
# Assessment of impacts of the EC proposal for the review of the $CO_2$ performance standards for HDVs

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# Colophon

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# Executive summary

In this report the results are presented of an impact analysis of the recently proposed tightened $CO_2$ performance standards for heavy-duty vehicles, as well as of two policy variants. In the current proposal (scenario A) the proposed targets do not apply to all vehicle categories. As an alternative scenario (scenario B) we have analysed the impacts of a policy variant in which the proposed targets do apply to all categories. Also a third scenario is considered (scenario C), which is based on the global Memorandum of Understanding (MoU) as signed by 27 countries amongst which the Netherlands.

Our analysis shows that the proposed policy does lead to an increase in zero emission (ZE) vehicles as well as zero emission (mostly electric) kilometres driven. However a net zero fleet in 2050 is not within reach. The European Commission proposal results in a share of 69-72% of zero emission vehicles in the fleet by 2050 driving 82-84% of the vehicle kilometres. The more ambitious scenario C comes closer to a net zero fleet in 2050 with a zero emission fleet share of 83-84% and a 97% share of zero emission kilometres.

The performed analysis is largely based on the Dutch fleet. It should therefore be considered that the average age of the Dutch fleet is lower compared to the total European average, meaning that for a European net zero emission fleet the ICE sunset date should be earlier in time than is necessary for achieving zero emissions in the Dutch fleet.

Also the share of ZE vehicles in the fleet depends on which vehicle groups are included in the $CO_2$ performance standard. Results are therefore sensitive to different assumptions for the categories of vehicles included.

In the analysis the uptake of ZE vehicles in new vehicle sales is based on a pessimistic / conservative approach in which it is assumed that ZE trucks are only implemented to bridge the gap between the target and the maximum reduction potential achievable in conventional diesel trucks. In reality it is expected that the uptake will be more smooth, and also motivated by other drivers, which might lead to a higher uptake of zero emission vehicles.

# Contents

# 1. Introduction and context

- On February 14th the European Commission (EC) presented their proposal for the revision of the $CO_2$ performance standards for heavy-duty vehicles (HDVs)
- The Ministry of Infrastructure and Water Management (IenW) wants to be prepared for further discussions following the proposal and has asked TNO to make an impact assessment for the Dutch fleet
- IenW is interested in effects on cumulative $CO_2$ emissions up to 2050 and the share of zero emission vehicles in the fleet in the Netherlands in 2050
- Additionally IenW has asked TNO to provide support on a number of questions with regard to the interpretation of the new directive

# 2. The Commission proposal

- The EC has proposed tightened $CO_2$ reduction targets for the vehicles currently regulated (groups 4, 5, 9 and 10) per 2030
- The EC also proposed targets for the vehicle groups 1, 2, 3, 11, 12, 16 and busses and (semi-)trailers per 2030
  - While the EC has proposed targets for trucks, busses and (semi-)trailers, this analysis focuses on trucks only
  - The target for busses has no impact in the Netherlands since there already is a ZE busses policy in place
- The baseline year for the newly added vehicle groups is set to be 2025
- The EC has proposed average reduction targets of respectively 45% in 2030, 65% in 2035 and 90% per 2040 for both new and already regulated vehicles
- For trucks the reduction targets per vehicle sub-group are slightly lower than the average values, respectively 43%, 63% and 90%
- For coaches similar targets as for trucks apply
- For busses a 100% ZEV mandate applies per 2030
- For semi-trailers a 15% reduction target applies from 2030 onwards
- For drawbar trailers a 7.5% reduction target applies from 2030 onwards

# 3. Approach

- The analysis is made using a cohort model for HDVs to model fleet development for the Dutch situation based on both NL and EU data
- Assumptions were made for the development of $CO_2$ emissions of conventional diesel trucks until 2050
- The analysis is based on a “worst case” approach by calculating the minimum share of ZEVs necessary to reach the target. The specific drivetrains of these ZEVs are not further specified and can be any drivetrain that is considered as zero emission.
- Flexibilities with regard to the targets are not included. Allowed flexibilities are:
  - Super credits (2019-2024)
  - Banking and borrowing (proposed to remain after 2030)
  - ZEVs outside regulated categories not included
  - ZLEV benchmark (from 2025 onwards) (proposed to phase out per 2030)
- The HDV fleet composition and kilometres are based on the Klimaat en Energieverkenning 2022 (KEV)
- 2019/2020 is the baseline period for vehicle groups 4, 5, 9 and 10
- 2025 is the baseline period for other vehicle groups
- The diesel trucks not covered in the regulation are assumed to have decreasing $CO_2$ emissions in line with diesel trucks in vehicle groups 1, 2, 3, 11, 12, 16
- In the proposal vocational vehicles in groups 4 and 9 are not regulated. Based on EEA data for the period 2019/2020 the share of vocational vehicles in groups 4 and 9 is about 5% resulting in a total share of 1% in the total sales. Because of its minor impact vocational vehicles are not considered in this assessment.

