ESG Economist

Emission scenarios for road mobility

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- **Whereas GHG emissions for the Netherlands declined by 29% between 1990 and 2022, GHG emissions from mobility declined by only 8%**
- **We have defined three possible future emission scenarios for cars, buses, vans and trucks namely policy/positive scenario, a base scenario and a negative scenario**
- **For the policy scenario, which is also the positive scenario, we assume that the targets that the government has set will be reached and the charging and fuelling infrastructure will be ready on time. In this scenario, we also assume that the technologies develop in such a way that shortages of metals and/or batteries will be avoided and that marginal abatement costs of crucial technologies will decline and stimulate the adoption of zero-emission vehicles.**
- **In our base scenario, we take government policy as a starting point but also incorporate some of the bottlenecks such as affordability, shortages of metals and batteries, delay of infrastructure readiness. The marginal abatement costs of the crucial technologies will decline but not enough to considerably stimulate the adoption of zero emission vehicles beyond the early movers.**
- **In the negative scenario, we assume that there are substantial bottlenecks. The affordability remains an issue in cars as prices will rise due to substantial shortages in metals and/or batteries. The technologies will remain expensive resulting in a substantial longer use of old vehicles with internal combustion engines. Moreover the infrastructure will be far from ready for both battery electric vehicles and for fuel cells. There remains limited availability of green hydrogen and synthetic fuels for road transport and they remain expensive.**

Introduction

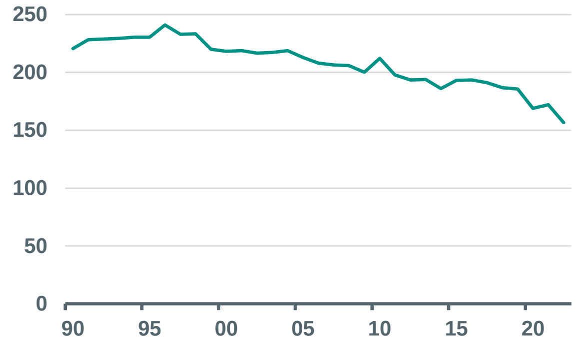
In this ESG Economist publication, we start with an overview of the greenhouse gas emissions for the mobility sector in the Netherlands. Here we find that the mobility sector is lagging behind in reducing greenhouse gas emissions compared to the trends in emissions in the Dutch economy as a whole. Then we define three emission scenarios for the subcategories of road mobility: cars, buses, vans and trucks. With these scenarios we can clearly see what the possible trajectories are for these subsectors and crucially what the key assumptions are behind the different trajectories. Going forward, by monitoring developments in these assumptions, we can assess what trajectory looks most likely. We set out the following scenarios: policy/positive, base and negative. The policy scenario is also the positive scenario assuming that the government policy is executed according to plan and the bottlenecks are sufficiently addressed. In the other scenarios we take into account bottlenecks such as affordability, technology, costs, shortage of metals, challenges to adjust the grid that result in a deviation from the policy scenario.

Greenhouse gas emissions

In 2022 the Netherlands emitted 156.6 megaton greenhouse gas emissions. This comes with a reduction of around 29% compared to 1990. The mobility sector emitted 29.6 megaton in 2022; a reduction of only 8% (see the graphs below). The mobility sector clearly lags behind in terms of reducing greenhouse gas emissions compared to the Netherlands overall. The government has set ambitious targets in reducing emissions in this sector, even more ambitious than the EU27.

GHG emissions Netherlands

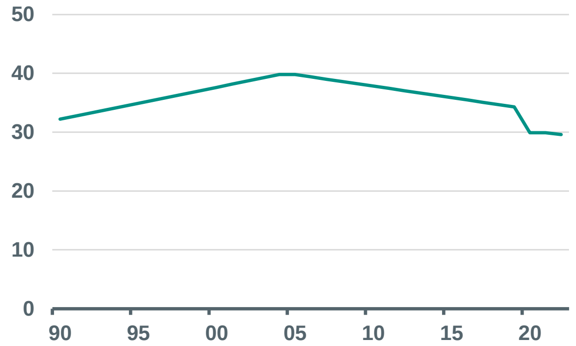
In Mt



Source: CBS, ABN AMRO Group Economics

GHG emissions mobility sector

In Mt



Source: CBS, ABN AMRO Group Economics

The mobility sector includes emissions from personal cars, light-duty vehicles or vans, heavy-duty vehicles or trucks, buses/motors/motorcycles, construction traffic and domestic navigation. Road transport is the biggest emitter in the mobility sector. It is responsible for around 85% of the total emissions of the mobility sector. Passenger cars account for around 51% of emissions of the mobility sector. Heavy duty vehicles account for 20% of the emissions, light-duty for around 11% and buses/motors/motorcycles for around 3%. The table on the left below shows the greenhouse gas emissions of the Netherlands in 2022 and the table on the right the possible emissions reductions per subcategory if the emission shares are taken into account.

