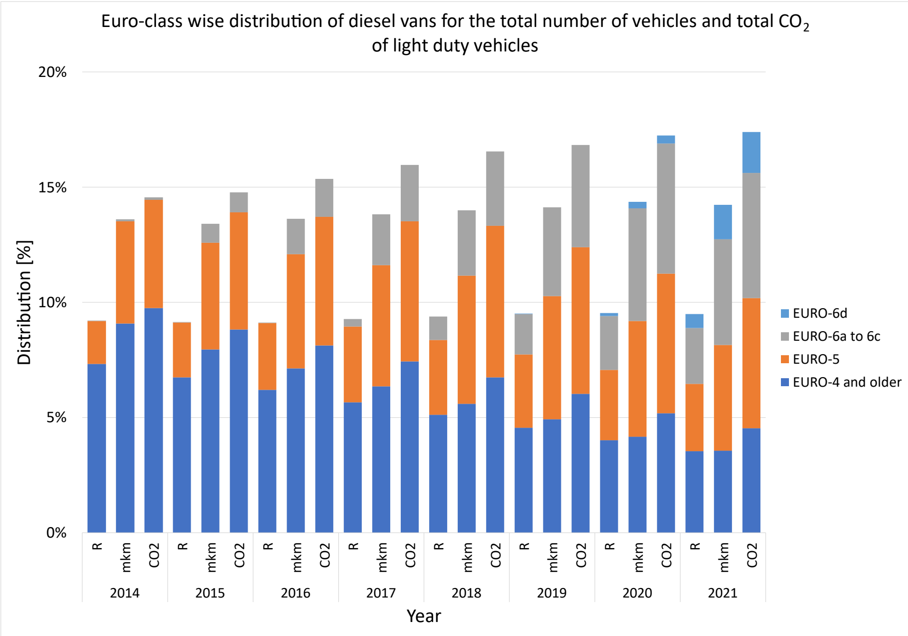


Figure 31: Distribution of diesel vans per Euro-class for the total number of vehicles (represented by R), total kilometres and total CO_2 based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

For NO_x (Figure 32), Euro 4 (and older) and Euro 5 diesel vans accounted for about 9% of the LDV fleet in 2014, driving about 13% of the kilometres but were responsible for about 35% of the total NO_x from LDV fleet, with a majority coming from Euro 4 and older vehicles. In 2021, the share of these vehicles decreased to about 7.5%, driving about 8% of the kilometres but their share of NO_x remains around the 30% mark, majority coming from Euro 5 vans. It is noteworthy and requires special attention that there are no big improvements in all these years. This group does not account for a large number of vehicles and also do not drive the most kilometres but they are more polluting than the newer generation of vans and hence contribute quite heavily to the total emissions. Just like diesel passenger cars, diesel vans also have seen a considerable improvement in their development from Euro-6a to Euro-6d. In 2021, Euro-6d diesel vans drove 1.5% of all LDV kilometres and contributed to only 0.6% of all LDV NO_x emissions. This is an improvement also from Euro-6a which drove 4.6% of all LDV kilometres and contributed to about the same in NO_x emissions.

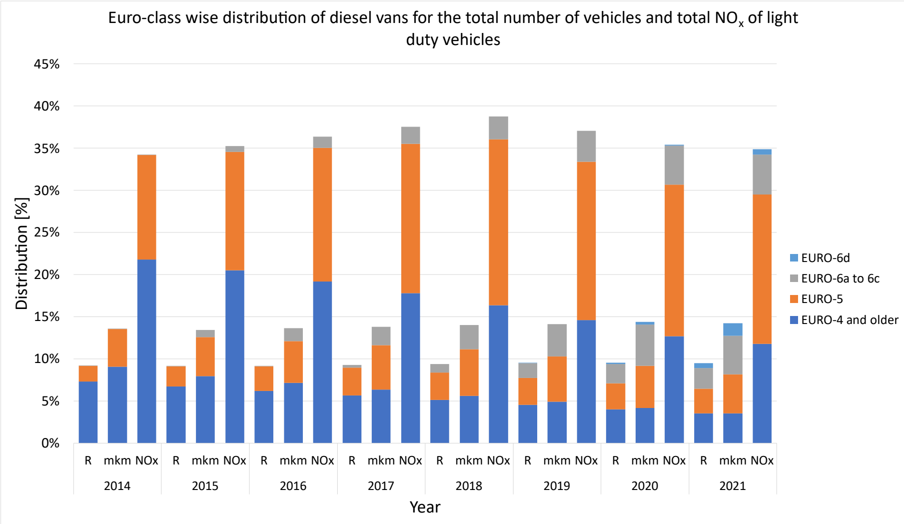


Figure 32: Distribution of diesel vans per Euro-class for the total number of vehicles (represented by R), total kilometres and total NO_x based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

For exhaust-PM emissions, it shows that Euro 4 and older vans account for about 44% of total exhaust-PM emissions from LDV in 2014 and it has only decreased to 41% in 2021. It is astonishing to see that this small group, that accounts for only 3.5% of the total LDV fleet, that also drives about 3.5% of the kilometres is responsible for almost half of the total LDV exhaust-PM emissions.. Although it is very slightly decreasing, the older vans seem to have a disproportional amount of contribution to the total emissions. The presented particle matter emissions include tailpipe emissions.

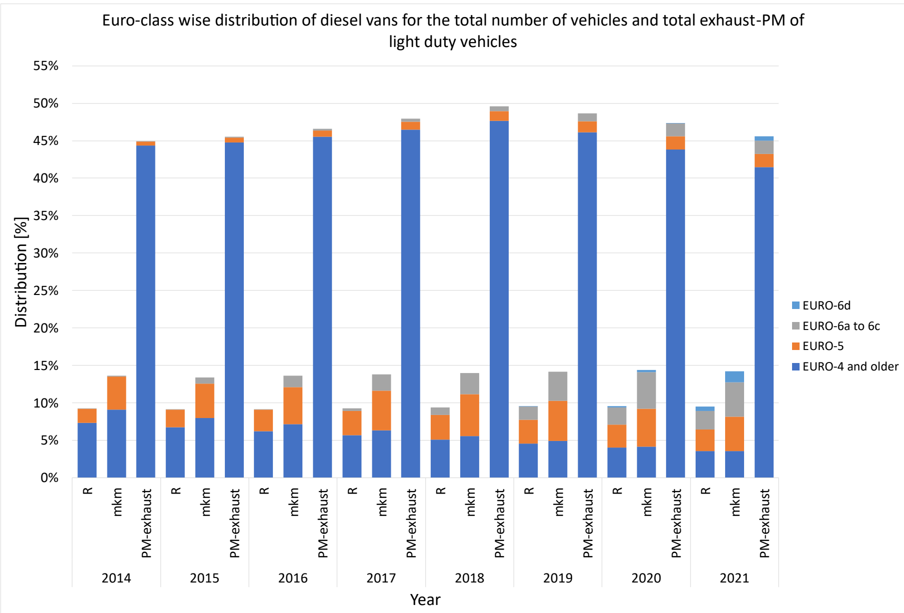


Figure 33: Distribution of diesel vans per Euro-class for the total number of vehicles (represented by R), total kilometres and total exhaust-PM based on kilometers driven by each Euro-class of vehicles when compared to the total light-duty vehicle fleet

Following the analysis of the Euro 4 and Euro 5 diesel vans, it is also important to shed some light on the high emitter category of these vans. A similar analysis as the one for passenger vehicles was repeated for vans to see the impact of the high-emitting vans.

The table below (Table 3) shows the share of such emitting vans and how much they contribute to the total NO_x and PM_{10} along with a projection of how the fleet evolved over time. It is quite alarming to see the contribution of these high emitting vans on NO_x. In 2021, 65% of the vehicles accounted for about 84% of the total NO_x emitted by vans. Although this number is predicted to reduce in the future, the disproportional share presently is to be noted. The case for PM is also similar but stronger on a smaller scale. For PM_{10} emissions, in 2021, 35% of the vehicles account for about 56% of the PM_{10} emissions of passenger cars. The uptake of zero-emission vans also seems to be slow in the coming years, thereby the van fleet remaining predominantly diesel. As mentioned earlier, the shares and absolute numbers for 2022, 2025 and 2030 are derived from KEV2021VV and hence the absolute numbers might not be completely true but the shares of older vehicles (high NO_x and high PM_{10} vehicles) is expected not to be very different from reality.

Table 3: Share of vans per fuel-type along with the share of emissions (NO_x and PM_{10}) of high emitting vans in the vans fleet. The data also represents the projections for the years 2022, 2025 and 2030 based on KEV21VV[21]. Absolute numbers are rounded to thousands.

	2019	2020	2021	2022	2025	2030
Total fleet of vans	1,016,000	1,029,000	1,002,000	933,000	964,000	995,000
Share of fully electric vans	0%	0%	1%	1%	4%	9%
Share of Petrol and Gas vans	6%	6%	6%	6%	6%	7%
Share of Diesel vans	94%	93%	93%	93%	90%	84%
Number of high NO_x emitting vans	794,000	740,000	686,000	557,000	408,000	204,000
Share of high NO_x emitting vans	78%	71%	65%	60%	42%	21%
Share of NO_x of high emitters compared to total NO_x of vans	89%	85%	84%	82%	73%	52%
Number of high PM_{10} emitting vans	457,000	410,000	366,000	217,000	128,000	50,000
Share of high PM_{10} emitting vans	45%	39%	35%	23%	13%	5%
Share of PM_{10} of high emitters compared to total PM_{10} of passenger vans	67%	60%	56%	50%	31%	13%

3.4 Particulate matter tax[22]

Similar to passenger cars also vans are in some conditions obliged to a particulate matter tax. Opposed to passenger cars the condition for vans is rather simple. All vans more than 12 years old from the first date of registration are eligible for the particulate matter premium. In addition also vans can have their soot filter removed and make them eligible for the premium. As of 2022 about 4,300 vans have their soot filter removed and hence are required to pay the particulate matter surcharge, see Figure 34.

[21] Klimaat en Energieverkenning 2021 vastgesteld en voorgenomen beleid.
[22] In Dutch, fijnstoftoeslag

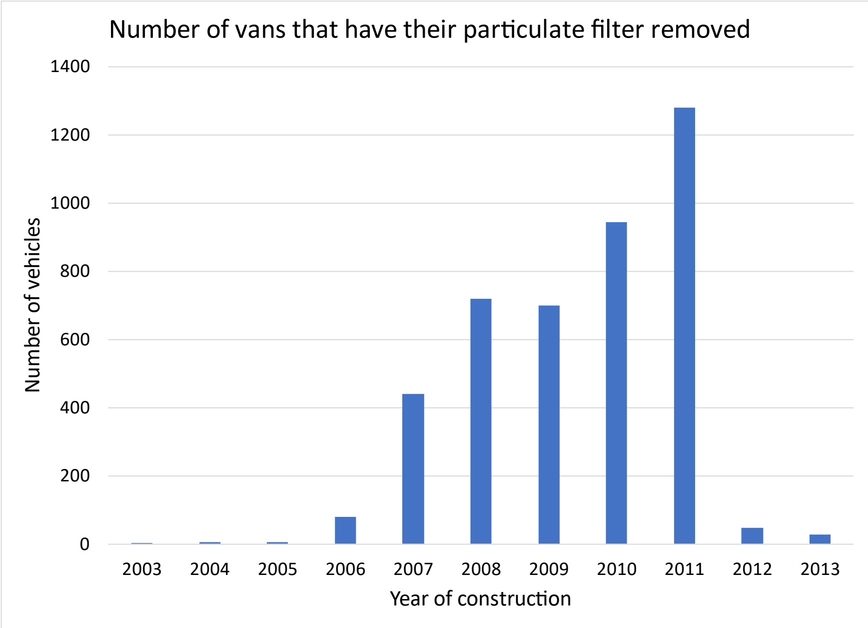


Figure 34: Number of vans in the fleet on 01-01-2022 that have their particulate matter filter removed.

Given the condition that all vans older than 12 years are eligible to pay the particulate matter surcharge, about 260,000 vans qualify for the surcharge in the active fleet as on January 1, 2022, see Figure 35. Including the about 4300 vans that qualify for a particulate matter surcharge based on the fact that they have had their particulate filter removed amounts to a total of about 265,000 vans that qualify for a particulate matter surcharge in the fleet as on 01-01-2022.

When assumed that as of year of construction 2007 50% of all vans have a soot filter and per 2008 all vehicles have soot filter, potentially another almost 350.000 vans could become eligible for the surcharge.

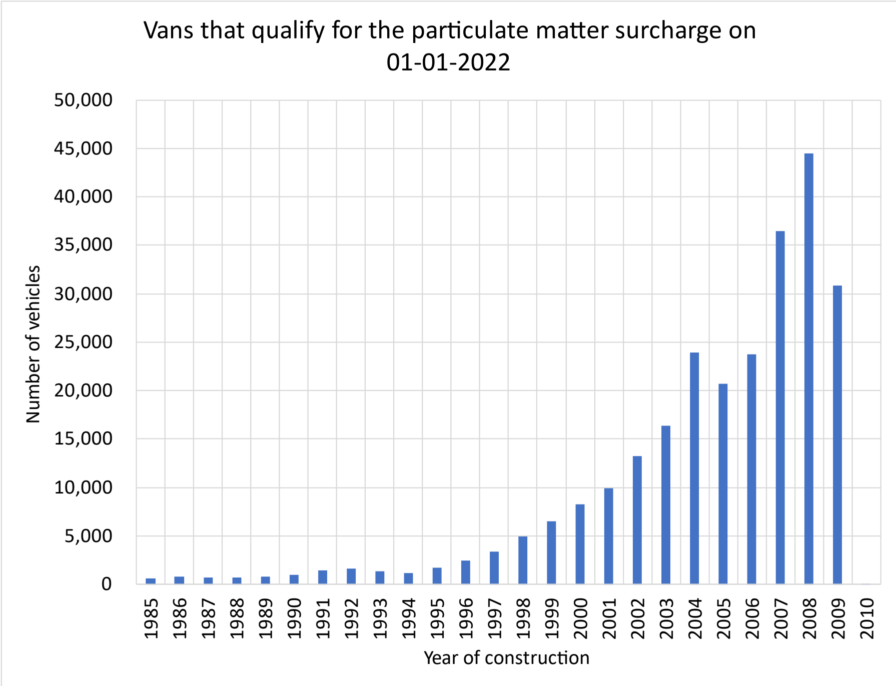


Figure 35: Number of vans that qualify for the particulate matter tax based on their emission value - as described in condition 1, 2, and 3 above.

Similar to passenger cars also for vans an estimate is given for the number of vehicles that will be eligible for the particulate matter surcharge based on the KEV 2022 data. It must be noted that in the KEV numbers the impact of the BPM regulation[23] is not included. However, the impact of this measure will most likely lie with vehicles sold per 2025 and therefore only have a limited impact on the analysis here.

Per 2025 it is expected that there will be more than 200.000 diesel vans older than 12 years that will have to pay the surcharge. These are vehicles with year of construction 2012 and older. Given that only vehicles with a first date of registration before 2017 are allowed to have their soot filter removed gives a potential of almost 180.000 additional vehicles that could have their soot filter removed.

In 2030 it is expected that 230.000 diesel vans are at least 12 years old. That is these have a year of construction from 2017 and before. Which means that there is no potential left as from 2017 onwards the removal of soot filters is no longer allowed under the current regulation.

Type approval for vans is not always clear. Sometimes vans are approved according to the light-duty regime and other times according to the heavy-duty regime. This difference is larger than in the case of passenger cars, as can be seen in Table 4. Table 5 further sub-divides this into the different euro-classes. In the case of vans, about 3.4% of the current van fleet is approved according to the heavy-duty regime.

[23] Beslisnota's bij Kamervragen over voorgenomen afschaffing BPM-vrijstelling voor bestelauto's | Beleidsnota | Rijksoverheid.nl

This is especially high for the Euro-6 vans. Euro 5, Euro-6A, Euro-6d-temp and Euro-6D[24] that account for about 67% of the van fleet. About 3.5% of these vans are approved according to the heavy-duty regime. This accounts to roughly 37,000 vans. It must however be noted that the quality of this datafield is unknown.

Table 4: Type approval according to the light and heavy-duty regime for vans

Vehicle Type	No Approval	Light-duty regime	Light and Heavy-duty regime	Heavy-duty regime	Total
N1	373173	698342	277	37985	1109777
N1	33.6%	62.9%	0.02%	3.4%	100.0%

Table 5: Type approval according to the light and heavy-duty regime for vans per euro-class. Each euro-class is represented as a fraction of the total fleet.