# 4. Vehicle segmentation vs VECTO groups

- Fleet modelled for four different segments as discerned in Dutch statistics:
  - Light rigid (3.5-10 tons), medium rigid (10-20 tons), heavy rigid (>20 tons) and tractor semi-trailer (all weights)[1]
- These segments do not one on one relate to VECTO vehicle groups, which is a limitation for the current analysis. Having more vehicle categories in Dutch monitoring data would make comparisons such as this more easy.
- Since no Dutch data is available on VECTO groups a categorization has been made in the table below, based on IHS sales data for Europe in 2019.
- Based on this data in 2019 79% of HDVs were in groups 4, 5, 9 and 10

| | Currently regulated vehicle groups: 4, 5, 9 and 10 | | Proposed vehicle groups to be included: 1, 2, 3, 11, 12, 16 | | Non-regulated vehicles groups: 6, 7, 8, 13, 14, 15, 17 | |
|---|---|---|---|---|---|---|
| | Non-vocational vehicles | Vocational vehicles | Non-vocational vehicles | Vocational vehicles | Non-vocational vehicles | Vocational vehicles |
| Light truck | | | 100% | | | |
| Medium truck | 58% | 3% | 25% | | 13% | |
| Heavy truck | 62% | 3% | 27% | | 7% | |
| Tractor | 97% | | 1% | | 2% | |

[1]) Light truck (3.5 – 10 tons) , medium truck ( 10-20 tons), heavy (>20 tons) and tractor semi-trailor

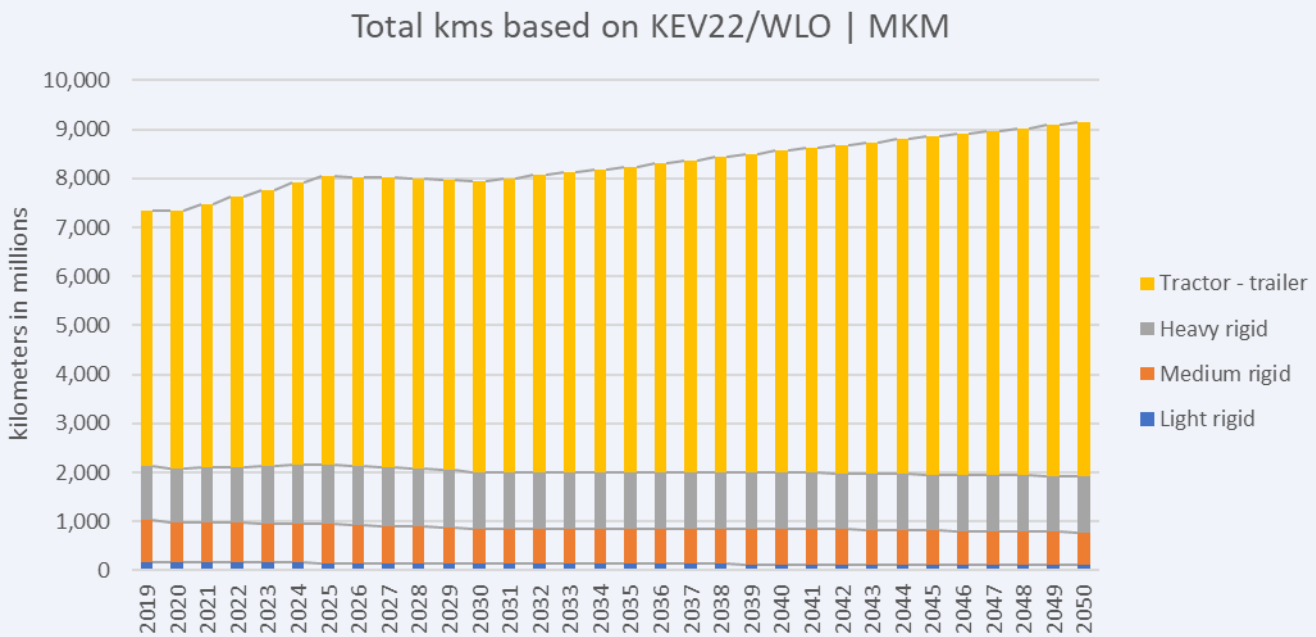
# 5. $CO_2$ development diesel trucks towards 2050