Shares of GHG emissions mobility NL

In % and Mton

	Emissions GHG in %	GHG end 2022 in Mton
Cars	51%	15.1
Heavy duty	20%	5.9
Light duty	11%	3.3
Buses, motors and motor cycles	3%	0.9
Contruction traffic, mobile tools & machinery	10%	3.0
Shipping NL & fishery	5%	1.5
Mobility total	**100%**	**29.6**

Source: CBS, ABN AMRO Group Economics

Emissions reductions by 2030 per subcategory

In Mton

	Reduction GHG 2030	Emissions GHG 2030 Mton
Cars	4.4	10.7
Heavy duty	1.7	4.2
Light duty	0.9	2.3
Buses, motors and motor cycles	0.3	0.6
Contruction traffic, mobile tools & machinery	0.9	2.1
Shipping NL & fishery	0.4	1.1
Mobility total	**8.6**	**21.0**

Source: CBS ABN AMRO Group Economics

Scenarios for road mobility

Positive/policy scenario

The policy scenario is our positive scenario. It assumes that the government policy is executed perfectly according to plan and that the bottlenecks are sufficiently addressed. The government policy plays a crucial role in the decarbonization effort of a subsector. Government policy can limit the choices in buying new vehicles (for instance, all new cars need to be zero-emission in 2030), it can make the use of fossil fuels more expensive (mobility part of ETS2 in 2027) and it can make electric vehicles less expensive by subsidies. Finally, it can facilitate the rolling out of charging infrastructure. However, the reality is usually far messier than policy and plans. There are a number of bottlenecks that could result in a path deviating from policy targets. In the base scenario we take some of these bottlenecks into account, for the negative scenarios we assume that the bottlenecks are more substantial. In both the base and the negative scenarios we assume no change in government policy but that the bottlenecks cause the deviation from the policy. So in these scenarios, policy is not assumed to be delayed but the rise of unexpected bottlenecks would make these policies less effective. Accordingly, despite the ambitious targets, the base and the negative scenarios show that it is unlikely that these emissions targets will be met.

Base and negative scenarios

In the other scenarios we take into account bottlenecks that result in a deviation from the policy/positive scenarios. There are a number of bottlenecks that can cause a deviation in the trajectory from the policy scenario, and the strength of these bottlenecks is responsible for the size of this deviation. We mention some of the most likely bottlenecks, but there could be also others.

First, the availability of, and the initial investment in, certain technologies for a subsector play a crucial role in the decarbonisation effort of a subsector. For example, the total ownership of a vehicle may be attractive, but the initial cost does not match the willingness to pay by consumers. Another example is that a vehicle with a fuel cell that burns hydrogen may be possible, but the infrastructure is in limited availability, while this technology is expensive. A third example could be related to the weight of the battery, the current range of the battery and the lack of charging infrastructure, which could make investing in battery-electric trucks unattractive. Accordingly, the battery technology needs to be developed further.

Second, even if the technology is readily available, as is the case for lithium-ion batteries in cars, a shortage of the needed metals or shortage of batteries could still result in a delay of the transition. China dominates the mining and processing of these critical metals and plays a crucial role in battery technology and manufacturing. This is also the case for the availability for other fuels in road transport. Most of the synthetic fuels that could be used in internal combustion engines are not produced on a large scale.

Third if the costs of the fuel are very high, as is the case for green hydrogen and synthetic fuels, the subsector may prefer to continue to use internal combustion engines burning fossil fuels. These alternative fuels are not competitive which slow the uptake of associated technologies. So then there is little incentive to decarbonize in this subsector. This could also delay the decarbonisation of the subsector.

Fourth, the shortage in technical personnel and slow upgrades of the electricity grid are also possible bottlenecks. Finally the fuelling infrastructure is also an important bottleneck.