Vehicle Type	No Approval	Light-duty regime	Light and Heavy-duty regime	Heavy-duty regime	Total
PR82	1.8%	0.0%	0.0%	0.0%	1.8%
1982	0.1%	0.0%	0.0%	0.0%	0.1%
1983	0.1%	0.0%	0.0%	0.0%	0.1%
1984	0.2%	0.0%	0.0%	0.0%	0.2%
1985	0.2%	0.0%	0.0%	0.0%	0.2%
1986	0.2%	0.0%	0.0%	0.0%	0.2%
1987	0.2%	0.0%	0.0%	0.0%	0.2%
1988	0.2%	0.0%	0.0%	0.0%	0.2%
1989	0.2%	0.0%	0.0%	0.0%	0.2%
1990	0.2%	0.0%	0.0%	0.0%	0.2%
1991	0.3%	0.0%	0.0%	0.0%	0.3%
1992	0.3%	0.0%	0.0%	0.0%	0.3%
EUR0	0.0%	0.0%	0.0%	0.0%	0.0%
EUR1	1.1%	0.0%	0.0%	0.0%	1.1%
EUR2	2.1%	0.0%	0.0%	0.0%	2.2%
EUR3	6.7%	0.1%	0.0%	0.0%	6.8%
EUR4	15.1%	1.0%	0.0%	0.0%	16.1%
EUR5	3.6%	21.4%	0.0%	0.8%	25.9%
EUA6	0.2%	22.2%	0.0%	1.2%	23.6%
EDT6	0.0%	7.5%	0.0%	0.7%	8.2%
EUD6	0.0%	8.4%	0.0%	0.6%	9.1%
EUR6	0.3%	1.3%	0.0%	0.0%	1.7%
ZEEV	0.4%	1.0%	0.0%	0.0%	1.4%
Grand Total	**33.6%**	**62.9%**	**0.0%**	**3.4%**	**100.0%**

[24] In the table are 4 different categories of Euro6. EUA6 refers to EURO6A up to EURO6C, EUDT refers to EURO 6D-Temp, EUD6 refers to EURO6D final and EUR6 refers to EURO6 vehicles with a fuel type other than diesel or electric.

Based on Table 5 and the KEV an estimate is made for the type approval is made for 2025 and 2030. For the calculation of the estimates it is assumed that the share of approval per Euro class remains constant over time. The shift in shares per approval category is then merely a shift in the share of Euro classes over time. The results of this analysis are presented in Table 6.

Based on the analysis it appears that the share of vehicles with no type approval decreases. This is due to the fact that mostly older vehicles have no type approval and that these older vehicles are leaving the fleet. The increase in vehicles with an approval following a heavy-duty regime can be explained due to the increasing share of Euro 5-6D vans.

Table 6: Share of the fleet per type approval category

Year	No Approval	Light-duty regime	Light and Heavy-duty regime	Heavy-duty regime	Total
2023	33.6%	62.9%	0.0%	3.4%	100.0%
2025	20.04%	75.62%	0.03%	4.31%	100.00%
2030	12.98%	82.26%	0.03%	4.73%	100.00%

3.5 Trends in ownership of vans

A similar methodology as the one for passenger cars was used to study the trends in ownership of vans in the country. This methodology was described in Section 2.5. It is important to note that this analysis was performed for data until mid-2019 and the effect shown in this section is based on the cumulative effect of buying and selling transactions from 2016 until 2019. The number of transactions considered in this analysis was roughly 55000. This number is not comparable to the passenger car fleet since the total van market is roughly one million vehicles versus roughly nine million passenger cars. Also the majority of vans are registered as business owned vehicles while here only van transactions between privately owned vehicles were considered.

3.5.1 Vehicle age

When looking at the age of the vehicles and how it influences the choice of the next vehicle, it can be seen from Figure 36 that the households that sell their older van from ages 2 until 15 years usually end up buying a newer vehicle aged 0 to 1.5. This implies that people keep their vans longer than they keep passenger cars as can be seen in Figure 16 and hence the transactions are also lower than in the case of passenger vehicles. The second group that can be identified is the group that sells their older vans aged 9 until 16 years old buy an older van aged 4 until 11 years old. This group overlaps with the first group of people who sell their older van at a certain age but end up buying an older next van unlike the first group. This last group of people are the ones that are generally interested in buying older vans, further research is needed to find out what drives vehicle choice for this group in order to understand how this group can be influenced to opt for cleaner and more fuel-efficient vehicles.

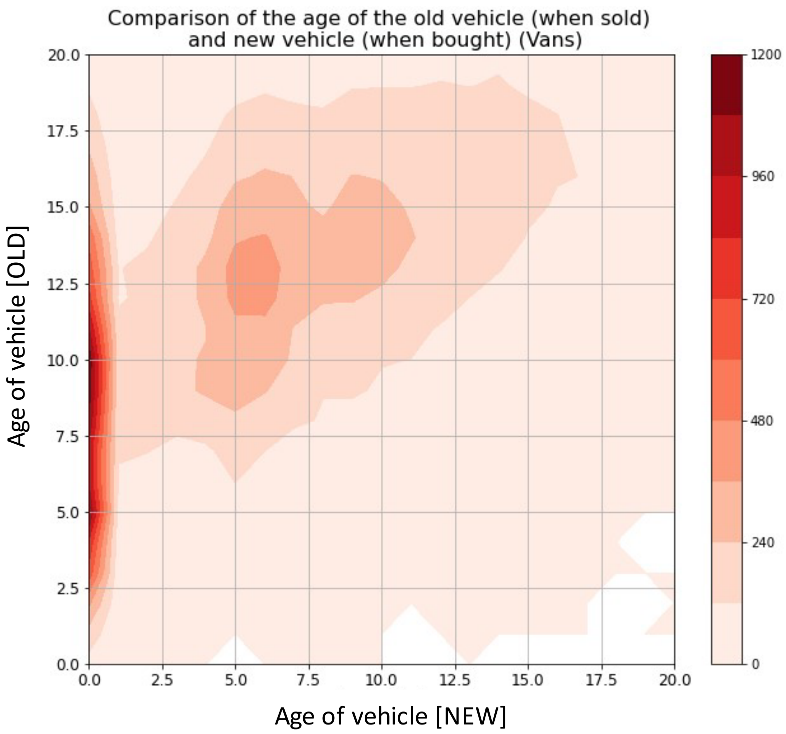


Figure 36: The age distribution of vans when they change an owner, i.e., what is the age of a van when it is sold and the age at which a van is bought. The figure shows the cumulative effect between 2016 and 2019.

3.5.2 Vehicle mass

Another variable that shows interesting results is the mass of vans. As can be seen in Figure 37, there are two groups of vans clearly visible. One is the lighter vans and the other is the heavier vans. In the lighter group of vans, it can be seen that people often tend to replace their older van by a heavier van when they trade vehicles. This can be attributed to either vehicles becoming bigger in general or people having a preference for heavier vehicles or having more features in it thereby making it heavier. A second group of vans, the heavier vans, also experiences similar trends. People replace their older van with a heavier van. Overall the trend towards heavier vehicles seem to be stronger with passenger cars compared to vans which is expected to be mainly caused by a stronger hybridization of the passenger car market in this period and a trend towards bigger and heavier cars. In the period analysed (2017 until mid-2019) the hybridization is mainly (plug-in) hybrids, availability of full electric vehicles was still limited.

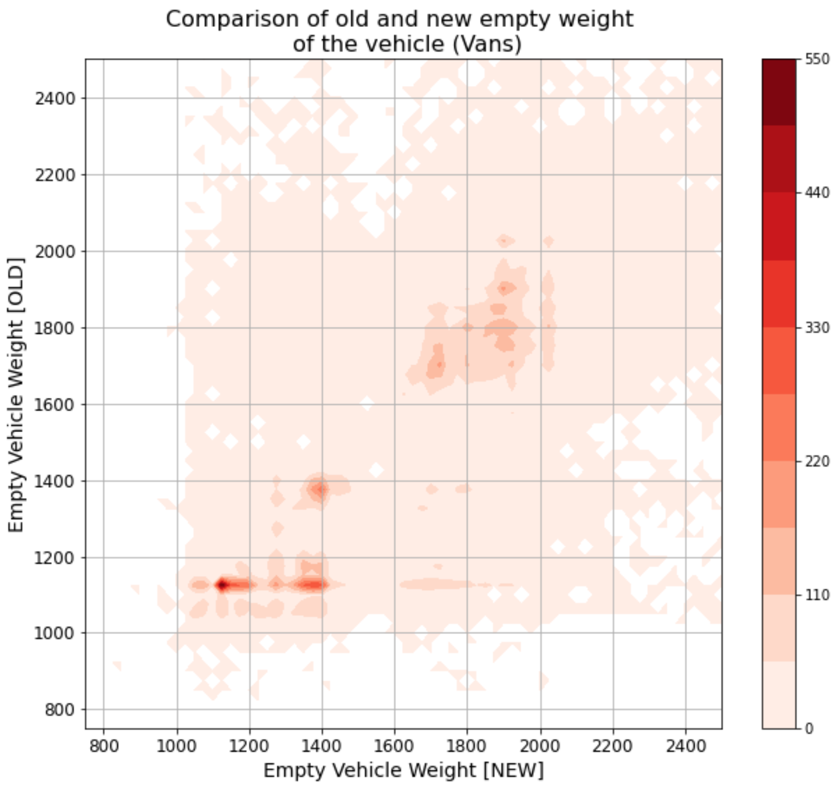


Figure 37:The mass distribution of vans when they change an owner, i.e., how does the mass of the older car compare with the next vehicle bought by a household. The figure shows the cumulative effect between 2016 and 2019.

3.5.3 Vehicle fuel-type

The fuel-type of vehicles is another factor that is important. Figure 38 gives further information on how an old vehicle is replaced by the next vehicle in a household based on the fuel-type. The figure shows the share of replacement of the old vehicle. Each row in the scatter plot adds to 1 (if not, it is a rounding error) thereby implying how likely is it for a particular fuel-type car to be replaced by the same fuel-type or be changed to some other fuel-type for the next vehicle. The fact that the preference for diesel vans still dominate the choice of fuel-type of the vehicle is notable as was petrol vehicles in the case of passenger cars. Majority of owners replace their older van with a diesel van. 97% of the diesel vans are again replaced by a diesel van. 60% of the households which had a petrol vehicle end up replacing it with a diesel vehicle while 36% of them buy a petrol vehicle again. It is to be noted that this is based on analysis of data until 2019 and can be further enriched with newer data. Vans did not have a lot of electric uptake in the fleet as can be clearly seen in the figure. There are very little transactions of electric vans. This can also be enriched with newer data.

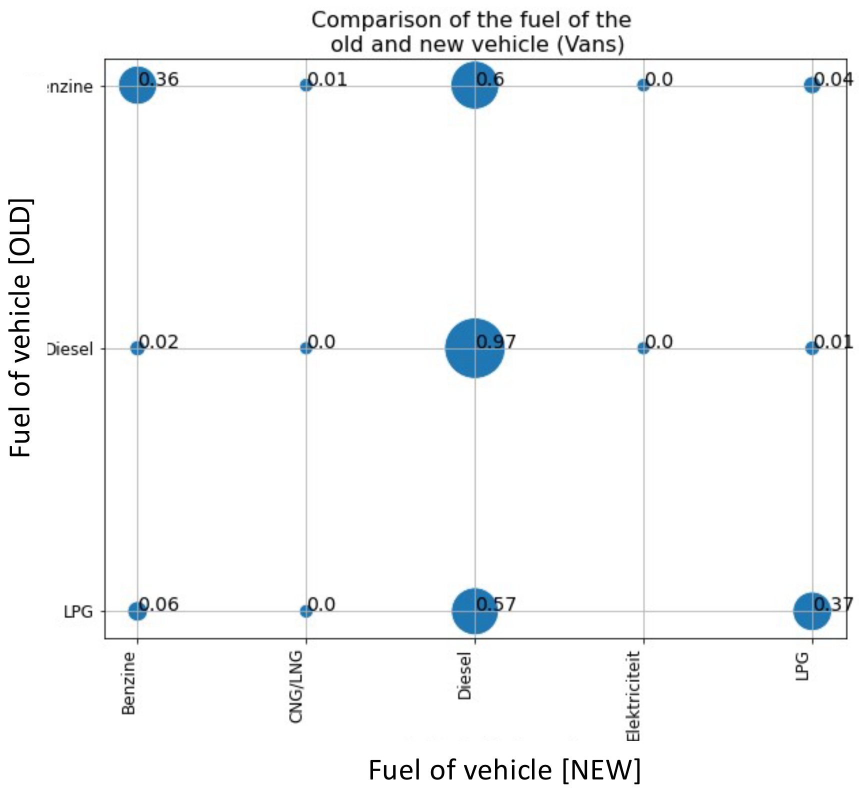


Figure 38: The fuel-type of vans when they change an owner, i.e., how does the fuel-type of the older van compare with the next van bought by a household. The figure shows a share of older vehicles and how likely are they to have the same or different fuel to the next vehicle. The figure shows the cumulative effect between 2016 and 2019.

3.5.4 Vehicle ownership status

The next analysis is performed of the type of ownership and how it changes from one owner to the next. Figure 39 shows how likely people are to replace their current vehicle with a used vehicle or a new vehicle amongst others. Each row in the scatter plot adds to 1 (if not, it is a rounding error) thereby implying how likely is it for a particular ownership-type of a car to be replaced by the same ownership-type or be changed to some other ownership-type for the next vehicle. The 4 different types of ownership has been defined for the sake of analysis similar as in the case of passenger cars. A vehicle could be new, which means it was first registered in the Netherlands as a new vehicle. It could be a used vehicle which is a vehicle that has been registered at some other address (inside the Netherlands) before it is registered at the current address. It could be a first owned imported car in the Netherlands, i.e., the vehicle had a previous owner outside the Netherlands but it is registered under its first owner in the Netherlands. The last is the used imported vehicle which is an imported vehicle but has been registered with one (or more) owners in the Netherlands before its current address of registration. It is quite interesting to see that people have a big preference for a used van thereby implying that the second-hand market in the Netherlands is quite big and plays a major role in deciding how the fleet in the country is evolving. 73% of the people having an older vehicle (used vehicle) end up buying a used vehicle as well which is comparable to how it is observed for passenger cars. It is also quite a popular choice of vehicle for people who had a new vehicle previously. 30% of the people who had a new vehicle replace it with a used vehicle and 62% of them replace it with another new vehicle which is a better trend than passenger cars.

This also explains why the new sales of vehicles in the country is not diminishing as fast (Figure 27 and Figure 28) as in the case of passenger cars (Figure 4 and Figure 5).

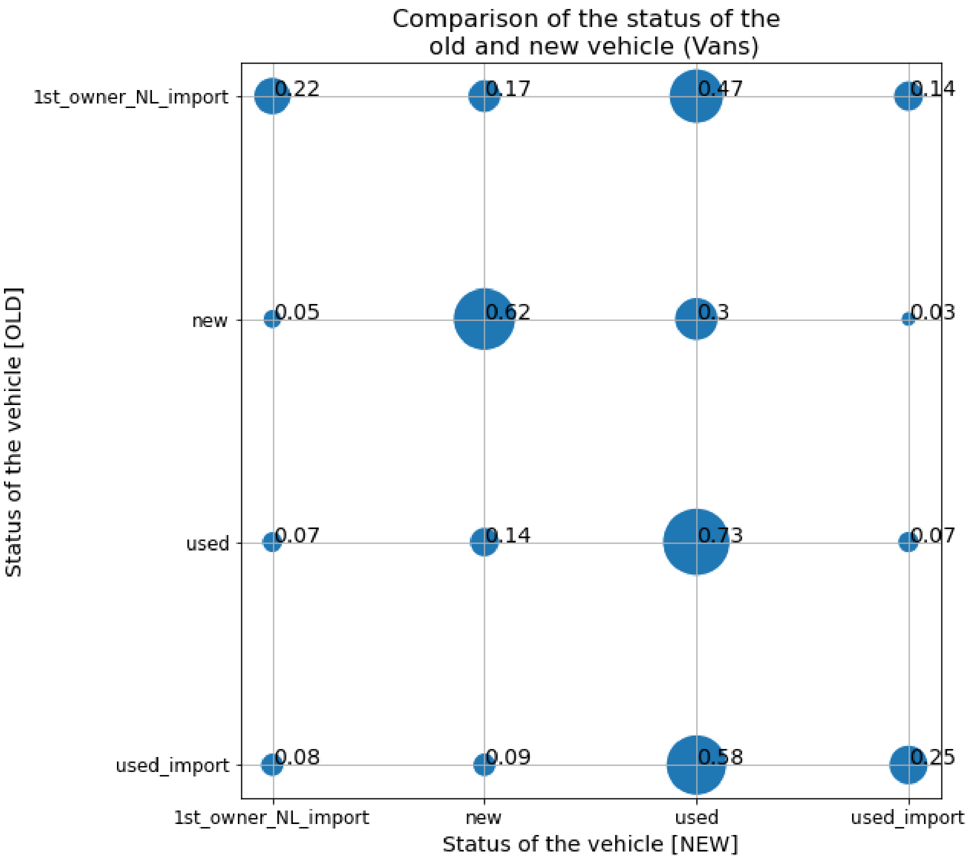


Figure 39: The type of ownership of passenger cars when they change an owner, i.e., how does the type of ownership of the older car compare with the next vehicle bought by a household. The figure shows a share of older vehicles and how likely are they to have the same or different ownership-type to the next vehicle. The figure shows the cumulative effect between 2016 and 2019.