- The assumption is that for the newly included vehicle groups no $CO_2$ reduction is expected until 2026 because any reduction before the baseline period tightens the target for 2030 as the 2025 emissions are the baseline for these groups. This is in line with our “worst case” approach.
- The second assumption is that per 2026 the emissions of the groups 1, 2, 3, 11, 12 and 16 will in two years time catch up with the reductions realised for groups 4, 5, 9 and 10, most likely by switching to engine and other technologies developed for the latter groups. This seems most likely as also EURO 7 is expected to enter into force around this period.
- Two scenarios for development of the $CO_2$ emissions of diesel trucks until 2050
  - A **limited** reduction of the $CO_2$ emissions of 0.5% per year until 2035
  - A **strong** $CO_2$ reduction scenario based on a recent TNO (2022)[1] study where energy use was calculated using the ADVANCE energy consumption model and where in the 2020-2030 timeframe an increasing number of energy reducing technologies are assumed to be added to the trucks. This results in a $CO_2$ reduction of about 16-22% in 2030 compared to 2020. After 2030 no further $CO_2$ reductions are expected.
- Note: The $CO_2$ reduction for diesel trucks, assumed in the second scenario, is lower than the potential as calculated in an earlier study by TNO (2018)[2]. In the 2018 study a different base year was used (2015 vs 2020). Also in the 2022 study only technologies were included that are readily available or that would lower the energy use of all types of drivetrains. This is why the assumed reduction in the 2022 study is lower compared to the 2018 study.
- In the remainder of this presentation only the strong $CO_2$ reduction scenario is presented, the scenario with a limited $CO_2$ reduction for conventional trucks will be used to provide a bandwidth of the results.
- It is assumed that real world $CO_2$ reductions are the same as the modelled reductions.

[1]) TNO, 2022. Techno-economic uptake potential of zero-emission trucks in Europe. R11862
[2]) TNO, 2018. Assessments with respect to the EU HDV $CO_2$ Legislation. P10214

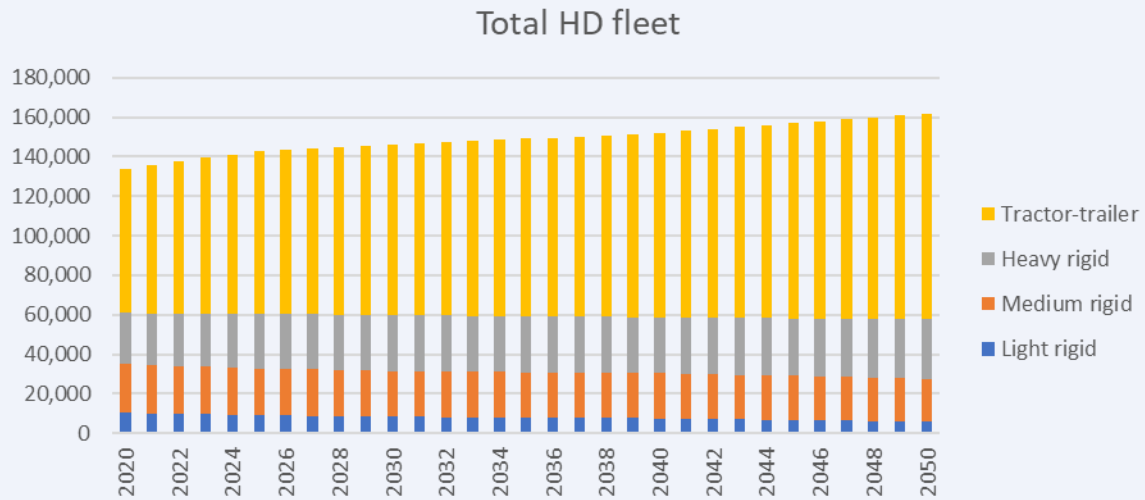
# 6. Kilometres

- Future developments in the fleet and hence also kilometres are based on Dutch HDV fleet using KEV2022
- The yearly kilometres as a function of age are based on CBS data
- Total kilometres per vehicle segment in different years based on KEV 2022 until 2040 and extrapolated to 2050



# 7. Fleet development

- Fleet development based on Dutch HDV fleet using KEV2022
- Per subsegment the age distribution is assumed to remain constant
- Total fleet size and total kilometres driven follow from the KEV2022
- Size of rigid truck segments decreases over time while size of tractor-trailer segment increases due to long term trends in the fleet based on the KEV2022