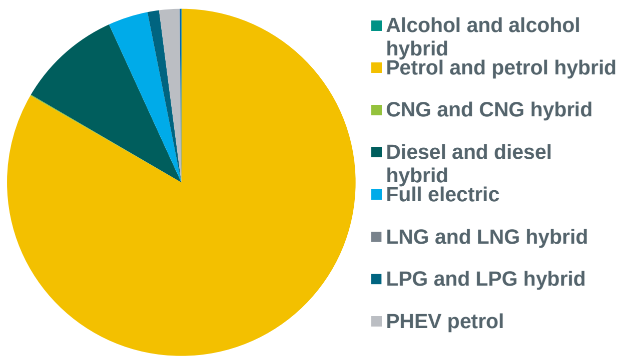
Scenarios for cars

Climate policy cars

The Dutch government's policy is that 50% of every new car sold will have an electric powertrain and a plug in 2025At least 30% of these vehicles (15% of the total) will be zero emission (battery electric or fuel cell). In 2027 road mobility becomes part of ETS2. Moreover, in 2030 all new passenger cars sold will be zero-emission. This can be battery electric car or a hydrogen fuel cell electric car. This target is more ambitious than the EU27 target which has this ban starting in 2035. Another target is to have 8 bn less work-related kilometres by car in 2030. In 2022, in the Netherlands there were close to 8.9 million cars on the road (source CBS). The graph below shows the share of the fuel types of the fleet.

Fleet composition cars 2022

In %



Source: CBS, ABN AMRO Group Economics

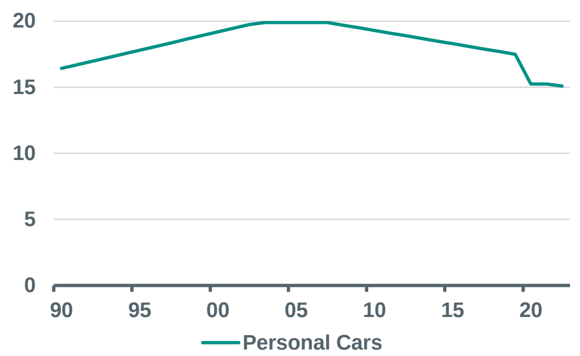
The fuel type petrol and petrol hybrid take the largest share accounting for 83% of the total; diesel accounts for 10% and full electric 4%, while the share of fuel cell cars is negligible. On average 380,000 cars are sold annually (average of 2016-2022 including the dampening impact of chip bottlenecks). Before the pandemic 440,000 cars were sold annually. We assume that the average life of a car is 15 years. For the greenhouse gas emissions of the different scenarios we take into account the total emissions in recent years and the composition of the fleet.

Scenarios for cars

For the positive scenario we assume that policy targets are reached and that the needed charging points (total of 1.8 million by 2030) are installed on time and that grid is adjusted to deal with the extra electricity demand. We also assume that the battery technology improves so that the range is increased and lower amounts of critical metals are used. Furthermore, we assume that the annual car sales reach 440,000 cars again even once the combustion engine sales ban comes into force, meaning that the change in the stock in vehicles to electric cars occurs at a rapid pace.

GHG emissions personal cars

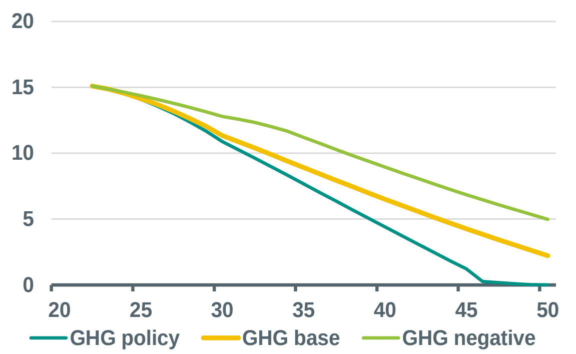
In Mt



Source: CBS, ABN AMRO Group Economics

Emission scenarios personal cars

In Mt



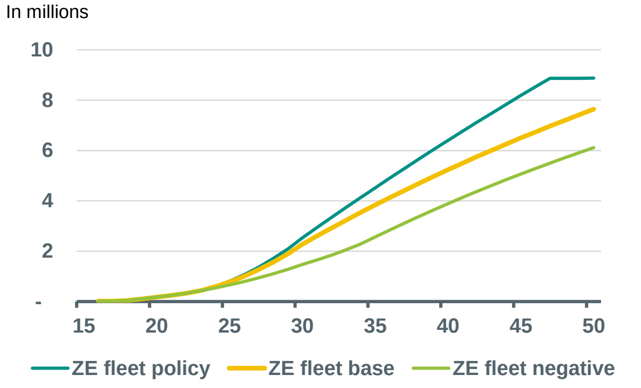
Source: ABN AMRO Group Economics

Indeed, the fleet of zero emission cars (mainly full battery electric) rises substantially and vice versa the fleet of cars with internal combustion engines and the greenhouse gas emissions drop (see graphs above and below).