3.6 Climate Actions

3.6.1 Comparing the CO_2/km of vans for the imported, exported and new vans

The weighted average real-world CO_2/km of the new van sales can be seen in Figure 40. The trend seemed to be decreasing until 2010 but has been increasing ever since. This can be attributed to the increasing weight of the vans or electrification or the addition of newer and heavier features in the vans.

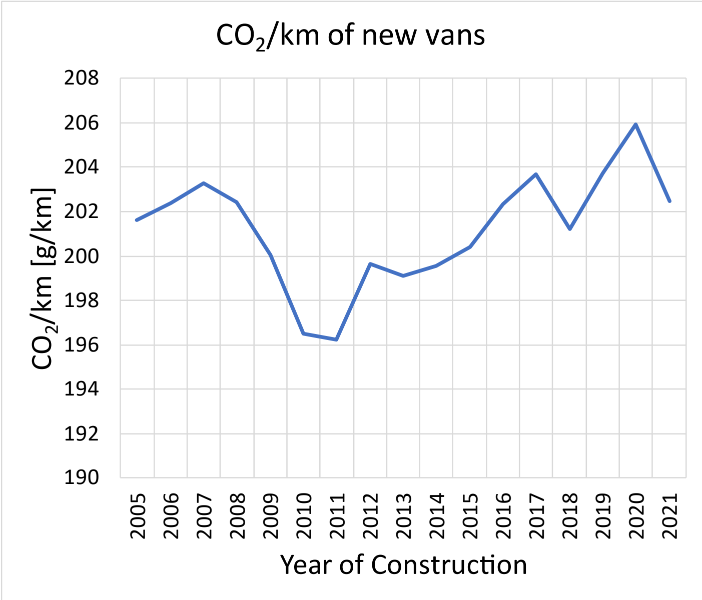


Figure 40: Real-world CO_2/km for newly sold vans over the years from 2005 to 2021. The trend seemed to be decreasing until 2010 but has been rising ever since. Be aware that the y axis does not start at zero.

The new vans seem to have an increasing CO_2/km and since the new sales of vans contributes the most to the fleet of the vans in the country, it also has a major effect on the emissions. Imported vans do not contribute to the inflow more than the new sales for vans and hence the effect from new vans dominates the trend in the inflow. It is quite alarming to see that the average CO_2/km for new vans has been on the rise as can be seen in Figure 41. It is contradicting to the trends seen in passenger vehicles which is further elaborated in the next sub-section. It is also quite alarming to see that there has been no visible improvement in vans through all the years from 2005 to 2020.

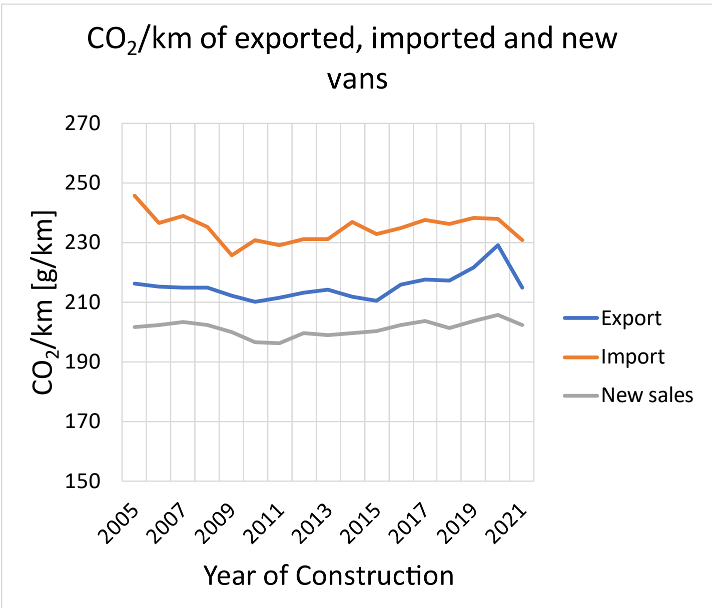


Figure 41: Real-world CO_2/km of imported, exported and new vans and how it evolves from 2005 to 2020. The trends seem to be more or less constant except for the very recent decrease in the CO_2/km of imported vans and the increase of the new vans.

The increase in CO_2 emissions per kilometre of vans can be attributed to the increasing vehicle mass of vans. Figure 42 shows the CO_2 emissions per kilogram of vehicle mass for vans. The fact that the CO_2 emissions per kilogram of vehicle mass for vans has been decreasing entails that the increase in CO_2 emissions per kilometre of new sales is caused by the new vans getting heavier over the years and thereby more polluting.

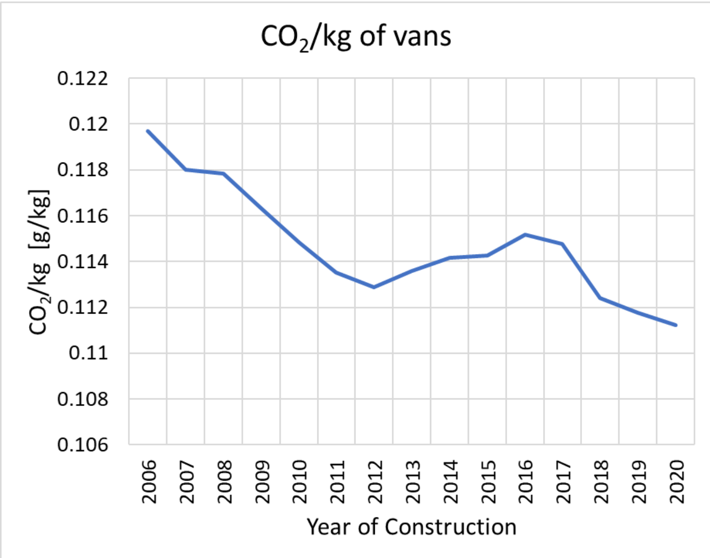


Figure 42: Real-world CO_2/kg of vans from 2006 to 2020. It shows that the vans have been getting heavier over the years.

3.6.2 Comparison of CO_2/km between passenger cars and vans

Passenger cars have seen improvements in the years as can be seen by the downward trend in the real-world CO_2 emissions per kilometre of new sales as visualized in Figure 43. From the figure different periods can be distinguished. In the 2007 2014 period the emissions in gram per kilometre drops significantly. Per 2015 the there is an increase in emissions to change into a decrease again as per 2017. The first decreasing period can in part be attributed to the benefits for lease vehicles with low type approval emissions. Per 2015 this tax scheme was cut back to a large extend for vehicles with low emissions and shifting the higher benefits to plug-in hybrid and full electric vehicles. For a large part the reduction per 2017 can be attributed to a growing share of zero emission vehicles in the new sales of passenger cars. The real-world emissions from ICE passenger cars have seen little to no improvement after a fall in emissions between 2005 and 2012, see Figure 21. The share of zero emission vehicles in vans new sales is rather limited. The real-world emissions per kilometre for new sales of vans has been slightly increasing since 2010 implying little to no improvements in the past.

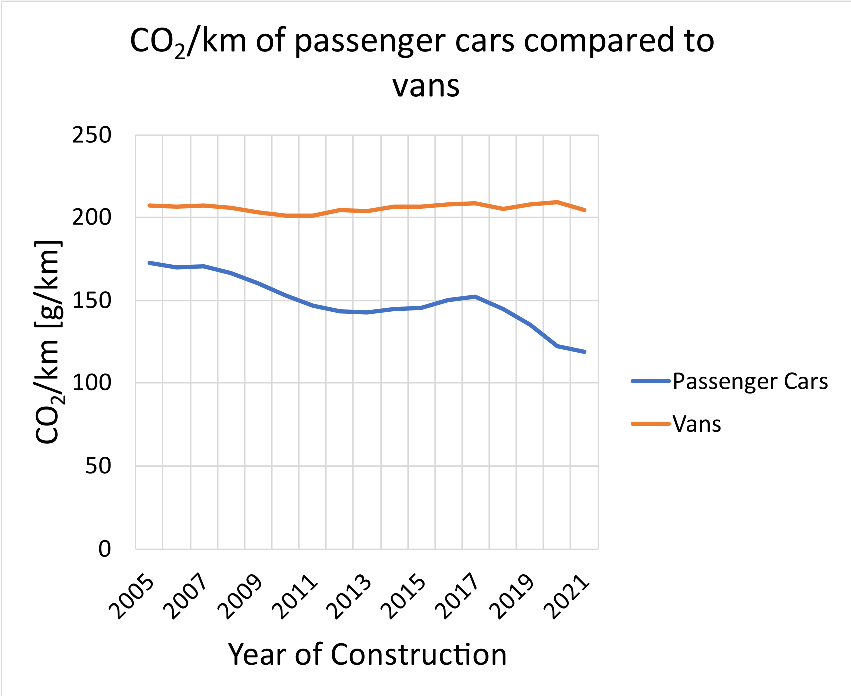


Figure 43: Comparison of real-world CO_2/km between new passenger cars and new vans. The passenger cars have a decreasing trend in CO_2/km whereas vans have a slight increase in the CO_2/km. This implies little to no improvements in the new sales of vans through the years.

4 Heavy-duty vehicles

Heavy-duty vehicles have been divided into four categories for the sake of analysis. These groups are defined on the basis of VERSIT classes.

The four groups and their weights are:

1. Medium-Heavy-Light Rigid Trucks (3.5 to 12 tons)
2. Medium-Heavy Rigid Trucks (>12 and <=19.5 tons)
3. Heavy Rigid Trucks (>19.5 tons)
4. Heavy Tractor Semi-Trailers (>19.5 tons)

This definition of the medium-heavy-light rigid truck as mentioned above also entails that heavy vans which are legally allowed to have a gross vehicle weight above 3.5 tonnes are also included here. The share of heavy vans in this segment has not been analysed.

The heavy-duty vehicle (HDV) fleet changes over time can be seen in Figure 44. It shows how each of the vehicle segments in the HDV fleet changes year-on-year. The drop in 2020 can be attributed to COVID-19 and the global chip shortage but the trends seem to reverse back in 2021. The figure sheds light on several interesting trends. First of all, the total year-on-year change is positive since 2015 and only is negative in 2020. This shows that the total heavy-duty fleet is increasing in size. Secondly, the figure also shows that for both the medium-heavy-light rigid truck and the tractor semi-trailer the year-on-year change is both positive and higher than the total fleet year-on-year change, except for tractor semi-trailers in 2020. This shows that the increase of the total heavy-duty fleet is mainly due to the fact that both the fleet of medium-heavy-light rigid trucks and tractor semi-trailers is increasing. The figure also shows that the year-on-year change of heavy rigid trucks is above zero during the 2016-2019 period, but other than for medium-heavy-light rigid trucks and tractor semi-trailers the year-on-year change does not reverse back in 2021.

The year-on-year change for medium-heavy rigid trucks is below zero in all years analysed. This shows that the fleet of medium-heavy rigid trucks is decreasing in size. Since 2014 the trend was towards a lower decrease each year though since 2019 this trend has reversed and the decrease in fleet size is growing.

The decreasing size of the medium-heavy rigid truck and the increasing size of both the medium-heavy-light rigid trucks and tractor semi-trailers show that there is a move away from medium-heavy rigid trucks towards both medium-heavy-light rigid trucks and tractors semi-trailers, Until 2018 the trend is strongest for the latter.

Figure 46 shows that heavy tractor semi-trailers are the majority in the HDV fleet and this also follows from Figure 44 as the total HDV fleet trends follows the same pattern as that of the heavy tractor semi-trailer. In the next sections, each of these vehicle types will be analysed in detail.

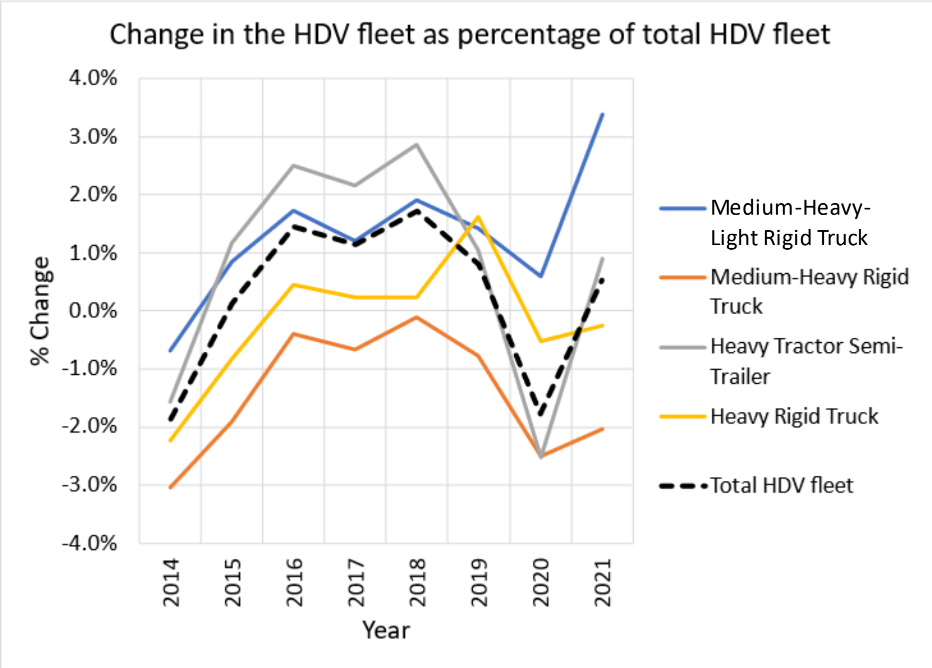


Figure 44: Net change in the fleet of medium-heavy-light rigid trucks, medium heavy trucks, heavy trucks and tractor semi-trailers per year. It shows the change in the HDV fleet in a particular year as compared to the fleet at the beginning of that year.

The average age of the HDV fleet is represented in Figure 45. As can be seen the fleet is steadily getting older over the years. The rate at which the heavy rigid trucks are getting older is the highest as the average age of the fleet increase from 8.5 to 10.2 between 2014 and 2021. The following sections dive deeper into the reasons for the increase of the age of fleet for each vehicle type.

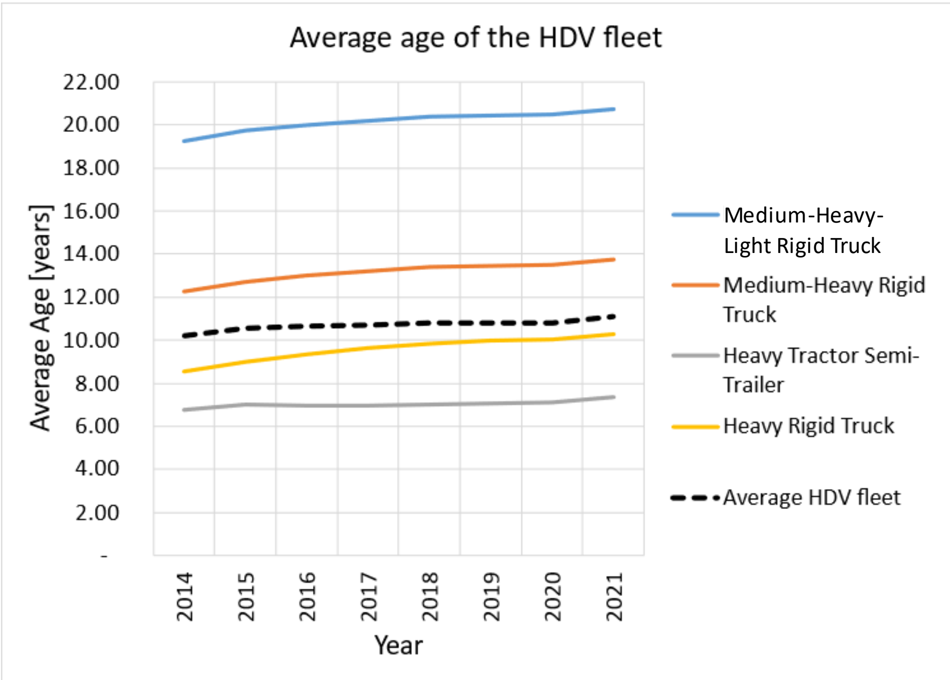


Figure 45: Average age of the HDV fleet. The average age of the medium-heavy-light rigid, medium heavy rigid, heavy rigid trucks and the tractor semi-trailers are also represented.