# 8. Legislative details

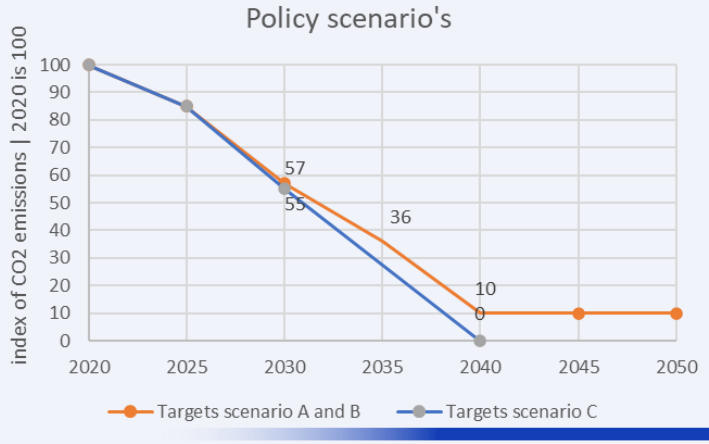
- The legislation sets $CO_2$ standards per VECTO subgroup in g/t-km using payload factors. OEM specific $CO_2$ emissions are calculated using mileage and payload weighting factors (MPW).
- However, since payload factors and weighting factors are constant at the subgroup level and changes in OEM sales compositions are not considered, the $CO_2$ standards are considered here in $CO_2$ emissions in g/km.
- The trend in the fleet is a move away from smaller/medium rigid trucks which could mean that less ZE vehicles are needed to reach the target since the MPW factor of tractors is relatively higher. In this analysis only the trend away from smaller and medium trucks as present in the KEV2022 is assumed. Other than this, no further shift towards tractor trailers (or any other vehicles with relative high MPW factors) as a result of the design of the proposal are assumed in our analysis.
- In the proposal the EC introduces an extra requirement of a minimal 350 km range for tractors in order to account for such risk.

[1]:TNO, 2022. Techno-economic uptake potential of zero-emission trucks in Europe. R11862

# 8. Policy scenarios

- Three scenarios with different targets or legislated vehicle groups are included. See table and figure.
  - Scenario A (EC proposal), including the targets and vehicle groups proposed by the EC
  - Scenario B is a scenario variant that is the same as scenario A scenario with the exception that here all vehicle groups are included. The targets remain the same. This scenario shows how much additional reduction potential there is if all vehicles were included.
  - Scenario C follows from the Global Memorandum of Understanding (MoU) an agreement by a number of countries to strive for 100%
    ZE sales of busses and trucks by 2040 in order to facilitate a net zero fleet by 2050.
- Important to note is that the baseline for the targets for the newly included vehicles is the average emissions of vehicles sold in 2024/2025 while for the vehicles that are regulated already the baseline is 2019/2020. However since it is assumed that between 2020 and 2025 for these vehicle groups no $CO_2$ reduction will be realised the baseline de facto is the same for all vehicle groups.

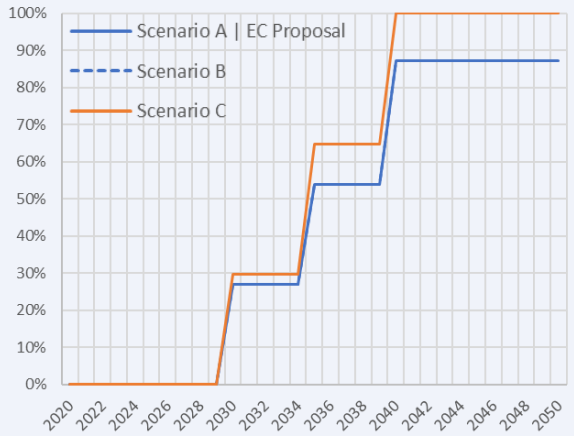
| VECTO vehicles groups included | 4, 5, 9 and 10 | 1, 2, 3, 11, 12, 16 | 6, 7, 8, 13, 14, 15, 17 |
|---|---|---|---|
| Scenario A \| proposal EC | Yes | Yes | No |
| Scenario B | Yes | Yes | Yes |
| Scenario C (Global MOU) | Yes | Yes | Yes |