For the base scenario we assume that the annual car sales will remain at the lower average of 380,000. We also assume that some of the charging infrastructure will not be ready on time and that there will be a shortage of critical metals and/or batteries which result in some higher prices of battery electric vehicles. Apart from the early adapters, consumers will choose to drive longer with their car with an internal combustion engines burning fossil fuels. As a result greenhouse gas emissions don't drop to zero.

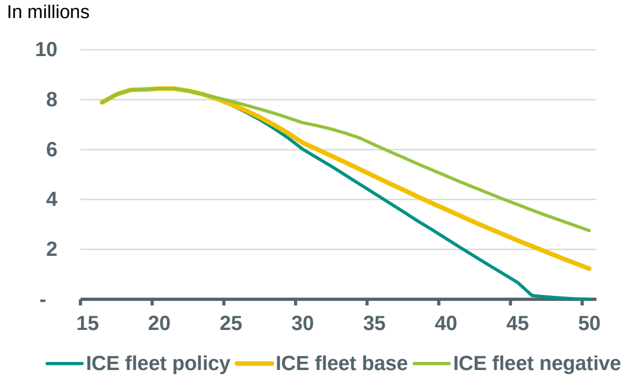
For the negative scenario we expect annual car sales to fall back further and consumers to drive much longer with their old vehicles due to higher prices as result of critical metals shortage and/or battery shortage. The lack of technical personnel and lack of investment to upgrade the grid results in a substantial delay in the needed charging infrastructure. As a result the fleet of cars with internal combustion engines and greenhouse gas emissions remain significant. The graphs below show that the fleet of zero-emission cars will rise more slowly and the fleet of internal combustion engine cars decline at a slower pace.

Fleet zero-emission (full battery, fuel cell) cars



Source: ABN AMRO Group Economics

Fleet internal combustion engine cars



Source: ABN AMRO Group Economics

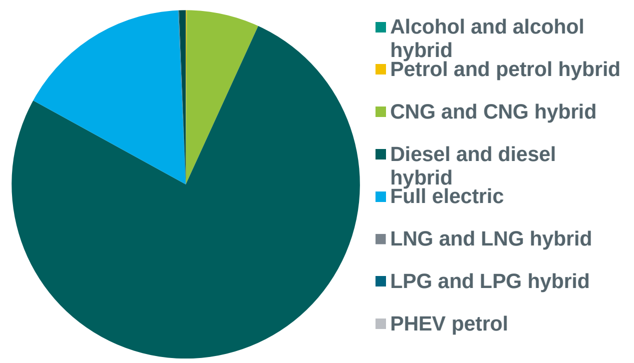
Scenarios for buses

Climate policy buses

The Dutch government's policy states that starting from 2025 all new buses used in public transportation should be zero-emission buses and they must use regionally-produced renewable energy. In 2027 road mobility becomes part of ETS2. From 2030 all buses used in public transportation should be zero-emission buses. This refers to approximately 5,248 buses. In 2022, in the Netherlands, there were close to 8,756 buses on the road and a large part of these were city buses. The graph below shows the share of the fuel types of the fleet.

Fleet composition buses 2022

In %



Source: CBS, ABN AMRO Group Economics

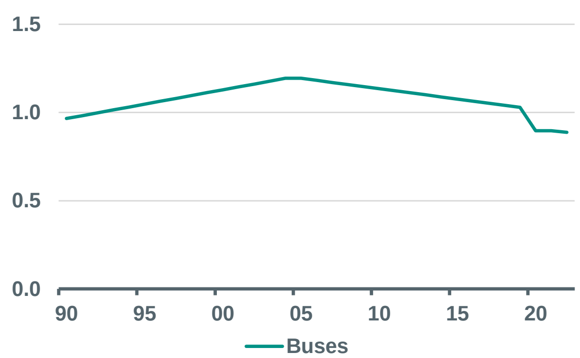
The fuel type diesel and diesel hybrid take the largest share, accounting for 76% of the total; full electric accounts for 16% and fuel cell accounts for only 0.6%. On average 290 buses are sold annually. We assume that the average life of a bus is 12 years. For the greenhouse gas emissions of the different scenarios we take into account the total emissions in recent years and the composition of the fleet.

Scenarios for buses

For the positive scenario we assume that policy targets are reached and that the (overnight) charging infrastructure is ready on time and that the grid is adjusted to deal with the extra electricity demand. We also assume that the battery technology improves so that the range is increased and lower amounts of critical metals are used. Moreover for long-distance travel there are mainly fuel cell buses. In the policy/positive scenario the fleet of zero emission buses rises substantially and the fleet of buses with internal combustion engines and the greenhouse gas emissions drop (see graphs below).