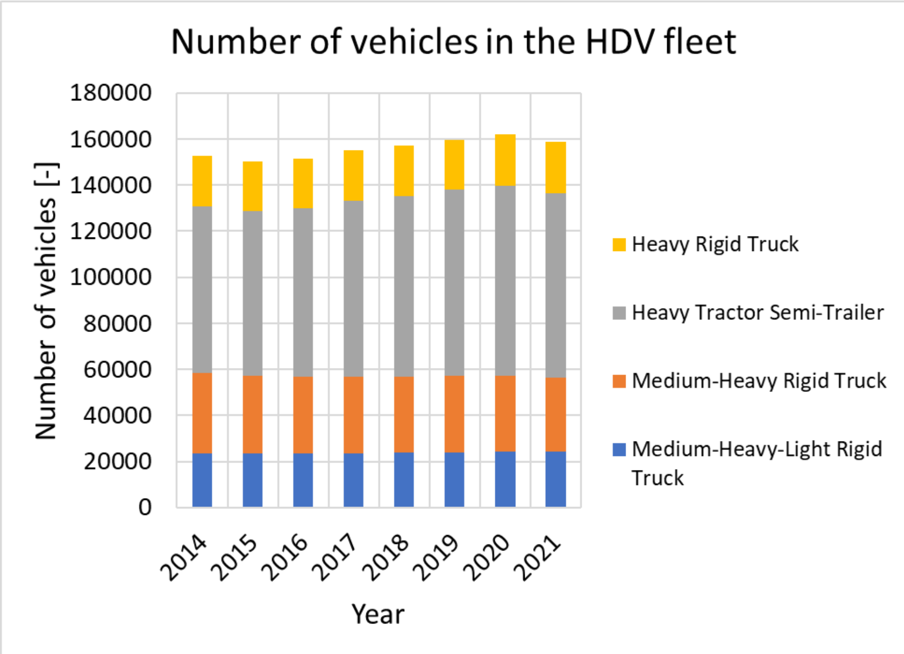


Figure 46: Number of vehicles in the HDV fleet per year as measured at the end of the year. The most distinguishable observation is the increasing number of heavy tractor semi-trailers through the years.

4.1 Medium-heavy-Light Rigid Trucks

4.1.1 Fleet size change

As seen in Figure 44, the medium-heavy-light rigid trucks have been increasing in the fleet since 2015. This is mostly due to the increasing inflow (imports and new vehicles) while the outflow of the medium-heavy-light rigid trucks staying the same (exports and scrapped vehicles).

Figure 47 shows that the new sales of medium-heavy-light rigid trucks has been increasing slightly until 2019 after which there has been a substantial increase in 2021. The imports also have a steady increase.

Another interesting phenomenon that is observed in the fleet development of medium heavy-light rigid trucks is that the inflow is almost equally dominated by both imports and new sales of vehicles. This can be seen in Figure 48

Figure 48. New sales contribute to about 60% of the inflow while imports contribute to the other 40%. This goes on to say that the fleet development is also quite heavily influenced by imported vehicles. The outflow on the other hand is largely dominated by exported vehicles and only about 10% by scrappage.
This implies that the light rigid trucks are not used in the country until the end of their lifetime but are in fact exported to other countries to be used after their use in the Netherlands. This is also evident in the next section which describes further the age developments of medium-heavy-light rigid trucks.

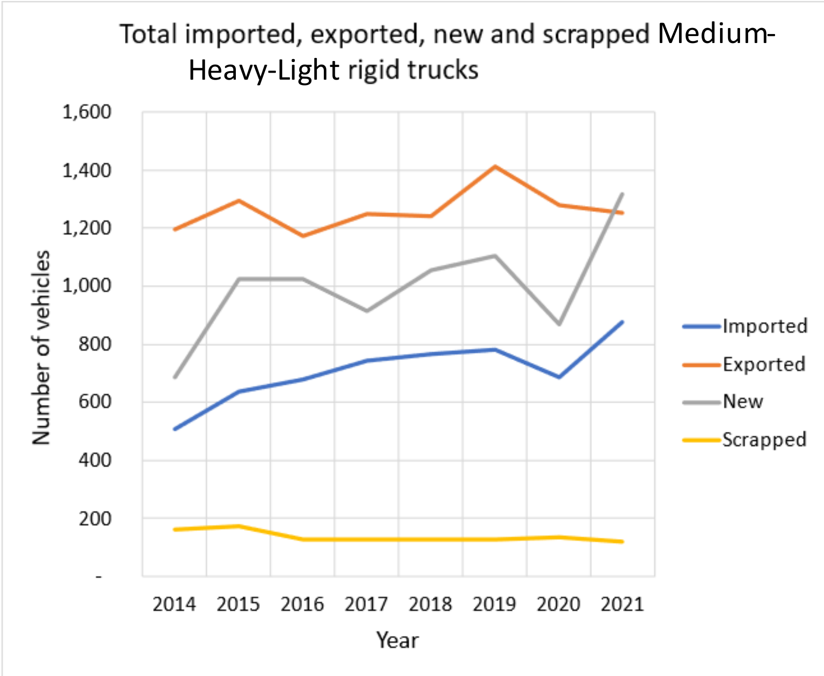


Figure 47: Total imported, exported, new and scrapped medium-heavy-light rigid trucks per year. The inflow (imports and new vehicles) of the medium-heavy-light rigid trucks has been increasing while the outflow (exports and scrapped vehicles) remains constant.

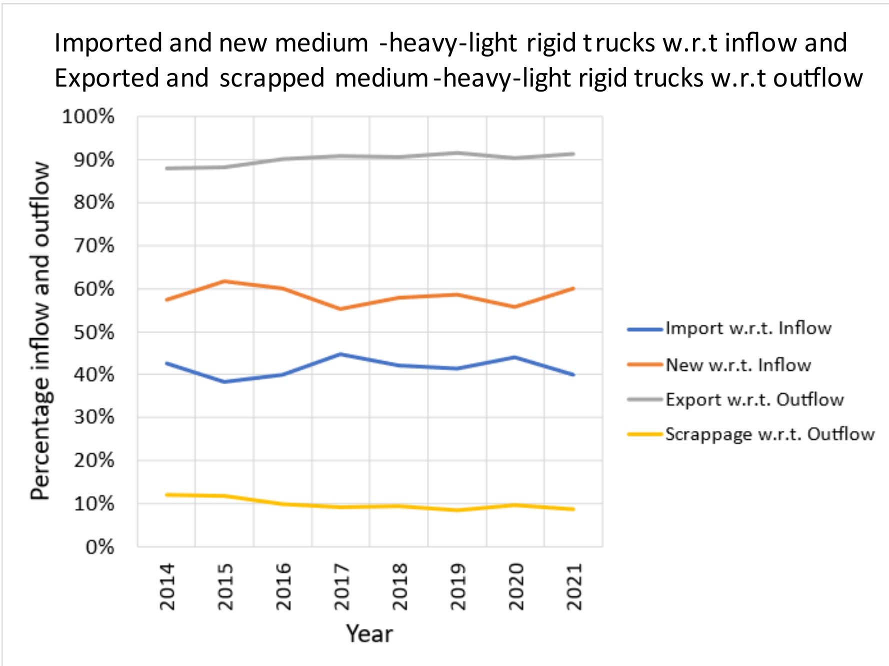


Figure 48: Percentage of imported and new medium-heavy-light rigid trucks as a share of total inflow in that year and the percentage of exported and scrapped medium-heavy-light rigid trucks as a share of the total outflow registrations in that year. Total inflow and total outflow add up to 100% for each year.

4.1.2 Average age of medium-heavy-light rigid trucks

As seen in Figure 45, the average age of medium-heavy-light rigid trucks is on the rise. It is also astonishing to see that the average of the fleet which is around 20 years is higher than the average age of exports and quite close to the scrappage age of medium-heavy-light rigid trucks. This implies that the fleet is extremely old. This can be explained with the help of Figure 49. As can be seen, the average age of scrappage has been fairly constant around the 25 year mark. There has been a slight increase in the age of exports which means that medium-heavy-light rigid trucks stay for a little longer in the fleet in 2021 compared to 2014. Another factor is the age of imports, this has also been increasing slightly over the years although this increase is not steady as 2017, 2018 and 2019 saw a decrease in the age of imported vehicles but it has increased again to reverse back to the original trend.

The increase in average age of the medium-heavy-light rigid trucks can hence be attributed to the following factors:

1. Exported vehicles have been more or less constant at around 90% of the outflow (Figure 48) and with the rising age of the exports (Figure 49), the average age of the light rigid truck fleet also increases.
2. A smaller impact is made by the imported vehicles that have been a big part of the inflow of the fleet (Figure 47 and Figure 48). Since the age of imported vehicles has been rising, it influenced the age of the fleet.

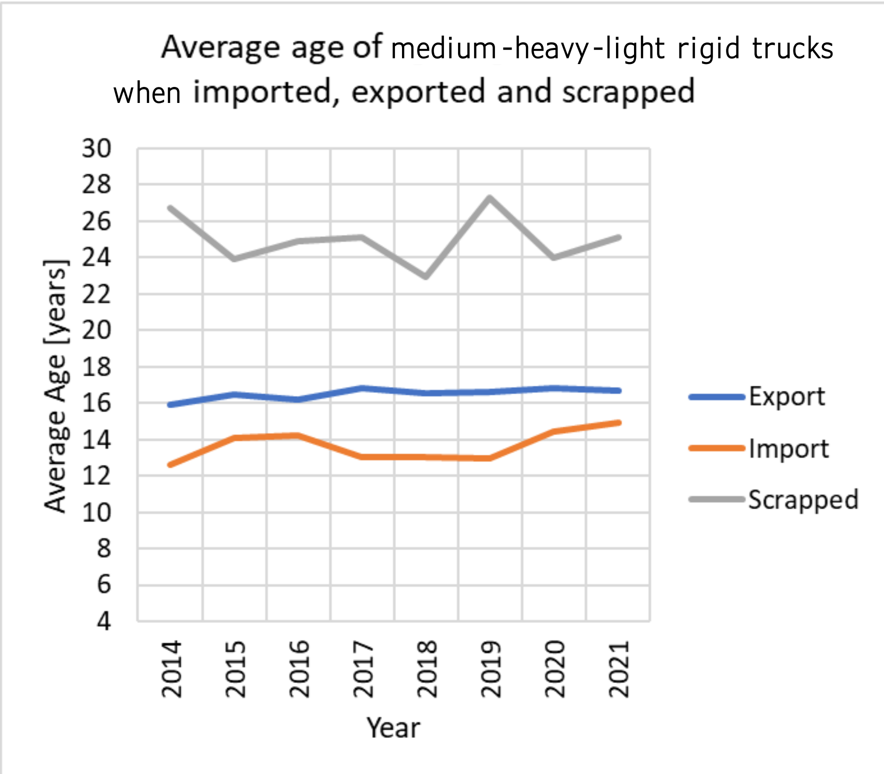


Figure 49.: Average age of medium-heavy-light rigid trucks when they are imported, exported and scrapped. It is to be noted that the average age of is influenced by exports, new and imported vehicles (in that order) more than scrapped vehicles (Figure 48).

4.1.3 Emissions from the medium-heavy-light rigid trucks when compared to the HDV fleet

A similar methodology as passenger cars and vans was used for calculating the total NO_x, CO_2 and exhaust PM for medium-heavy-light rigid trucks as elaborated in the section *Trends in Euro 5 and before vehicle groups and their impact on* total emissions.

Figure 50 shows the total number of vehicles (represented by R), the total CO_2, total NO_x and total exhaust PM. The figure shows the share of medium-heavy-light rigid trucks in the total heavy-duty vehicle fleet and its share in the number of kilometres along with the three aforementioned pollutants. This way, it can be inferred what portion of these trucks contributes to how much emission in the entire heavy-duty fleet in the country.

As can be seen, medium-heavy-light rigid trucks contribute to about 15% of the HDV fleet. The electric trucks have been not included in the analysis since they do not yet make a substantial contribution to the fleet or the kilometres driven. An interesting observation about the medium-heavy-light rigid trucks is that in 2014, Euro 4 and older trucks, which contribute to about 13% of the HDV fleet, drove about 1.2% of the total HDV kilometres and contributed to about 4%of the total HDV exhaust PM in the country. Although this is not a substantial amount, it is interesting to note that in 2021, this has not changed much when they amount to about 9% of the fleet, drove about 0.8% of the kilometres but still contributed to about 6% of the total exhaust PM emissions. This is quite contrary to the Euro 6 vehicles which are about 4% of the HDV fleet in 2021 and drive about 1.4% kilometres and contribute to about 0.3% of the total exhaust PM. This further stresses on the importance of better emission standards and how they indeed make a considerable difference in the total emissions.

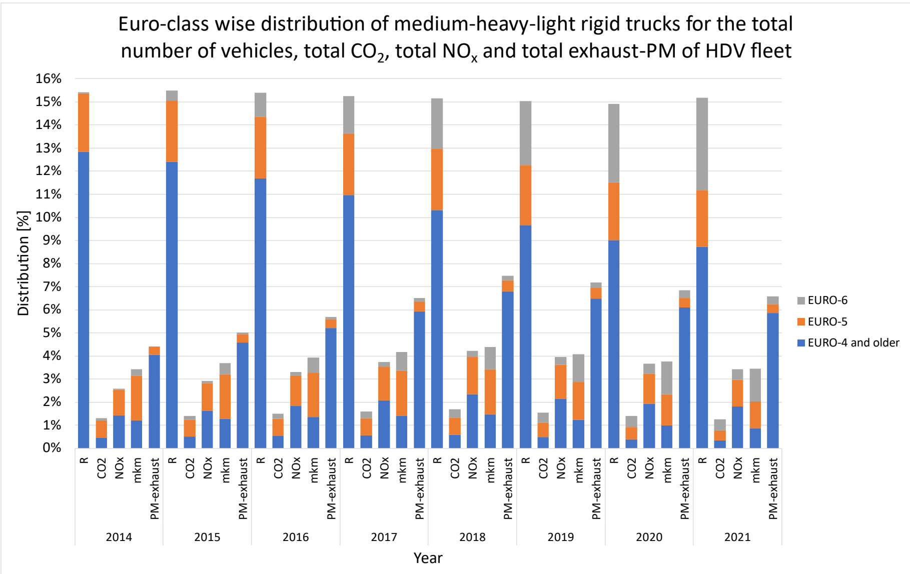


Figure 50: Distribution of medium-heavy-light rigid trucks per Euro-class for the total number of vehicles (represented by R), total kilometres, total CO_2, total NO_x and total exhaust-PM based on kilometers driven by each Euro-class of vehicles when compared to the total heavy-duty vehicle fleet

4.2 Medium-Heavy Rigid Trucks

4.2.1 Fleet size change

As seen in Figure 44, the medium-heavy rigid trucks have been decreasing in the fleet since 2014. This is mostly due to the outflow of the medium-heavy rigid trucks has been increasing in the form of exports while the inflow has been more or less constant over the years with a slight increase in imports. Figure 51 shows that the trend of an increase in the number of new sold vehicles has been broken in 2018 and has been strongly decreasing since. This shows a shift in preference from new to cheaper vehicles which is also emphasized by the increase in imports per 2021.

The increase in imports in 2021 does lead to some increase in the fleet of the medium-heavy trucks but it is not enough to compensate for the outflow caused by the exports which has been increasing since 2016.