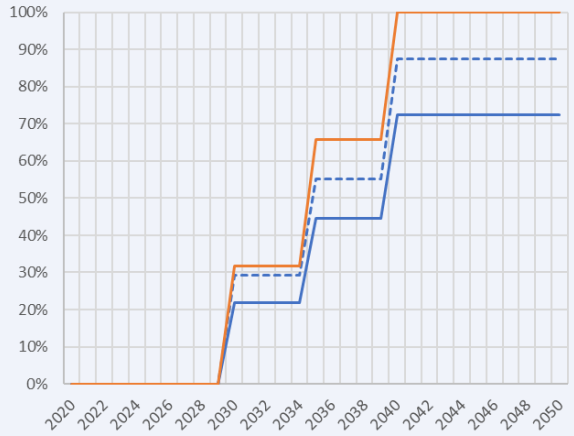
# 9. Results – ZEV sales per segment

- Minimum share of ZE sales per segment needed to reach target per vehicle segment given strong[1] $CO_2$ reduction scenario for diesel trucks (16-22% reduction compared to 2020)

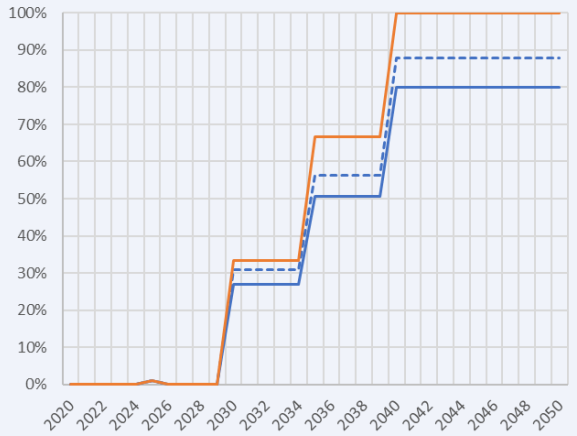
Light truck



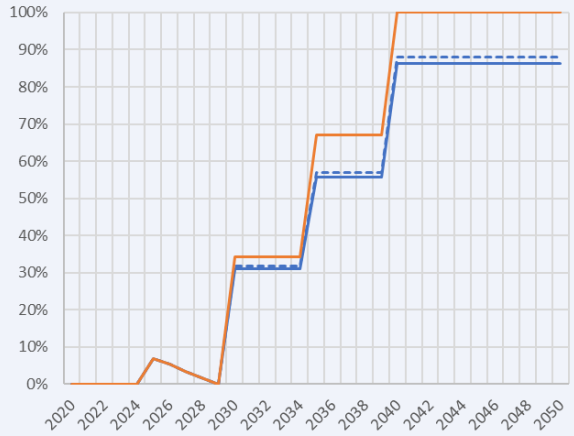

Medium truck




Heavy truck




Tractor

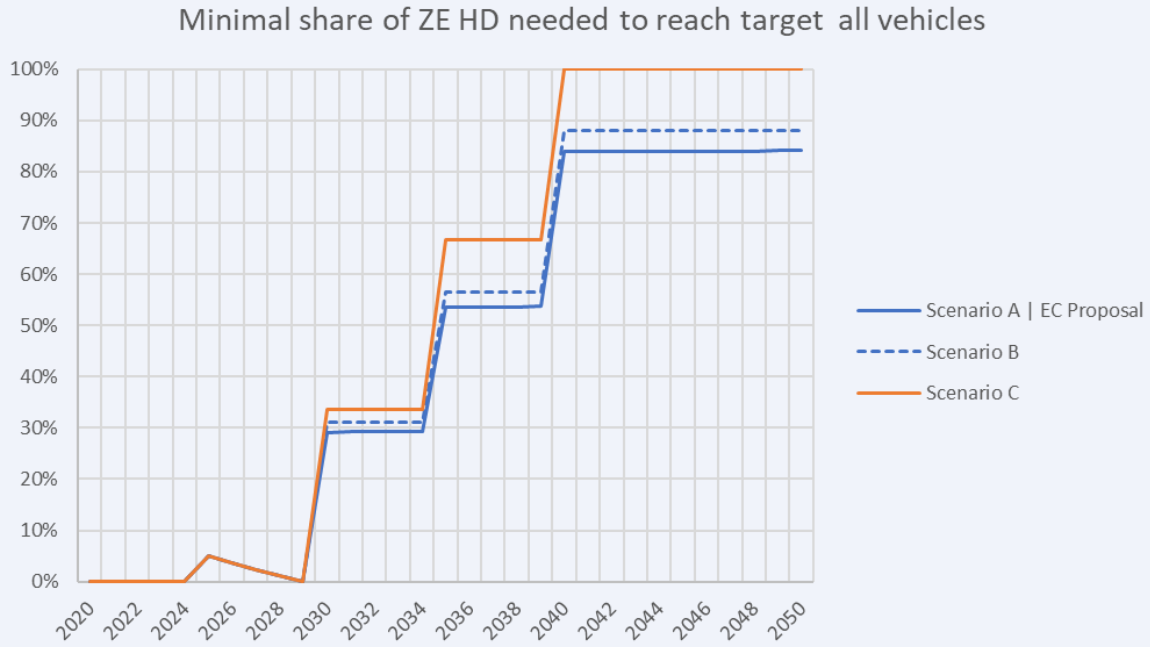



- Assumptions
  - Overall targets assumed to apply to all segments individually (it might be more cost effective to have a different effort per segment).
  - In intermediate years the norm remains constant (e.g. target for 2026 is the same as 2025). As the $CO_2$ emissions of conventional trucks are projected to decreases gradually over time (until 2030 in the strong scenario), the share of ZEVs needed to reach the target may decrease in intermediary years.

1: For more details on the strong scenario see slide 9

# 9. Results – ZEV SALES OVERALL

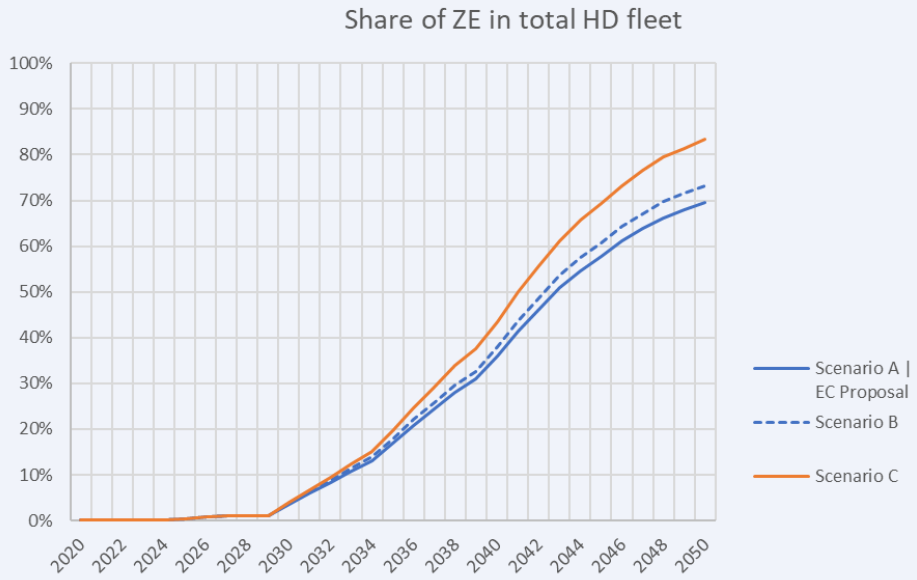
- Minimum share of ZEVs in the overall sales needed to reach target per vehicle segment given strong $CO_2$ reduction scenario for diesel trucks (16-22% reduction compared to 2020)