GHG emissions buses

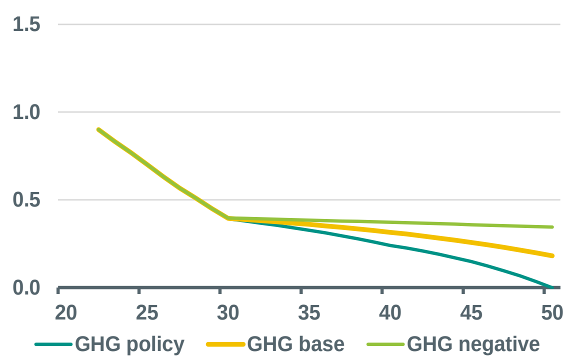
In Mt



Source: CBS, ABN AMRO Group Economics

Emission scenarios buses

In Mt

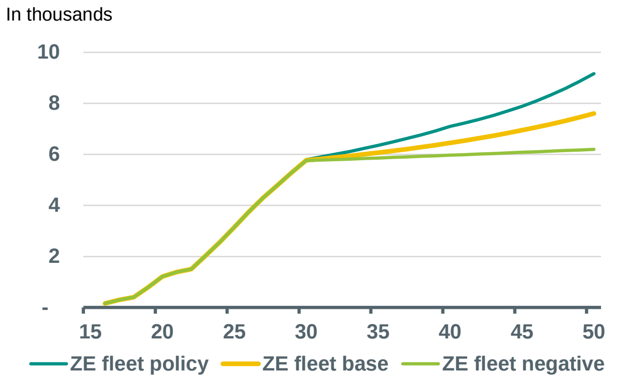


Source: ABN AMRO Group Economics

For the base scenario we assume that there will a similar number of electric buses, but considerably less fuel cell buses after 2030. We also assume that some of the charging infrastructure for overnight charging will not be ready on time and that the fuel cell infrastructure will also be ready later. There will be a shortage of critical metals and/or batteries which drive up the price of battery electric vehicles. As a result the fleet of zero emission buses will grows more slowly and hence greenhouse gas emissions will go down also more slowly.

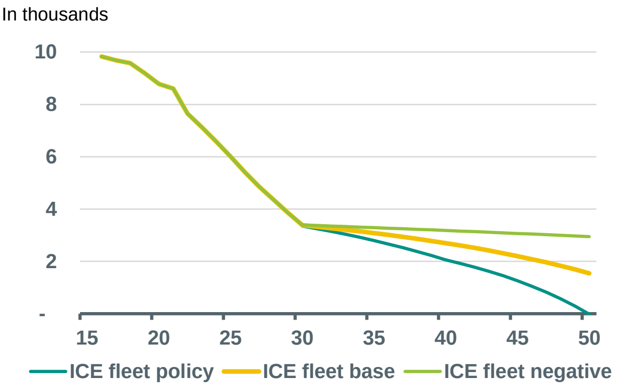
For the negative scenario we expect a substantially lower amount of battery electric buses and fuel cell buses. In this scenario the overnight charging infrastructure and the fuel cell infrastructure will be delayed substantially. There also is a substantial shortage of materials and the battery range is not sufficient for long-distance bus travel. As a result, the path of reducing emissions will be slow and there will be a considerable ongoing emissions.

Fleet zero-emission (full battery, fuel cell) buses



Source: ABN AMRO Group Economics

Fleet internal combustion engine buses



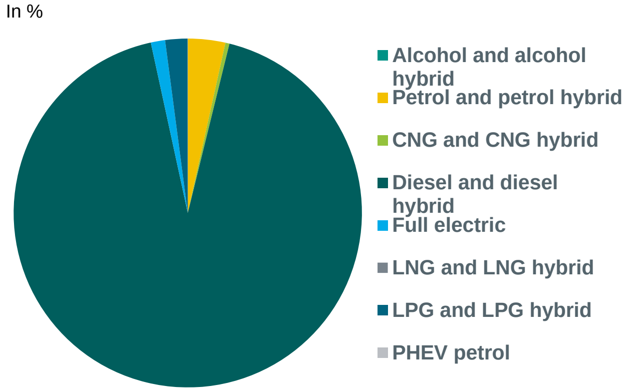
Source: ABN AMRO Group Economics

Scenarios for vans

Climate policy vans

The Dutch government's policy is that in 2025 there are middle-sized zero-emission zones for trucks and vans in 30 to 40 municipalities and that there are 50,000 zero emission vans. In addition, in 2027 road mobility becomes part of ETS2. Furthermore, in 2030 all construction traffic (including vans), mobile tools and machinery should be zero-emission. Next to this the government expects that there are 115,000 zero emission vans in 2030. The EU has set a 100% CO2 emission reduction target for both new cars and vans by 2035. In 2022 there were 1,024,000 vans on the road in the Netherlands. The graph below shows the share of the fuel types of the fleet.