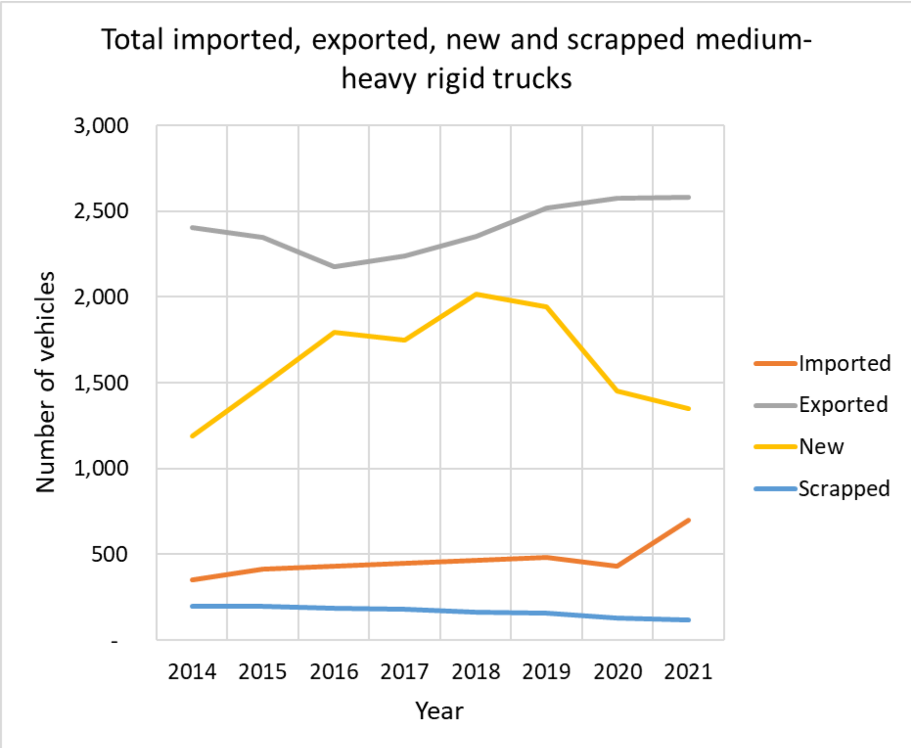


Figure 51: Total imported, exported, new and scrapped medium-heavy rigid trucks per year. The inflow (imports and new vehicles) of the medium-heavy rigid trucks has been constant while the outflow (exports and scrapped vehicles) increasing.

The inflow was almost fully dominated by the new sales of vehicles but imports has been increasing in the recent past from 2019. This can be seen in Figure 52. New sales contribute to about 65% of the inflow while imports contribute to the other 35% in 2021. This goes on to say that the fleet development is also quite heavily influenced by the imported vehicles. The outflow on the other hand is largely dominated by exported vehicles and only about 5% by scrappage. This implies that the medium-heavy rigid trucks are not used in the country until the end of their lifetime but have a second life outside of the Netherlands.

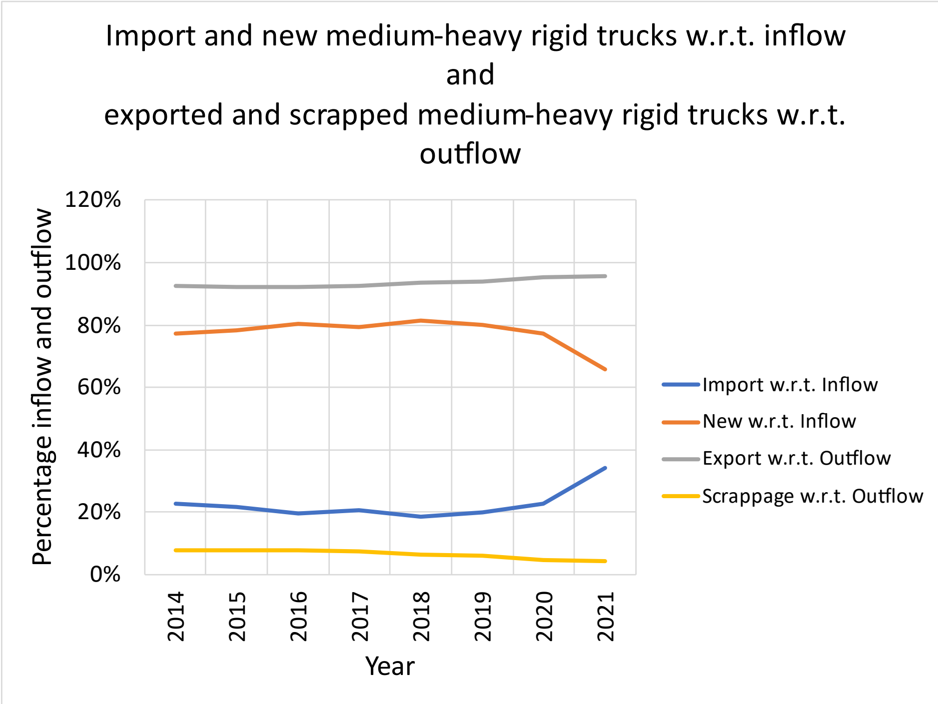


Figure 52: Percentage of imported and new medium-heavy rigid trucks as a share of total inflow in that year and the percentage of exported and scrapped medium-heavy rigid trucks as a share of the total outflow of registrations in that year. Total inflow and total outflow add up to 100% for each year.

4.2.2 Average age of medium-heavy rigid trucks

As seen in Figure 45, the average age of medium-heavy rigid trucks is on the rise from about 12 years in 2014 to about 14 years in 2021. Which is roughly similar to the average age of exports of medium-heavy rigid trucks. The increase in average fleet age can be explained with the help of Figure 53. As appears from the figure, the average age of scrappage has been fairly constant around the 19 year mark. There has been a slight increase in the age of exports thereby implying that people keep the truck for a little longer in 2021 than they used to in 2014. Another factor is the age of imports, this has also been increasing slightly over the years which was about 8 years in 2014 and was 11 years old in 2021 which stresses on the preference for older imported vehicles in the recent past.

The increase in average age of the medium-heavy rigid trucks can hence be attributed to the following factors:

1. Exported vehicles have been more or less constant at over 90% of the outflow (Figure 52) and with the rising age of the exports (Figure 53), the average age of the medium-heavy rigid truck fleet also increases. The increase in outflow alleviates the increase in age a little
2. The impact made by the imported vehicles has been increasing over time (Figure 51 and Figure 52). Since both the age and number of imported vehicles has been rising, this has an aging effect on the average age of the fleet.

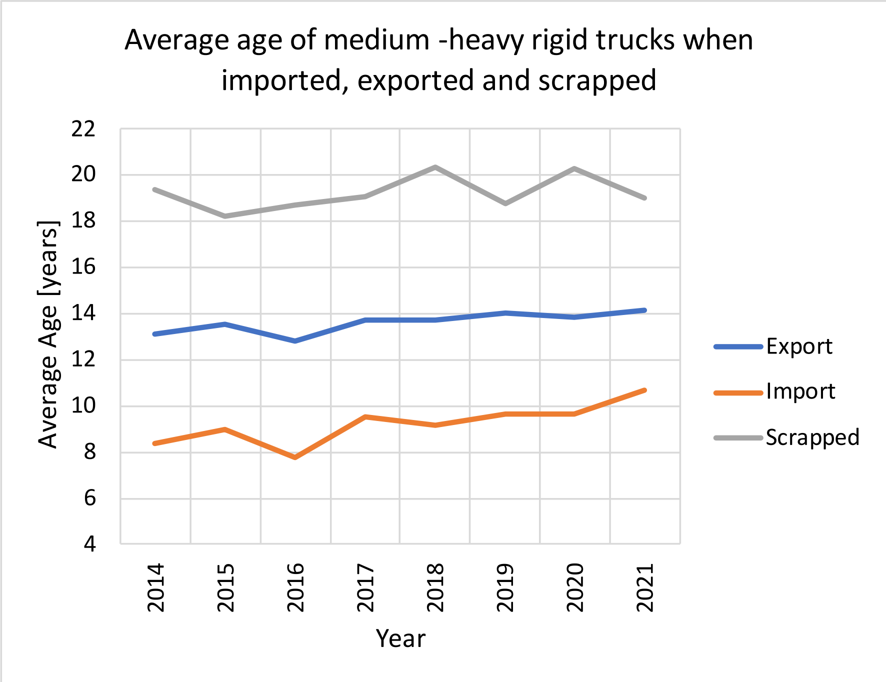


Figure 53: Average age of medium-heavy rigid trucks when they are imported, exported and scrapped. It is to be noted that the average age of is influenced by exports, new and imported vehicles (in that order) more than scrapped vehicles (Figure 51)

4.2.3 Emissions from the medium-heavy rigid trucks when compared to the HDV fleet

To estimate the emissions of medium-heavy trucks a similar methodology as passenger cars and vans was used for calculating the total NO_x, CO_2 and exhaust PM as elaborated in the section *Trends in Euro 5 and before vehicle groups and their impact on* total emissions. Figure **54** shows the total number of vehicles (represented by R), the total CO_2, total NO_x and total exhaust-PM. The figure shows the share of medium-heavy rigid trucks in the total heavy-duty vehicle fleet and its share in the number of kilometres along with the three aforementioned pollutants. This way, it can be inferred what portion of these trucks contributes to how much emission in the entire heavy-duty fleet in the country.

As can be seen, medium-heavy trucks have been reducing in the fleet. They were about 16% of the HDV fleet in 2014 and now account to 8.5% in 2021. Another noteworthy observation is the uptake of Euro 6 trucks. This has been faster than the medium-heavy light rigid trucks. In 2021, Euro 4 and older and Euro 6 trucks were approximately equal in the fleet. It is notable that although Euro 4 and older trucks in 2021 drive less than 1% of the total HDV kilometres, they contribute to over 2% of NO_x and about 7% of the exhaust-PM emissions while Euro 6 trucks drive about 4% of the kilometres but contribute to about 2.5% of NO_x and about 2% of the exhaust-PM emissions.

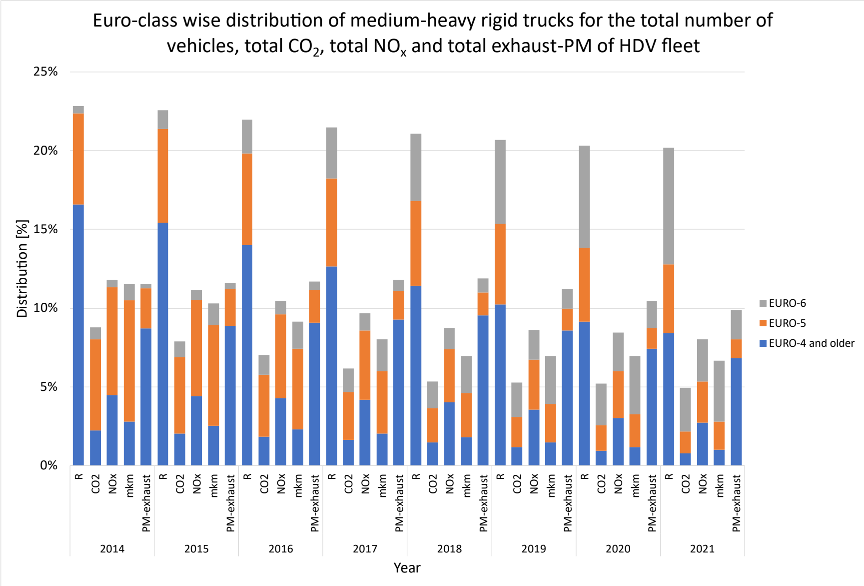


Figure 54: Distribution of medium-heavy rigid trucks per Euro-class for the total number of vehicles (represented by R), total kilometres, total CO_2, total NO_x and total exhaust-PM based on kilometers driven by each Euro-class of vehicles when compared to the total heavy-duty vehicle fleet

4.3 Heavy Rigid Trucks

4.3.1 Fleet size change

As seen in Figure 44, the heavy rigid trucks have been increasing in the fleet very slightly until 2018 followed by a larger increase in 2019. After 2019, the heavy rigid trucks have been decreasing in the fleet. This can, in part, be attributed to COVID-19 and the global chip shortage. Figure 55 shows that the new sales of heavy rigid trucks has been increasing until 2019 after which there has been a substantial decrease per 2020. Imported vehicles also show a rising trend which is stronger for 2021.

The fact that there are more vehicles that are exported than new vehicles that flow into the fleet does indicate why the fleet of the heavy rigid trucks has not been increasing at a faster rate. This trend was reversed in 2019 when the new sales were almost equal to the exported vehicles and with the imports, the inflow of the fleet was much higher than the outflow in that year. In the years before 2019 from 2016, the fleet was almost constantly increasing at a rate of 0.5% per year. Overall, the fleet of the heavy rigid trucks has not changed in 2021 when compared to 2014.

Another phenomenon observed in Figure 56 is the increase in imports of the heavy rigid trucks. In the recent years, imported trucks have been increasing in the total inflow contribution. Imports were responsible for about 20% until 2019 but has increased since to around 30% in 2021. This implies that there is a shift from new vehicles to imported vehicles which would impact the fleet and its age. This is discussed further in the next section. The outflow is almost fully dominated by exported trucks, which contribute to over 95% of the outflow. This means that the trucks are not used in the Netherlands until the end of their lifetime but are rather mostly exported to other countries.

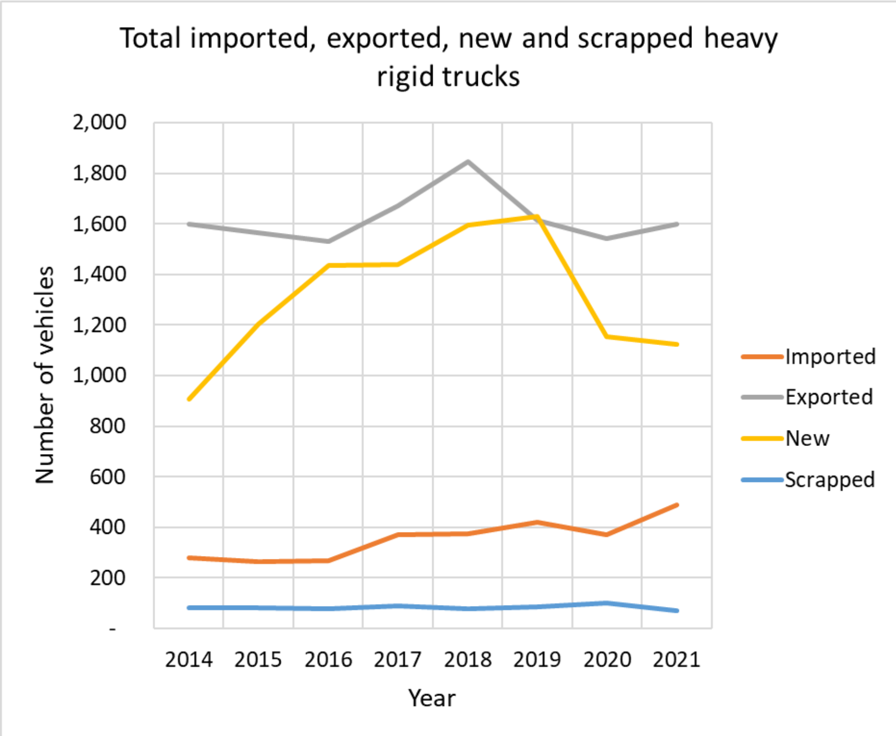


Figure 55: Total imported, exported, new and scrapped heavy rigid trucks per year. The new sales of the heavy rigid trucks has been increasing until 2019 followed by a decrease while the imports have been increasing while the outflow (exports and scrapped vehicles) is more or less constant.

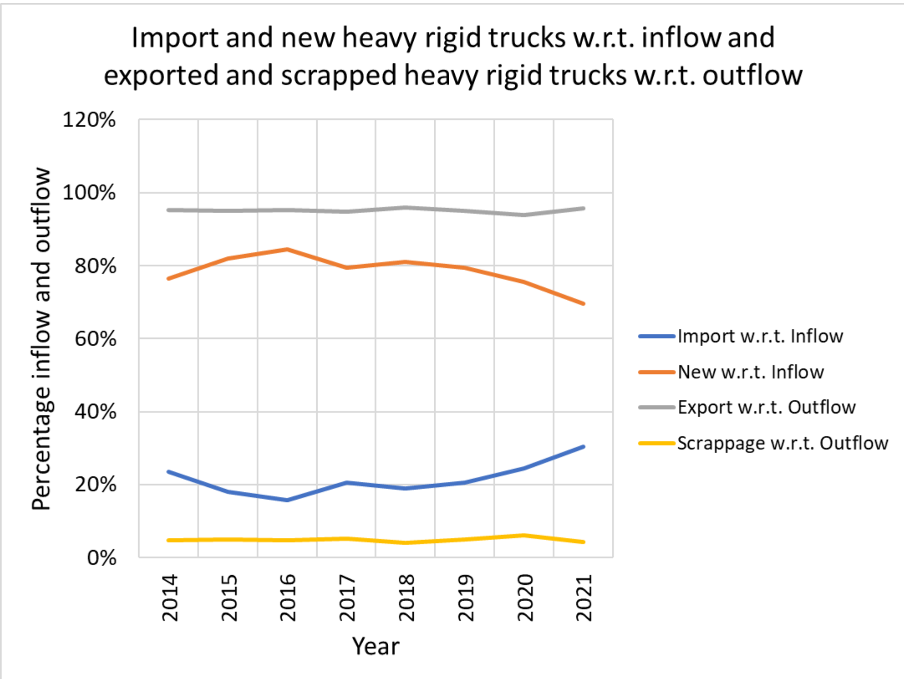


Figure 56: Percentage of imported and new heavy rigid trucks as a share of total inflow in that year and the percentage of exported and scrapped heavy rigid trucks as a share of the total outflow of registrations in that year. Total inflow and total outflow add up to 100% for each year.