- Figure represents minimum share of ZEV needed to reach the given target. This is a pessimistic estimate of the actual ZEV share because it is assumed that uptake of ZE trucks will only take place when strictly necessary given the target and the $CO_2$ development of diesel trucks. In reality it is expected that the uptake will be more smooth. Amongst others this might be driven by a more gradual scale up of production and market demand that requires OEMs to have electric alternatives on offer.

# 9. Results - Fleet

- The graph shows the resulting share of ZE vehicles in the fleet given the strong reduction scenario for reduction of diesel truck $CO_2$ emissions
- The table shows the results for both scenarios for the reduction of diesel truck $CO_2$ emissions (limited and strong, see slide 9)
- The share of ZE vehicles in the fleet in 2050 ranges from 69% in scenario A to 84% in scenario C
- Lower shares of ZEV are expected for the strong ICEV $CO_2$ reduction scenario because more reduction is realized through reducing emissions of diesel trucks
- Difference between scenario A and C is about 12-14 percent points




| | Share of ZE vehicles in the fleet in 2050 | |
|---|---|---|
| | Limited ICEV $CO_2$ reduction | Strong ICEV $CO_2$ reduction |
| Scenario A \| Proposal EC | 72% | 69% |
| Scenario B | 75% | 73% |
| Scenario C | 84% | 83% |