Fleet composition vans 2022



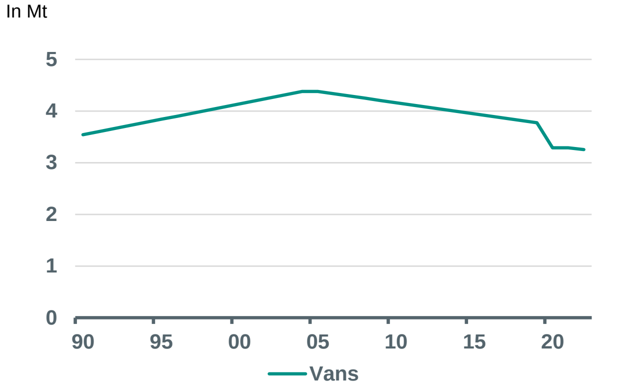
Source: CBS, ABN AMRO Group Economics

The fuel type diesel and diesel hybrid take the largest share, accounting for 93% of the total; petrol and petrol hybrid account for 3.5%, LPG and LPG hybrid for 2.1% and full electric 1.3%. On average 64,000 vans are sold annually (average 2020-2022). We assume that the average life of a van is 15 years. For the greenhouse gas emissions of the different scenarios, we take into account the total emissions in recent years and the composition of the fleet.

Scenarios for vans

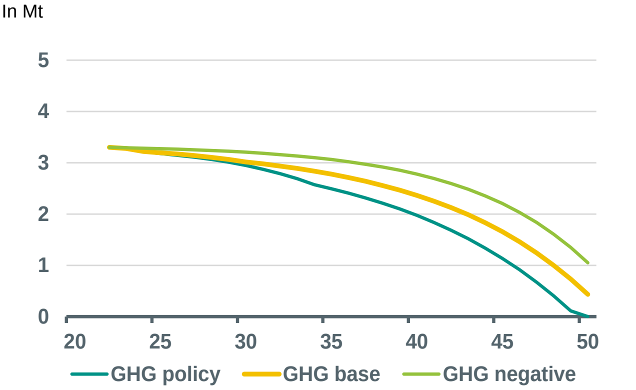
For the policy/positive scenario we assume that policy targets are reached and that the needed charging points are installed on time including the overnight charging infrastructure and that the grid is adjusted to deal with the extra electricity demand. We also assume that the battery technology improves so that the range is increased and lower amounts of critical metals are used. In the policy/positive scenario the fleet of zero emission vans (mainly full battery electric) rises substantially but the fleet of vans with internal combustion engines and the greenhouse gas emissions drop (see graphs below).

GHG emissions vans



Source: CBS, ABN AMRO Group Economics

Emission scenarios vans

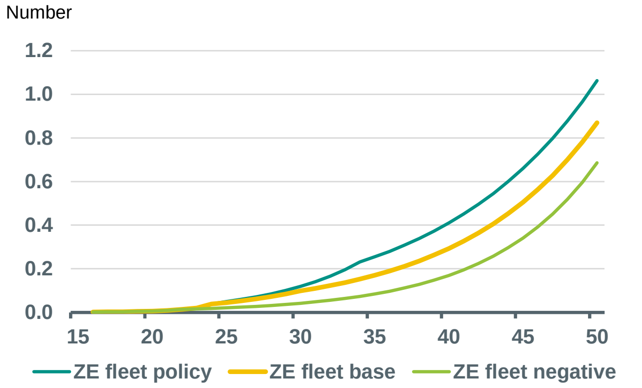


Source: ABN AMRO Group Economics

For the base scenario we also assume that the zero emission vans are mainly battery electric, but that the sales are lower resulting in some fleet of vans with internal combustion engines. We assume that some of the charging infrastructure for overnight charging will not be ready on time. There will be a shortage of critical metals and/or batteries which drive up the price of battery electric vehicles. As a result emissions will not drop to zero in 2050.