4.3.2 Average age of heavy rigid trucks

As seen in Figure 45, the average age of heavy rigid trucks has been increasing from 2014 to 2021 from about 8.5 to 10.2 years. Explanation for this can be further found in Figure 57. As can be seen in the figure, the average age of scrapped trucks has been slightly decreasing and the average age of exported vehicles has been rising. It was about 10.2 years until 2018 and is now close to 12 years old. This goes on to say that the trucks were used for longer in the country in 2021 than they were in 2014. Since the number of new vehicles are also relatively high, it reduces the effect of rising age of the exports. But the increasing number of imports and the decreasing new sales lead to an increasing age of the fleet.

The increasing average age of the heavy rigid trucks can hence be attributed to the following factors:

1. Exported vehicles have been more or less constant at over 90% of the outflow (Figure 56) and with the increase in the age of the exports (Figure 57), the average age of the heavy rigid truck fleet also increases.
2. The impact made by the imported vehicles have been an increasing part of the inflow of the fleet (Figure 55 and Figure 56). Since the age and the share in inflow of imported vehicles has been rising, it increases the age of the fleet.
3. Since scrapped vehicles contribute very little to the fleet outflow, the decrease in scrappage age does not influence the average age of the fleet a lot.

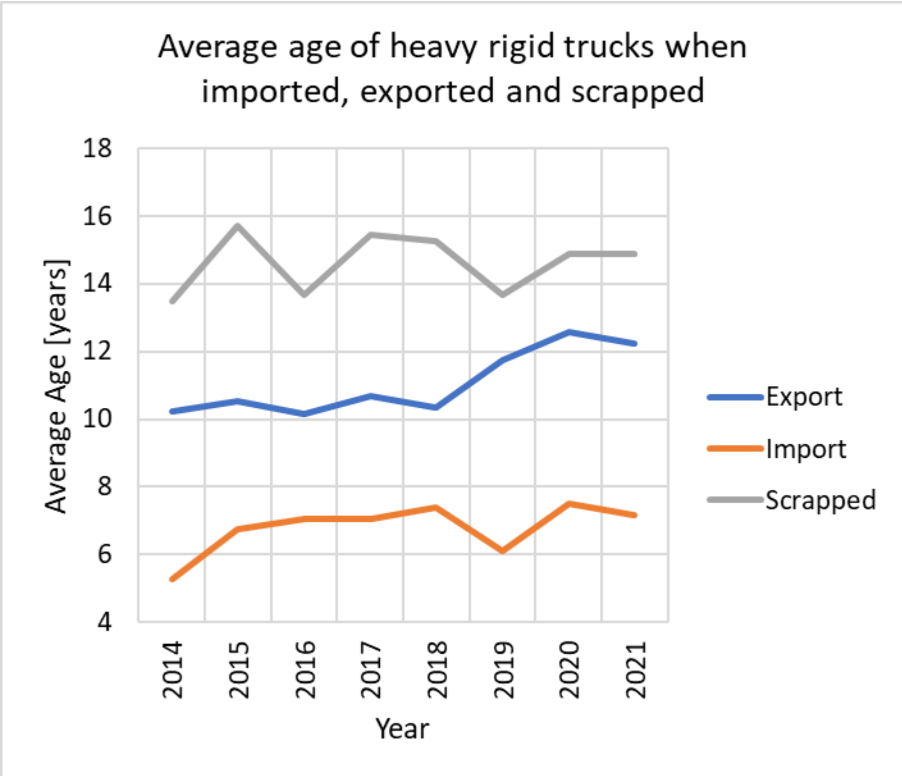


Figure 57: Average age of heavy rigid trucks when they are imported, exported and scrapped. It is to be noted that the average age of is influenced by exports, new and imported vehicles (in that order) more than scrapped vehicles (Figure 55)

4.3.3 Emissions from the heavy rigid trucks when compared to the HDV fleet

To estimate the emissions of heavy rigid trucks a similar methodology as passenger cars and vans was used for calculating the total NO_x, CO_2 and as elaborated in the section *Trends in Euro 5 and before vehicle groups and their impact on* total emissions.

Figure 58 shows the total number of vehicles (represented by R), the total CO_2, total NO_x and total exhaust-PM. The figure shows the share of heavy rigid trucks in the total heavy-duty vehicle fleet and its share in the number of kilometres along with the three aforementioned pollutants. This way, it can be inferred what portion of these trucks contributes to how much emission in the entire heavy-duty fleet in the country.

As can be seen, heavy trucks have been almost constant in the fleet. They have been about 14% of the HDV fleet. Another noteworthy observation is the uptake of Euro 6 trucks. This has been faster than the medium-heavy-light rigid trucks. In 2021, Euro 6 trucks were more than Euro 4 and older trucks in the fleet. The interesting observation is that in 2014, Euro 4 trucks drove 2% of the kilometres while the NO_x and exhaust-PM emissions were about 4% and 7% respectively. In 2021, Euro 4 trucks drove very little kilometres, about 0.7% of the total HDV kilometres but contribute to about 2.6% of NO_x emissions and about 5.5% for the exhaust-PM emissions. On the other hand, Euro 6 trucks drive about 7% of the kilometres and contribute to also about 7% of NO_x and 4% of the exhaust-PM emissions. This goes on to say that the emission standards and the developments in technology from Euro 4 to Euro 6 has been quite impressive. It is a similar observation as in the case of medium-heavy-light and medium-heavy trucks where Euro 6 trucks do make a considerable difference in the share of emissions.

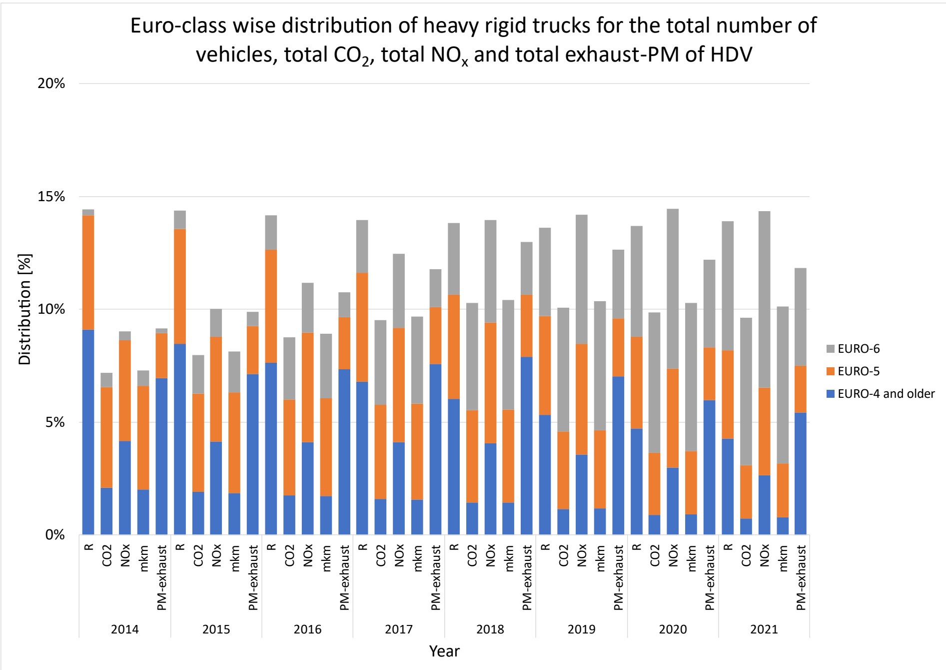


Figure 58: Distribution of heavy rigid trucks per Euro-class for the total number of vehicles (represented by R), total kilometres, total CO_2, total NO_x and total exhaust-PM based on kilometres driven by each Euro-class of vehicles when compared to the total heavy-duty vehicle fleet

4.4 Heavy Tractor Semi-Trailer

4.4.1 Fleet size change

As seen in Figure 44, the heavy tractor semi-trailers is the dominant heavy-duty vehicle in all of the Dutch heavy-duty fleet. Tractor semi-trailers have been increasing in numbers until 2019 followed by a decrease in 2020. This can, in part, be attributed to COVID-19 and the global chip shortage. Figure 59 shows that the new sales of heavy tractor semi-trailers has been more or less constant until 2019 after which there has been a substantial increase after the COVID-19 period of 2020. The imports also have a steady increase. The fact that there are more vehicles that are exported than newer vehicles come into the fleet from 2019 indicates why the fleet of the heavy tractor semi-trailers has not been increasing at a faster rate as before 2019. Tractor semi-trailers have been increasing at an average rate of 2% between 2015 and 2019 and after the COVID-19 decrease, it has come back to a 1% increase but this increase was mostly dominated by imports and not by new vehicle sales as was the trend earlier.

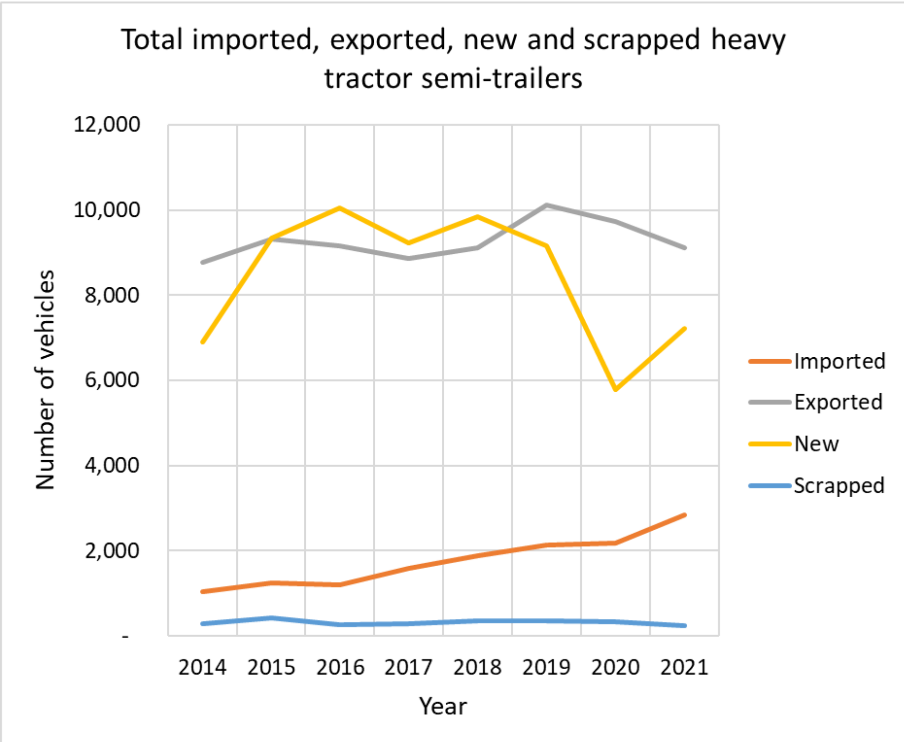


Figure 59: Total imported, exported, new and scrapped heavy tractor semi-trailers per year. The new sales of the heavy tractor semi-trailers has been constant until 2019 followed by a decrease in 2021 while the imports have been increasing while in the outflow, exports have been slightly increasing while scrapped vehicles decreased.

Another phenomenon observed in Figure 60 is the increase in imports of the heavy tractor semi-trailers. In the recent years, imported trucks have been increasing in the total inflow contribution. Imports was responsible for about 15% until 2018 but it is around 30% in 2021. This implies that there is a shift from new vehicles to imported vehicles which would impact the fleet and its age. This is discussed further in the next section.

The outflow is almost fully dominated by exported tractors, which contribute to over 95% of the outflow. This means that the tractors are not used in the Netherlands until the end of their lifetime but are rather mostly exported to other countries.

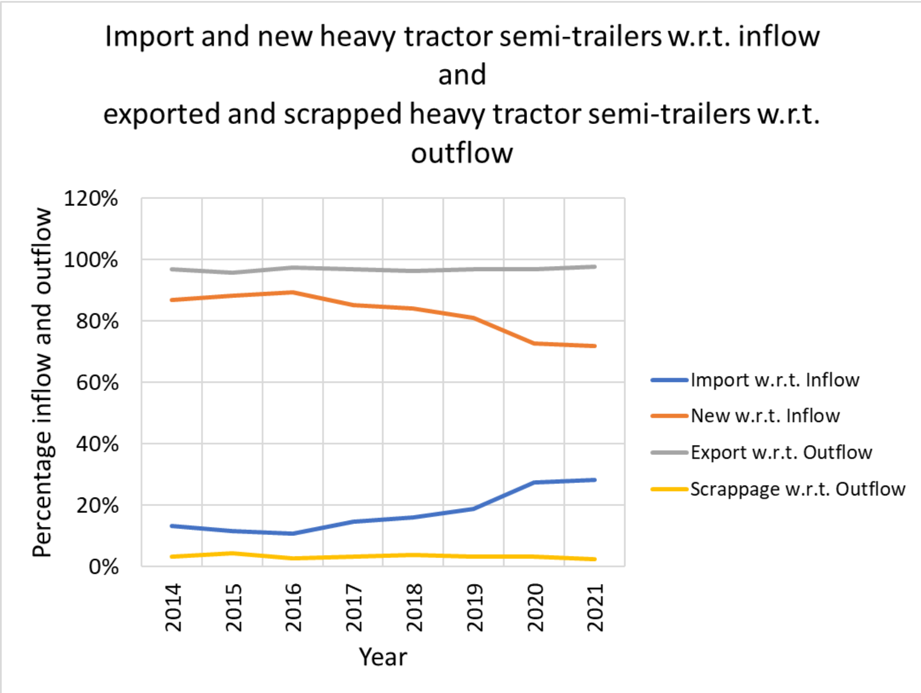


Figure 60: Percentage of imported and new *heavy tractor semi-trailers* as a share of total inflow in that year and the percentage of exported and scrapped heavy tractor semi-trailers as a share of the total outflow of registrations in that year. Total inflow and total outflow add up to 100% for each year.

4.4.2 Average age of heavy tractor semi-trailers

As seen in Figure 45, the average age of heavy tractor semi-trailers has been quite steady from 2014 to 2019 around 7 years after which it experiences a slight increase. Explanation for this can be further found in Figure 61. As can be seen in the figure, the average age of scrapped trucks has been increasing and the average age of exported vehicles has also been rising. This goes on to say that the trucks stayed longer in the Dutch fleet in 2021 than they were in 2014. Since the number of new vehicles were higher than exported vehicles until 2018, it reduces the effect of rising age of the exports , after which the effect of rising age of the exports also has a greater effect. But the increasing number of imports and the decreasing new sales lead to an increasing age of the fleet from 2019.

The stable average age of the heavy tractor semi-trailers until 2019 and then the slight increase after 2019 can hence be attributed to the following factors:

1. Until 2019 the inflow in the fleet was higher compared to the outflow. This has a decreasing effect on average fleet age.
2. The share of imports in the inflow is increasing with a slightly increasing age this is expected to have an increasing effect on average vehicle age. although this is reduced by the fact that inflow is increasing as well.
3. The increase in the number of imports after 2019 (Figure 59) with their age also increasing (Figure 61) lead to an increase in the average age of the fleet.

But the major contribution in the increase of average age of the tractor semi-trailer fleet in the period after 2019 was because of the increase in the age of exports. This implies vehicles stayed in the fleet longer in 2021 compared to 2014. With the number of exported vehicles also contributing to inflow more than the new sales (Figure 59), this effect was also more exaggerated.

4. Since scrapped vehicles contribute very little to the fleet outflow, they do not influence the average age of the fleet a lot.