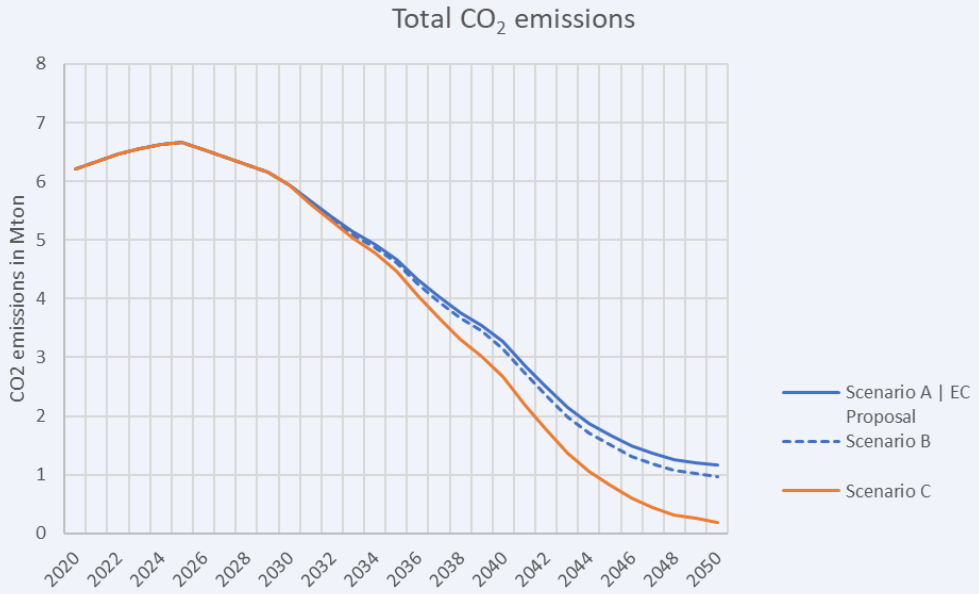
# 9. Results - Kilometres

- Resulting ZE kilometres given the two reduction scenarios for diesel truck $CO_2$ performance
- No net zero emission fleet is reached by 2050 in any of the scenarios
- Difference between scenario A and C is about 13-15 percentage points

| | Share of ZE kilometres in 2050 | |
|---|---|---|
| | Limited ICEV $CO_2$ reduction | Strong ICEV $CO_2$ reduction |
| Scenario A \| EC proposal | 84% | 82% |
| Scenario B | 87% | 85% |
| Scenario C | 97% | 97% |

# 9. Results – $CO_2$ emissions

- $CO_2$ emissions in 2050 without taking into account the further uptake of sustainable fuels
- In 2050 scenario A leads to about 1 Mton more emissions compared to scenario C
- Including all vehicles results in almost 0.2 Mton lower emissions in 2050




| ICEV $CO_2$ reduction | $CO_2$ emissions in Mton | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2030 | | 2035 | | 2040 | | 2050 | |
| | Limited | Strong | Limited | Strong | Limited | Strong | Limited | Strong |
| Scenario A \| EC proposal | 6.1 | 5.9 | 4.7 | 4.7 | 3.30 | 3.3 | 1.2 | 1.2 |
| Scenario B | 6.0 | 5.9 | 4.7 | 4.6 | 3.2 | 3.2 | 1.0 | 1.0 |
| Scenario C | 6.0 | 5.9 | 4.5 | 4.5 | 2.7 | 2.7 | 0.2 | 0.2 |
| Difference scenario A and C | *0.02* | *0.02* | *0.19* | *0.19* | *0.60* | *0.59* | *0.98* | *0.97* |

# 9. Results – Cumulative emissions

- Cumulative emissions calculated over the 2020-2050 timeframe
- The cumulative emissions of the vehicle groups **not** included in scenario A are 2 Mton. Including these groups under the target leads to 1.8 % lower cumulative emissions over the 2020-2050 timeframe.
- Scenario A leads to 11 Mton additional cumulative emissions in the 2020-2050 period compared scenario C.

| ICEV $CO_2$ reduction | Cumulative emissions 2020-2050 in Mton | |
|---|---|---|
| | Limited | Strong |
| Scenario A \| EC proposal | 134 | 132 |
| Scenario B | 132 | 130 |
| Scenario C | 122 | 121 |

| ICEV $CO_2$ reduction | Difference in cumulative emissions compared to Global MOU with strong ICEV $CO_2$ reduction in Mton | |
|---|---|---|
| | Limited | Strong |
| Scenario A \| EC proposal | 13 | 11 |
| Scenario B | 11 | 9 |
| Scenario C | 2 | - |

# 9. Additional questions

- How much bio-/e-fuels are needed to decarbonize the remaining $CO_2$ emissions in 2050?