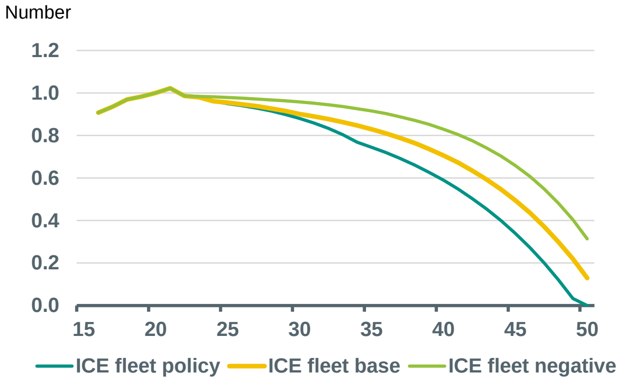
For the negative scenario we expect a substantially lower amount of zero emission vans (mainly full battery). In this scenario the overnight charging infrastructure will be delayed substantially. There also is a substantial shortage of materials. As a result, the path of reducing emissions will be slower and there will be a considerable ongoing emissions.

Fleet zero-emission (full battery, fuel cell) vans



Source: ABN AMRO Group Economics

Fleet internal combustion engine vans



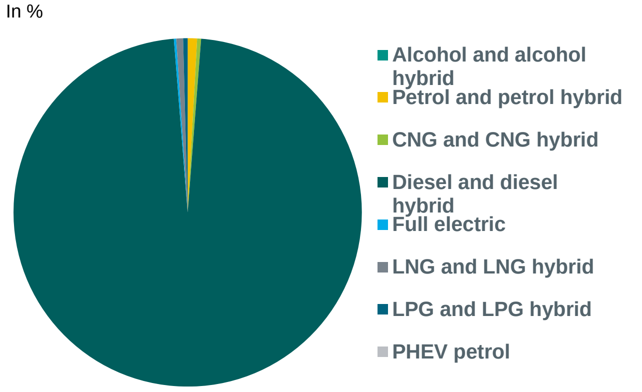
Source: ABN AMRO Group Economics

Scenarios for trucks

Climate policy trucks

The Dutch government's policy is that in 2025 there are middle-sized zero-emission zones for trucks and vans in 30 to 40 municipalities. In 2027 road mobility becomes part of ETS2. Moreover the government expects that there are 5,000 zero-emission/plug-in hybrid trucks in in 2025 and 10,000 in 2030. The EU has a target that there are recharging stations every 60 km on main roads for trucks above 3,5 tonnes and hydrogen refuelling stations at least every 200km on main roads by the end of 2030. The EU is preparing tougher CO2 standards for new trucks in the European market, aiming to meet a net zero emissions target across EU27 by 2050. In 2022 in the Netherlands, there were close to 168,000 trucks on the road. The graph below shows the share of the fuel types of the fleet.

Fleet composition trucks 2022



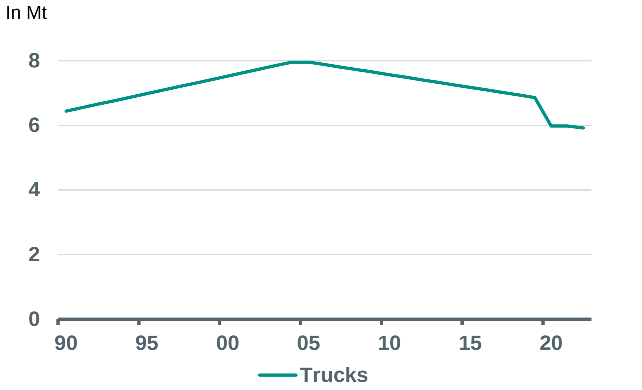
Source: CBS, ABN AMRO Group Economics

The fuel type diesel and diesel hybrid take the largest share, accounting for 98% of the total; full electric accounts for 0.2% and the fuel cell category is negligible. On average 12,000 buses are sold annually. We assume that the average life of a bus is 12.5 years. For the greenhouse gas emissions of the different scenarios we take into account the total emissions in recent years and the composition of the fleet.