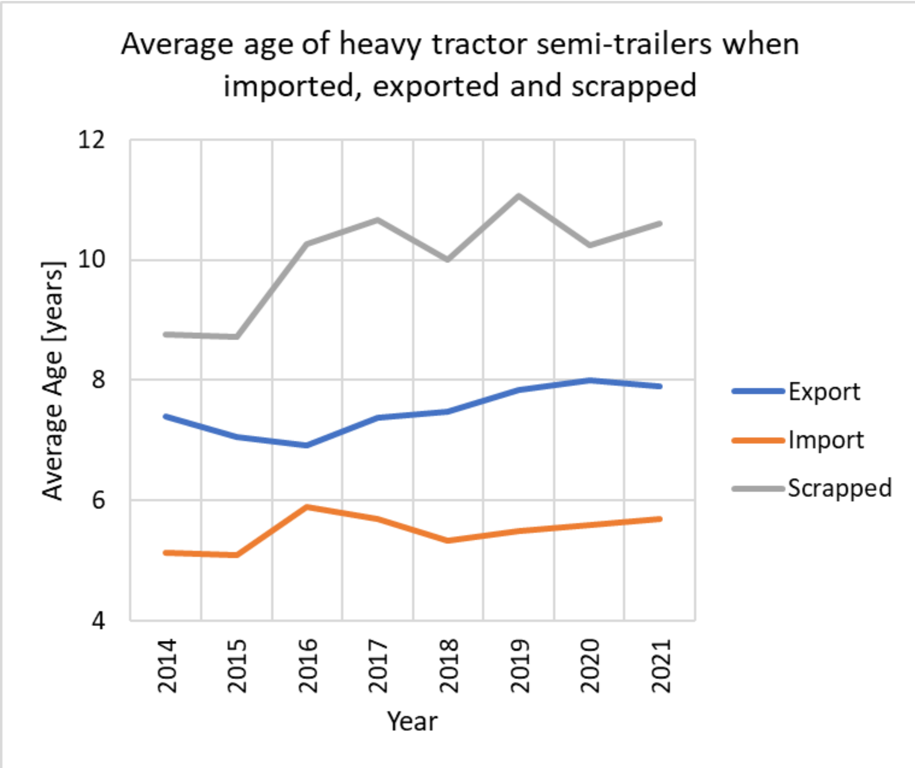


Figure 61: Average age of heavy tractor semi-trailers when they are imported, exported and scrapped. It is to be noted that the average age of is influenced by new (until 2018), exports (after 2018) and imported vehicles (in that order) more than scrapped vehicles (Figure 59).

4.4.3 Emissions from the heavy tractor semi-trailers when compared to the HDV fleet

To estimate the emissions of heavy tractor semi-trailers a similar methodology as passenger cars and vans was used for calculating the total NO_x, CO_2 and as elaborated in the section *Trends in Euro 5 and before vehicle groups and their impact on* total emissions.
Figure **62** shows the total number of vehicles (represented by R), the total CO_2, total NO_x and total exhaust-PM. The figure shows the share of heavy rigid trucks in the total heavy-duty vehicle fleet and its share in the number of kilometres along with the three aforementioned pollutants. This way, it can be inferred what portion of these tractor semi-trailers contributes to how much emission in the entire heavy-duty fleet in the country.

As can be seen, heavy tractor semi-trailers have been increasing in the fleet. They are also the most used heavy-duty vehicles in the fleet accounting for about 50% of the HDV fleet. Another noteworthy observation is the uptake of Euro 6 trucks, just like in the case of the medium-heavy and heavy rigid trucks.

In 2021, Euro 6 trucks were much more than Euro 4 and older trucks in the fleet.
The interesting observation is that in 2014, Euro 4 trucks drove 14% of the kilometres while the NO_x and exhaust-PM emissions were about 26% and 37% respectively. In 2021, Euro 4 trucks drove very little kilometres, about 2% of the total HDV kilometres but contribute to about 6% of NO_x and 14% of the exhaust-PM emissions. On the other hand, Euro 6 trucks drive about 65% of the kilometres but contribute to also about 50% of NO_x and 45% of exhaust-PM emissions. This goes on to say that the emission standards and the developments in technology from Euro 4 to Euro 6 has been quite impressive. It is a similar observation as in the case of medium-heavy-light, medium-heavy and heavy trucks where Euro 6 trucks do make a considerable difference in the share of emissions.
Tractor semi-trailers also drive about 80% of the kilometres but since the advent of Euro 6, in 2021, the NO_x and exhaust-PM have been about 75%. The uneven distribution of emissions between Euro 4 and older vehicles and Euro 6 vehicles is noteworthy.

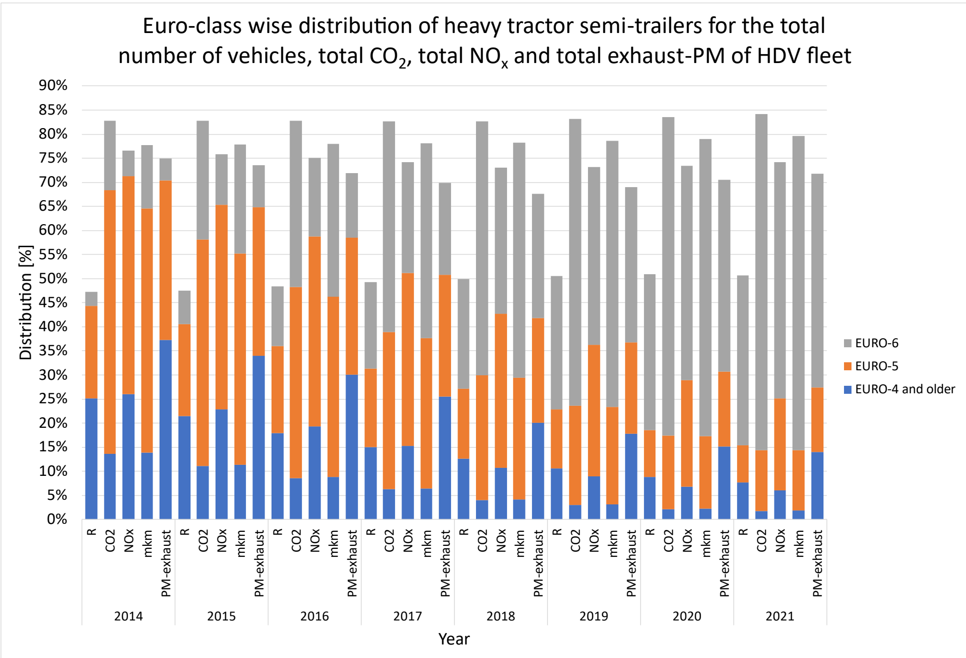


Figure 62: Distribution of the heavy tractor semi-trailers per Euro-class for the total number of vehicles (represented by R), total kilometres, total CO_2, total NO_x and total exhaust-PM based on kilometres driven by each Euro-class of vehicles when compared to the total heavy-duty vehicle fleet

5 Special issues regarding HDV's

5.1 CO_2 performance standards for heavy-duty vehicles

In 2019 the European Union agreed on the first CO_2 performance standards for new sold heavy-duty vehicles. The performance standards requires heavy-duty vehicles to reduce CO_2 emissions by 2025 with 15% compared to the baseline values. For 2030 the required reduction target is 30% compared to the 2019/2020 baseline[25]. The baseline is based on monitoring data from the first of July in 2019 until the end of June 2020[26] since both the baseline period and the reporting period have been shifted six months[27].

The performance standard currently applies to four out of eighteen vehicle groups and includes for about 65%[28] to 79%[29] of all new heavy-duty vehicles sold in the European Union. Vehicles are categorized based on axle type, chassis configuration and gross vehicle weight (GVW)[30]. Based on the current dataset it is not possible to present an accurate estimate for the number of vehicles in the Dutch fleet or sales that are covered with this legislation. Based on a new more extended dataset this would be possible.

Each vehicle group is further divided in sub-groups based on cabin type and engine power. Each group is to account for different mission profiles including urban delivery, regional delivery or long-haul deployment.

On February 14th the European Commission has presented its proposal for a tightened performance standard for 2030 and introduced new targets for 2035 and 2040[31]. Also the EC has proposed to broaden the legislation to include both busses and coaches and some types of trailers (O3 and O4). The targets are presented in Table 7.

[25] The CO_2 performance standard is described in regulation 2019/1242, see EUR-Lex - 32019R1242 - EN - EUR-Lex (europa.eu).
[26] The ICCT has published a report where they have analysed the baseline data and the respective baseline values for all OEMs. CO2 emissions from trucks in the EU: An analysis of the heavy-duty CO2 standards baseline data (theicct.org)
[27] ICCT, 2019. CO_2 standards for heavy-duty vehicles in the European Union
[28] TU Graz, 2012. hdv_2011_01_09_en.pdf (europa.eu) based on data for 2008 and 2009
[29] ICCT, 2021. ResearchGate based on 2019 IHS data
[30] ICCT, 2018. The European Commission's proposed CO_2 standards for heavy-duty vehicles.
[31] 2030 zero-emissions target for new buses and trucks (europa.eu)

Table 7: Targets per vehicle (sub-)group

Vehicle type	Baseline period	Targets			
		2025	2030	2035	2040
Trucks vehicle groups 4,5,9 and 10	2019/2020	-15%	-43%	-64%	-90%
Trucks vehicle groups 1,2,3,11,12,16	2024/2025		-43%	-64%	-90%
Trailers	2024/2025		-7,5%	-7,5%	-7,5%
Semi-Trailers	2024/2025		-15%	-15%	-15%

5.1.1 Specific average CO_2 emission

The CO_2 performance of trucks is based on simulated tail pipe emissions, according to a tank to wheel (TTW) approach using the energy consumption tool VECTO[32]. For each original equipment manufacturer (OEM) a fleetwide average CO_2 emission is calculated in gCO_2/t-km. The specific average CO_2 emission for a given OEM is based on the following steps:

1. For each subgroup CO_2 emissions are simulated for different cycles and payloads. The resulting CO_2 performance is weighted in order to arrive at a weighted CO_2 emission in gram per kilometre.
2. The result from 1 is divided by the average payload of the given subgroup which results in average CO_2 emissions of the subgroup in gram per ton-kilometre
3. Each subgroup emission factor is weighted using a mileage and payload weight factor (MPW) to account for differences in transport activity (e.g. Licht rigid trucks, on average drive less kilometres and transport less payload compared to a tractor semi-trailer and hence have a lower MPW).
4. The emissions factors are weighted based on the sales from the OEM which results in the sales based average CO_2 emission factor.
5. Finally in order to arrive at the average specific CO_2 emission factor for a given OEM in a given year a zero and low emission factor is applied to the sales based average CO_2 emission factor.

This calculation of the average specific CO_2 emission seems to be needlessly complex. Since both the payload factor and the MPW are constants the CO_2 emission could also be monitored using CO_2 in gram per kilometre, currently only data of CO_2 emissions for the base period are available on the EEA website. Though there is a catch. Since the CO_2 performance is compared to a 2019/2020 baseline a given OEM who has a given ratio between vehicle groups may shift this ratio towards vehicles with a higher MPW values in future years which would make the target more easily feasible for this specific OEM.

5.1.2 Flexibilities and ZLEV incentives

In the legislation several flexibilities and incentives are included which aim to provide OEM's some flexibility but do not have a major impact on the targets. In this section three different types of such measures are discussed.

[32] VECTO stands for Vehicle Energy Consumption Tool. For more information see Vehicle Energy Consumption calculation TOol - VECTO (europa.eu)

5.1.2.1 Super credits

In the 2019-2024 period ZLEVs are awarded super credits, meaning that vehicles with low or no tailpipe emissions are counted as more than one vehicle. Zero emission trucks are counted as 2 vehicles while low emission vehicles are counted as up to 2 vehicles. The value of a low emission vehicle can be calculated based on a linear function where vehicles with up to 50% lower emissions count as 1 and between 50% lower emissions and zero emission this increases linear to 2.

The ZLEV factor during this super credit phase is based on both the share of ZLEVs and the calculated multiplier for each ZLEV. Also zero emission vehicles outside of the regulated vehicle groups may be included in the ZLEV factor and may also be counted as two vehicles. The maximum effect of ZLEVs on a OEM’s target is capped at 3%, zero emission vehicles outside of the regulated groups may only contribute 1,5%.

Since the ZLEV factor is applied in step 5 this means that alle ZLEVs have a similar effect which benefits lighter trucks as they have a lower MPW factor. In the proposal of the EC no changes to the super credits phase are proposed.

5.1.2.2 Benchmarking

From 2025 onwards the super credit system is replaced by a benchmarking system. In this system OEMs are rewarded only when a given benchmark has been met. There are no negative consequences when the benchmark has not been met. Similar to the super credit phase also zero emission vehicles from outside the regulated vehicle groups may be included. Different from the super credit system is that zero emission vehicles count as 1 and low emission vehicles count as up to 1 based on a linear path between 50% lower emissions compared to the baseline emissions and zero emission. Currently the benchmark for ZLEVs is 2%. The effect of the ZLEV factor in the benchmarking phase is capped at 3%.

In the new proposal the Benchmarking phase ends per 2029. The initial goal of this flexibility was to incentivise OEMs to produce ZE trucks but given the direction the market is headed and the new stricter targets the EC expects that this incentive is no longer necessary.

5.1.2.3 Banking and borrowing system

In the 2019-2030 period there is a linear reduction path based on the prevailing targets for each OEM. The banking and borrowing system consists of two schemes divided in time. The first system runs from 2019 until and including 2024 and may be used to comply with the target of 2025. The second system runs from 2025 up to 2029 and all debt should be cleared in 2029. After 2029 the banking and borrowing system is stopped.

Credits can be earned if the specific average CO_2 emission of an OEM in a given year is below the reduction trajectory based on the linear path between the baseline and the targets. is baseline credit are accumulated. in the 2019-2024 period no debt is accumulated. in the 2025-2029 period debt is accumulated if the specific average CO_2 emission of an OEM is above the target value for 2025 (-15% compared to the baseline).

In the new proposal the EC extends the banking and borrowing scheme until 2040. Credits remain valid until 2040 while debts have to be cleared before a next target is implemented.

5.1.2.4 Vehicle trading

The EC proposed a new flexibility which is vehicle trading. Economically connected manufacturers (e.g. Volvo owns both Volvo and Renault trucks) may trade conventional trucks between them if this is necessary to reach the given target. This trading of conventional trucks is not allowed if manufacturers are not connected. Zero emission vehicles are allowed to be traded between manufacturers that are not economically connected.

5.2 Current uptake of zero emission (ZE) vehicles in the HD market

While the proposal of the European Commission is expected to include tightened performance standards the current market uptake of electric heavy-duty vehicles is rather limited. Expectations are that in the short to medium term this might increase rapidly which would also be due to stricter European emission performance standards.

In Figure 63 the uptake of zero emissions trucks in the new sales per segment are visualised. For tractor semi-trailers, which is the major part of the total heavy-duty fleet, this share remains well below the 1% mark. Only for medium-heavy-light rigid trucks there was a share of almost 9.5% in 2019 which dropped back to almost 3% in 2020. This drop might in part be due to the COVID-19 crisis, but it is also very likely that uptake of zero emission trucks is directly depended on financial incentives (DKTI projects and subsidies).
The uptake of zero emission trucks in the heavy-duty fleet per segment is presented in Figure 64. For all vehicle segments the share remains well below the 1% mark. This shows that there is still a big challenge ahead to realize a net zero heavy-duty fleet in 2050.

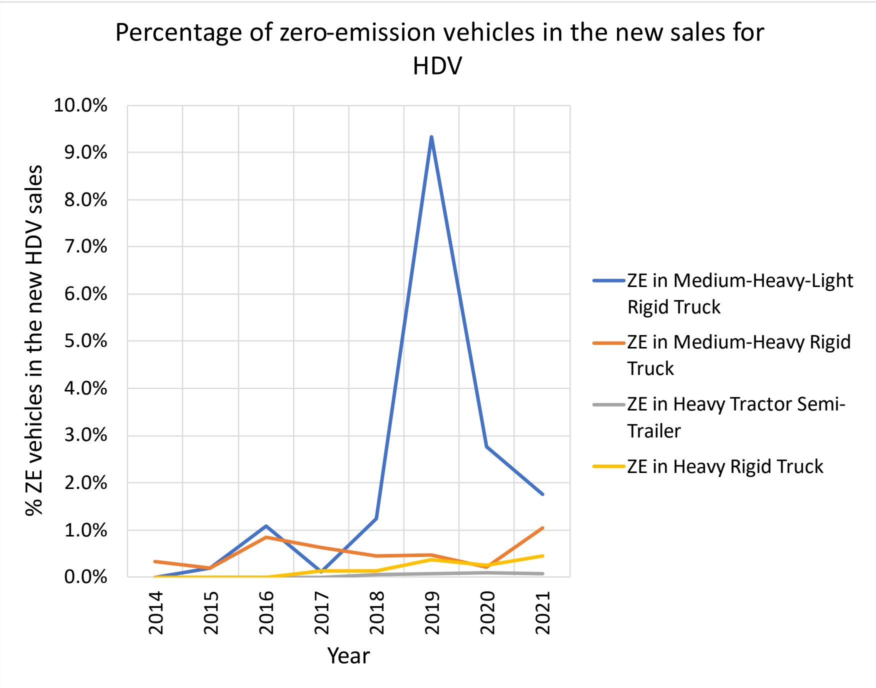


Figure 63: Percentage of zero-emission vehicles in the new sales every year.