  In scenario A (the EC proposal) there will remain about 1.2 Mton $CO_2$ emissions in 2050 from HD road freight transport in the Netherlands. This accounts to around 500 mln. litres of biofuels. Based on NEA reporting in 2021 around 550 million litres of diesel-substituting biofuels were sold. This includes all sectors. The amount of biofuel needed to to decarbonize the remaining ICE trucks in 2050 is thus of the same order of magnitude as the current biodiesel use in the Netherlands. Using biofuels to achieve a zero emission truck fleet by 2050 therefore seems technically feasible. This does, however, not answer the question whether biofuels are the optimal way of for achieving this goal.

  Based on a bottom up calculation assuming a 7% share of biofuels in current diesel use, a total of 180 million litres of biofuels were used by trucks in Dutch road transport in 2021. Based on this calculation the total biofuel use in the heavy road transport sector would need to nearly triple (factor 2.8) to decarbonize the remaining ICE trucks in 2050.

- What is the effect of the changed definition of a ZE vehicle?

  In the EC proposal the definition of a ZE vehicle has changed from < 1g/kWh to < 5g/ton-km. As a result now all hydrogen based solutions are included as ZE. For instance also $H_2$-HPDI engines (high pressure direct injection with the help of a pilot fuel, in the case of $H_2$-HPDI this is diesel) are included.

# 9. Additional questions

- How are semi-trailers/drawbar trailers included in the target?
  - Trailers have their own targets and own reference values. Also the trailers have their own “MPW” (Mileage Payload Weighting), normalized using the MWP of a group 5 long haul truck. This gives trailers similar weights compared to trucks.
  - The $CO_2$ emissions of trailers can be simulated using a simulation tool. Specific $CO_2$ values should be based on a weighted simulation of a number of mission profiles with a given truck.
  - The targets for trailers apply to the manufacturers of the trailers

- How are the reduction targets weighted?
  - From the proposal it seems that the EC has opted for separate targets for trucks, busses and trailers. This is however not made explicit. Also it remains unclear how the targets for each of these groups are weighted in the overall target (for instance the overall 2030 target is 45% while for trucks and some of the busses this is 43% and for urban busses this is 100%). The EC could be asked for an elaboration on these weights.

# 10. Limitations

- The average age of Dutch fleet is lower than the European average. This means that for a European net zero emission fleet the ICE sunset date should be earlier in time than is necessary for the Dutch fleet.
- The share of ZEVs in the fleet depends on which vehicle groups are included in the $CO_2$ performance standard. Results are therefore sensitive to different assumptions for the categories of vehicles included.
- Only changes in vehicle segments sizes / shares have been considered (decrease of rigid truck, increase in tractors). However, also within these segments changes might be expected.
- Fleet age distribution is assumed constant. Using historical survival rates in combination with trends in segment size from KEV22 might strengthen the analysis.
- In this assessment the uptake of ZE vehicles in new vehicle sales is based on a pessimistic / conservative approach in which it is assumed that ZE trucks are only implemented to bridge the gap between the target and the maximum reduction potential achievable in conventional diesel trucks. In reality it is expected that the uptake will be more smooth, and also motivated by other drivers, which might lead to a higher uptake of zero emission vehicles.
- The EC also made slight changes to the definition of regional delivery trucks and long haul trucks by adding a range requirement of 350 km on a single charge. This is proposed to prevent OEMs selling long haul trucks with limited range as this could relax their target because of the high “mileage-payload-weighting” factor (MPW).
- Vocational vehicles (only in groups 4 and 9) are not included in the assessment as these only concern 1% of the vehicles.

# 10. Conclusions

- In this work three policy scenarios for tightened $CO_2$ performance standards of heavy-duty vehicles are analysed. Our analysis shows that the proposed policy (scenario A) does lead to an increase in zero emission vehicles as well as electric kilometres driven. However a net zero fleet in 2050 is not within reach.
- The European Commission proposal (scenario A) results in a share of 69-72% of vehicles in the fleet to be zero emission by 2050 and 82-84% of vehicle kilometres. In 2050 1.2 Mton of $CO_2$ emissions remain.
- Scenario B, which consists of the EC targets but includes all vehicle groups, has a slightly higher share of zero emission vehicles (73-75%) and kilometres (85-87%) and results in a remaining emission of 1 Mton by 2050.
- The more ambitious MoU scenario comes closer to a net zero fleet with a zero emission vehicle share of 83-84% and 97% zero emission kilometres in 2050, and remaining emissions of 0.2 Mton.

# 11. Literature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