Scenarios for trucks

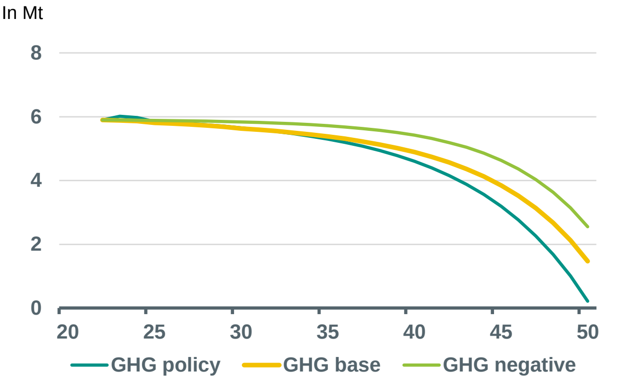
For the policy/positive scenario we assume that policy targets are reached and that the needed charging points are installed on time including the overnight charging infrastructure and that the grid is adjusted to deal with the extra electricity demand. We also assume that the battery technology improves so that the range is increased to minimum 500 km and lower amounts of critical metals are used. For shorter distances, battery electric trucks are used and for long-distance mainly fuel cell trucks. For 2023 the subsidy scheme for zero emission trucks was within one day four times oversubscribed.

GHG emissions trucks



Source: CBS, ABN AMRO Group Economics

Emission scenarios trucks



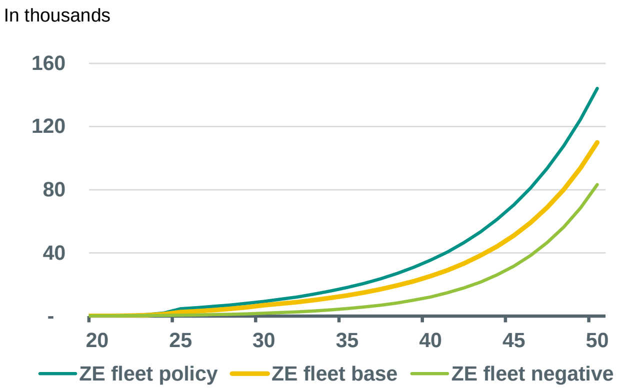
Source: ABN AMRO Group Economics

In the policy/positive scenario, the fleet of zero emission trucks start to rise considerably in 2035 due to the availability of technology and charging infrastructure. As a result the fleet of trucks with internal combustion engines and the resulting greenhouse gas emissions drop (see graphs above and below). As this trajectory has a later start, emissions will also decline later. This is a hard to abate subsector, so there will be some remaining emissions.

For the base scenario, we also assume that the fleet of zero emission trucks will increase, but at a slower pace than the policy scenario as we assume that some of the charging infrastructure and refuelling infrastructure will not be ready on time. Moreover the improvement in battery technology to increase the range will take longer. Furthermore there will be a shortage of critical metals and/or batteries which drive up the price of battery electric vehicles.

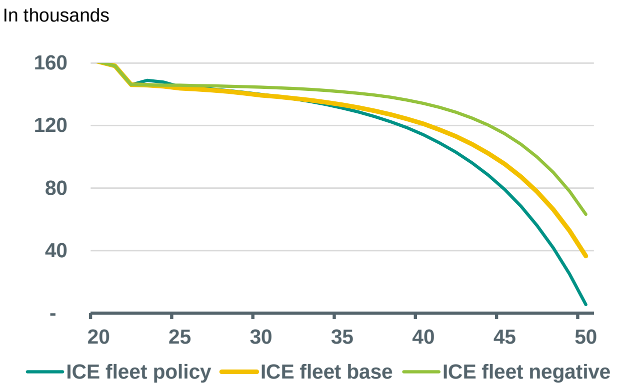
For the negative scenario we expect a substantially lower amount of zero emission trucks than in the other scenarios. In this scenario the charging and fuelling infrastructure is assumed to be delayed significantly. Furthermore, there will be also a substantial shortage of materials and the range of the battery will not be increased sufficiently. As a result, the path of reducing emissions will be slower and there will be substantial ongoing emissions.

Fleet zero-emission (full battery, fuel cell) trucks



Source: ABN AMRO Group Economics

Fleet internal combustion engine trucks



Source: ABN AMRO Group Economics

Conclusion

We have defined three emission scenarios for the subcategories in road mobility: cars, buses, vans and trucks. With these scenarios we can clearly see what the possible trajectories are for these subsectors and how the crucial assumptions behind them are developing. We have the following scenarios: policy/positive, base and negative. The policy scenario is also the positive scenario assuming that the government policy is according to plan and that the bottlenecks are sufficiently addressed. In the other scenarios we take into account bottlenecks such as affordability, technology, costs, shortage of metals, challenges to adjust the grid that result in a deviation from the policy scenarios. In the base scenario there is a modest deviation and in the negative scenario there is a substantial deviation. The subcategories have a different trajectories depending on the policy and the bottlenecks for these subsectors. For example, the reduction path for cars is already underway and will increase in pace in the coming years while for trucks this trajectory starts later and there will possibly be ongoing emissions in all scenarios as it is a hard to abate subsector.

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