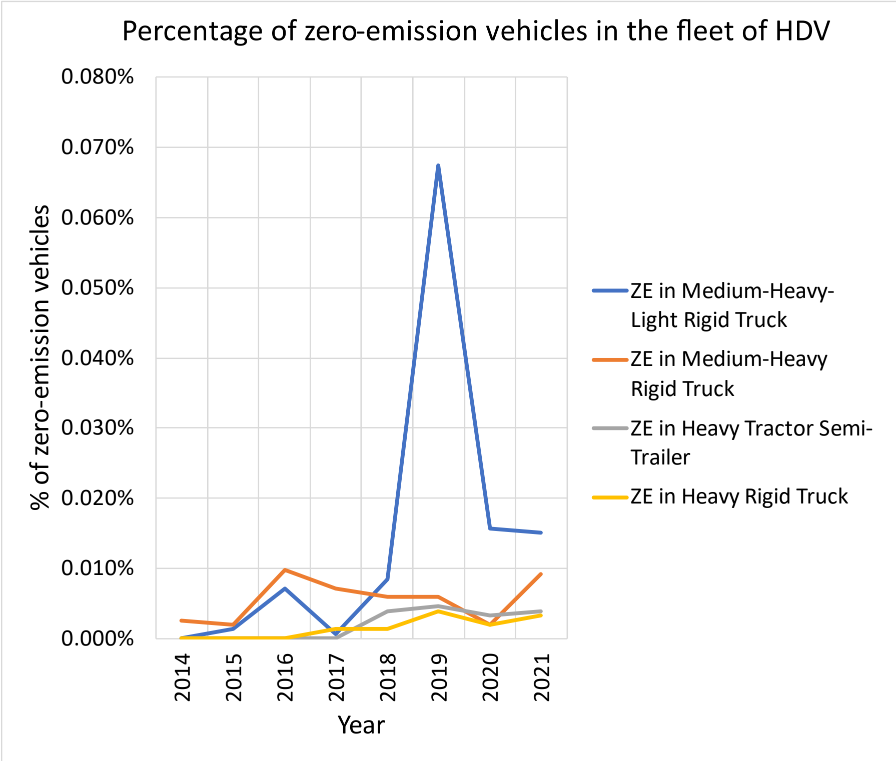


Figure 64: Zero-emission vehicle uptake in the HDV fleet. It can be seen that he smaller trucks see quite a spike in the electrification in the recent years but the heavier (long haul) trucks do not see a considerable shift.

5.3 ECO-Combi

Apart from CO_2 performance standards, a second way to reduce CO_2 emissions per ton-kilometre is to have longer trucks. Standard rigid trucks with trailer are allowed to have a maximum length of 18.75 metres and tractor semi-trailers may have a total length of 16.5 metres. Per 2020 the European Commission has laid down legislation which allows trucks to have a longer cabin to allow for better aerodynamics. This allows such vehicles to surpass the above-mentioned maximum lengths of the vehicle combinations.

Per 2013[33] it is allowed in the Netherlands to drive with longer heavier vehicles (LHV, or Eco Combi) with a total length of maximum 25.25 metres and a total mass of 70 tonnes. According to Daimler this can reduce fuel consumption by 15-20% since two LHV's can replace three standards tractor semi-trailer[34]. Research[35] found a 16% CO_2 reduction compared to a standard tractor semi-trailer for an Eco Combi (LHV) and 27% CO_2 reduction for Super Eco Combi's (SECs) reduction. A super Eco combi is a combination with a total length of 32 metres. For an overview of the combinations see Figure 65.

[33] wetten.nl - Regeling - Beleidsregel keuring en ontheffingverlening LZV - BWBR0032533 (overheid.nl) wetten.nl - Regeling - Beleidsregel keuring en ontheffingverlening LZV - BWBR0032533 (overheid.nl)
[34] Daimler, 2015 as mentioned in Zyl, van P.S et al. 2017. Using a Simplified Willans Line Approach as a Means to evaluate the Savings Potential of CO2 Reduction Measures in Heavy-duty Transport
[35] Cider L, Larsson L, HCT DUO2-project Gothenburg-Malmö in Sweden, 2019

Early 2022 the Dutch government has stopped experiments with SECs on Dutch roads[36]. Late 2022 the government has started talks about new experiments with SECs starting late 2023[37].

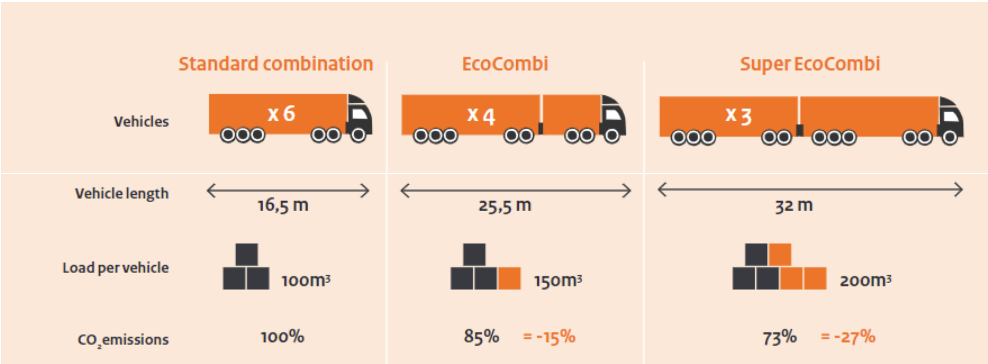


Figure 65: Length and relative CO_2 emissions of Eco Combi (LHV) and Super Eco Combi (from Factsheet Super EcoCombi)

[36] Regering zet streep door Super EcoCombi (logistiek.nl) Regering zet streep door Super EcoCombi (logistiek.nl)
[37] Goede voortekenen voor een pilot met Super EcoCombi - Transport en Logistiek Nederland (tln.nl) Goede voortekenen voor een pilot met Super EcoCombi - Transport en Logistiek Nederland (tln.nl)

6 Conclusions

6.1 Fleet renewal rates

Analysis of the RDW vehicle mutation dataset shows that the Dutch vehicle fleet is growing. From 2019 onwards the growth seems to be declining, commonly attributed to COVID-19. But the trends have almost completely reversed in 2021.

The increase in absolute numbers is highest in the passenger car fleet while in terms of percentages the increase in the van fleet is almost twice as high compared to the passenger car fleet. Combined with the fact that vans have higher emissions compared to passenger cars, this justifies policies targeted at vans as has been announced in recent government plans.

The HDV fleet also has some interesting trends. There is a shift observable to either lighter rigid trucks or the heavy semi tractor-trailers as both of these fleets have been increasing stronger than average in the years between 2014 and 2021. This comes at the expense of medium-heavy rigid trucks. The new sales of which has been on the decline since 2018. The heavy rigid trucks have seen a limited increase in total fleet size.

The analysis shows that for all modalities and truck segments studied that the number of imports are increasing. In most cases this seems a shift from new to imported vehicles which de facto leads to more (pollutant) emissions. This raises the question what the drivers are behind this shift, this has not been studied further here.

6.2 Average fleet age

Both the passenger car and van fleet have higher new registrations compared to the outflow. Which entails that both fleets are growing in size. For the passenger car fleet this also results in a higher average age of the fleet while the average age of the van fleet remains fairly level since 2016. Especially for passenger cars this brings with it the risk that there are more and more older vehicles in the fleet with relatively high emissions. This trend towards an older and more polluting fleet has a negative impact on air quality and climate change. Also if this trend is not broken this might also have a negative impact on the target to have a zero-emission passenger car fleet in 2050.

The trends are also similar for the HDV fleet. The average age is increasing for all the vehicle categories. In most cases of the HDV fleet, the vehicles are, on average, not used in the Netherlands until the end of their lifetimes but are rather exported. Nevertheless the age difference between the average fleet age and the average age of scrappage is about 3 to 4 years while for passenger cars and vans this is substantially higher with respectively 8 and 7 years. This shows that for trucks a bigger part of their useful lifespan is spent in the Netherlands compared to passenger cars and vans.

The increasing age can be attributed to the increased age of exported vehicles. Another reason for the increasing age is because of the increasing number of imports across the board and in most cases, the slightly increasing age of imports. Since the imported vehicles come at the expense of newer vehicles, they contribute to the increase in the average age.

6.3 Trends in passenger car and van ownership

The trends in vehicle ownership were analysed for vehicle transactions between 2016 and 2019. The four parameters analysed were age of the vehicles, mass of the vehicle, brand loyalty, fuel-type of the vehicle and the type of vehicle ownership. It was important to notice that the data analysed for this exercise was limited in time until 2019. The limitation of this data prevents further analyses in the more recent trends regarding ownership of vehicles but could be strengthened if newer data for ownership becomes available.

For passenger cars, it was notable to see that there is a group of people buy older vehicles. They sell their old vehicle (aged 13 to 18 years old) to replace it with another vehicle which is also quite old (10 to 17 years old). There is more research needed into this to explore what drives this group and they can be influenced to buy cleaner and more fuel-efficient vehicles. The mass of the passenger cars has been on the rise through the years. People making a shift to heavier cars can be attributed in part to the fact that newer systems in the cars weight more, thereby increasing the weight of the car. Another important reason is expected to be the shift to SUV's. The share of SUVs in new sold vehicles has been increasing since 2013 hence also increasing the mass of new vehicles. Since the data was limited to mid-2019, the uptake of electric vehicles was rather limited therefore this is expected to have a limited effect on the increased vehicle mass.

The analysis into brand loyalty it seems that this phenomenon is not very strong. From the analysis it appears that in the strongest case only 55% of the people chose the same brand as they had before. It is expected that if the analysis is repeated with more recent data that this might be even lower due to the introduction of electric vehicles that also introduced new brands on the market. For fuel-type preference, petrol vehicles is the choice of most people which would be expected since this is the largest part of the passenger car fleet. Interesting is that 56 percent of people who previously owned an diesel vehicle now opt for a petrol vehicle. Which indicated that the preference for petrol vehicles increases even further. An interesting finding was with electric vehicles. Until 2019, Only 41% replace their electric vehicle with another electric vehicle while 40% of them change it for a petrol vehicle. While this is interesting the explanation is rather difficult for a number of reasons.
For instance currently the market of electric vehicles is mainly an operational lease market. It might be that people shift to an electric lease vehicle and opt for a second car with a petrol drivetrain. The last parameter analysed was the type of ownership of the vehicle. The preference for used vehicles was the most prominent. It implies that the second-hand market in the Netherlands is quite big and it explains the increasing numbers of imported vehicles. 93% of the people having an older vehicle (used vehicle) end up buying a used vehicle as well while 50% of the people who had a new car also ended up replacing it with a used car.

Similar analysis for vans were performed. For the van transactions in terms of age, it was found that people tend to keep their vans for much longer than people keep their passenger cars. They change their van aged 2 to 15 years old for a younger 0 to 1.5 year old van. But, similar to the passenger car group, there is a group of people in the vans group who prefer older vans. They sell their 9 to 16 year old van for an also an older 4 until 11 year old van.

Again, further research is needed into this group of people to understand what is necessary for this group to buy a younger and more environmentally friendly vehicle. Similar trends as in passenger cars for mass of the vehicle was observed in vans. People were more inclined to buy heavier vans. Unlike passenger cars, diesel was the choice of fuel for vans. It was primarily the most preferred fuel-type. Since the data is limited until 2019, there were very little transactions of electric vans to make a proper conclusion. This could be enriched with newer data. In terms of the type of ownership of vans, similar conclusions passenger cars be drawn. There is high preference for second hand vans.

6.4 Trends in Euro 5 and older vehicle groups

A number of small groups of vehicles contribute disproportionally to the total emissions of light-duty vehicles. In particular Euro-4 (and before) and Euro-5 diesel vans along with euro 5 diesel passenger cars have substantial share in the NO_x emissions, and Euro-4 and older vans and passenger cars, despite the small size of the group dominate the total exhaust-PM emissions. These estimates are based on kilometres driven by the vehicle. The number of vehicles in each of these groups are relatively small, but their share in NO_x and exhaust-PM emissions decreases slowly, despite the ages of these groups.

In the case of the HDV fleet, the trends are not as strong as in the case of the LDV fleet. Although the group of Euro 5 and older vehicles contribute substantially more than the newer vehicles (Euro 6 vehicles), they have almost fully been replaced by the newer vehicles. This in turn means that although they contribute relatively more to the emissions (both NO_x and exhaust-PM) than a newer Euro 6 vehicle, they do not contribute so much in absolute terms.

6.5 Climate actions

Plug-in hybrid vehicles aim at reducing the total CO_2 emissions. However, it appears that the real-world CO_2 emissions are about the same as for ICE vehicles since 2018. The share of electric kilometres driven with a Plug-in Hybrid vehicle is way lower than assumed in the WLTP type approval test. Hence PHEVs are not as fuel efficient as often assumed and additional policies at both the European and national level might be necessary to address this issue.

Analysis from the export of lease vehicles with an age of 3 to 6 years show that this group has lower CO_2 emissions compared to the total export group. Also it appears that this group has lower CO_2 emissions compared to the new sales of 3 to 6 years earlier which implies that fuel efficient vehicles are leaving the fleet. This emphasises the need for policies for business cars to be directed at cars that are in demand in the private car market.

New sales of passenger cars have lower CO_2 emissions compared to vans. However in part this is due to an increasing share of zero emission vehicles in the Dutch passenger car new sales while for vans the share of zero emissions new sales falls behind.
Compared to other European member states the Netherlands do have relative low CO_2 emissions from new sales registrations. In part this can be attributed to several tax discounts for low emissions vehicles in the past and zero emissions vehicles today.

6.6 Future research

In this analysis it was found that the fleet of medium-heavy-light rigid trucks and tractor semi-trailers is increasing at the expense of medium-heavy rigid trucks. Also since 2018 the sales of the medium-heavy rigid trucks is decreasing. Further research should focus on what drivers are behind these shifts. This could be due to a shift in transportation demand or a shift in use-cases of trucks. This could be explored by studying CBS data.

Another important topic for future research should, amongst other topics, focus on the increasing fleet age of all vehicles analysed in this report. An aging fleet might lead to older vehicles driving relatively more kilometres and hence road vehicles will have a bigger impact on both pollutant emissions and climate impact. In most cases the reasons found for the increasing age in this analysis were older exports and an increase in imports. Future research should focus on understanding these developments better so future policies might reverse these trends.

A third important topic for further research would be to study the drivers behind the increasing number of imports as to understand how this increase could possibly be reversed in order to lower emissions. Also it would be interesting to find out if there are particular age groups in imports that have increased, which could help in understanding the rise in imports. Another interesting topic would be to study policy measures that are needed to mitigate the negative effects of the current registration tax (BPM) for passenger cars. Also, other basis for the determination of a registration tax could be considered and its possible effects compared to current policy.

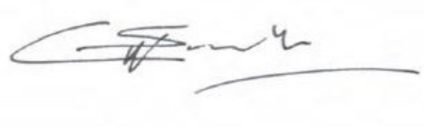
For Euro 4 and Euro 5 passenger cars and vans additional research is necessary to find pathways to reduce NO_x emissions faster.

Finally, future studies should also investigate the need for (additional) policy measures for vans and monitor the effects of the annulment of the registrations tax for business vans.

Throughout the report it has been mentioned that the ownership analysis is based on an older dataset and that newer data could shed light on the question if the trends found here still hold true in today's market. This is especially interesting for the passenger car market as in this segment the uptake of zero emissions vehicles has been highest.

Signature

TNO › Mobility & Built Environment › The Hague, 8 December 2023



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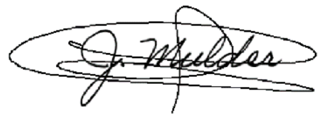

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