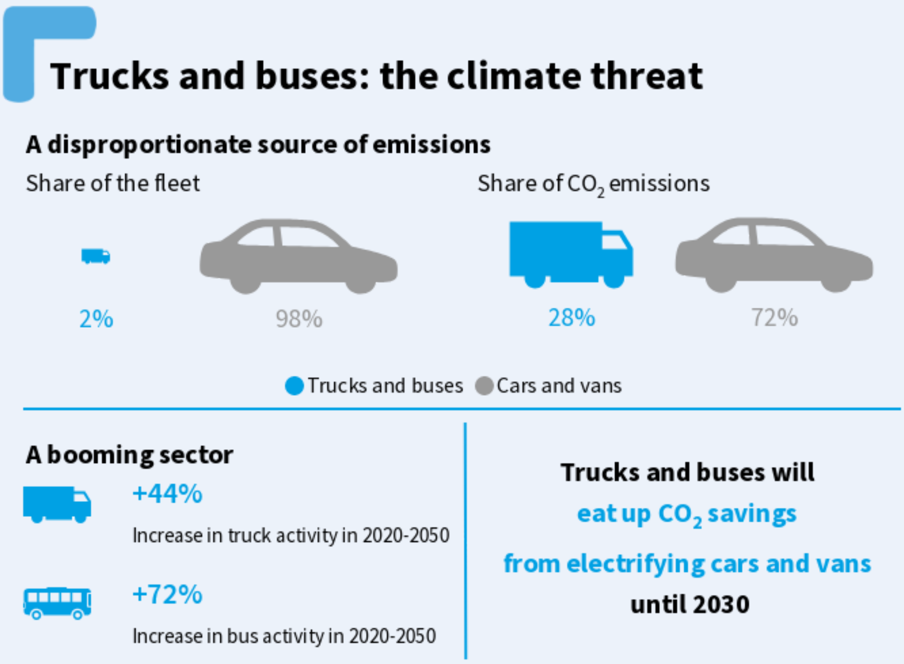
# Addressing the heavy-duty climate problem

Why all new freight trucks and buses need to be zero-emission by 2035

September 2022

## Summary


Trucks and buses pose a threat to the EU's climate ambition. Despite making up **only 2% of the EU fleet**, they accounted for **28% of Europe's road transport $CO_2$ emissions** in 2020. Driven by increasing activity and lack of efficiency improvements, $CO_2$ emissions from heavy-duty vehicles (HDVs) were 28% higher in 2019 than in 1990. And they will keep growing, with truck activity expected to further increase by a whopping 44% between 2020 and 2050 and bus activity by 72%. In a business-as-usual scenario, HDVs would undo the entire emissions savings from cars and vans expected by 2030 and eat up as much as 41% of the EU's dwindling carbon budget by 2050. Trucks and buses also burn massive amounts of oil. They are responsible for 42% of the EU's diesel consumption in road transport, a large share of which comes from Russia.


A study by TRANSPORT & ENVIRONMENT

The European Commission is set to unveil its **proposal to review the HDV $CO_2$ standards in November 2022.** This is **the opportunity to put freight trucks and buses on the road paved by the review of the cars and vans $CO_2$ standards: 100% new zero-emission sales in 2035**, and a fully zero-emission fleet by 2050.

Bearing in mind that **HDVs stay on the road for more than 18 years on average,** this study models three potential policy scenarios. The Central scenario sets a 100% zero-emission target in 2035 for all freight trucks and buses, in line with cars and vans. The Delayed scenario pushes the target back to 2040; and the Accelerated scenario brings it forward to 2030.

**Why a zero-emission sales target in 2035 is needed**

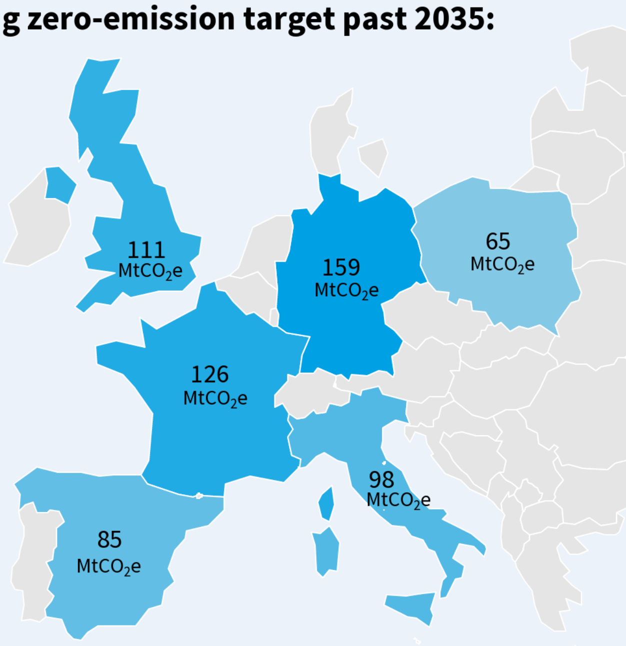
As shown below, **both the Central and Accelerated scenarios can set trucks and buses on a trajectory towards a fully zero-emission fleet in 2050**. On their own, the targets modelled achieve respectively a -95% and -98% $CO_2$ reduction by 2050, with only a small number of diesel vehicles — older than average retirement age — still on the road. On the contrary, the **Delayed scenario falls short** of setting HDVs on a credible path to full decarbonisation, as **by 2050 20% of the fleet still runs on diesel and emissions are only reduced by 89%.**

## 2040 deadline for ICE trucks blows carbon budget

### The climate cost of EU delaying zero-emission target past 2035:

= Cumulative 644 $MtCO_2e$ extra by 2050

= Annual road transport emissions in the six largest European markets

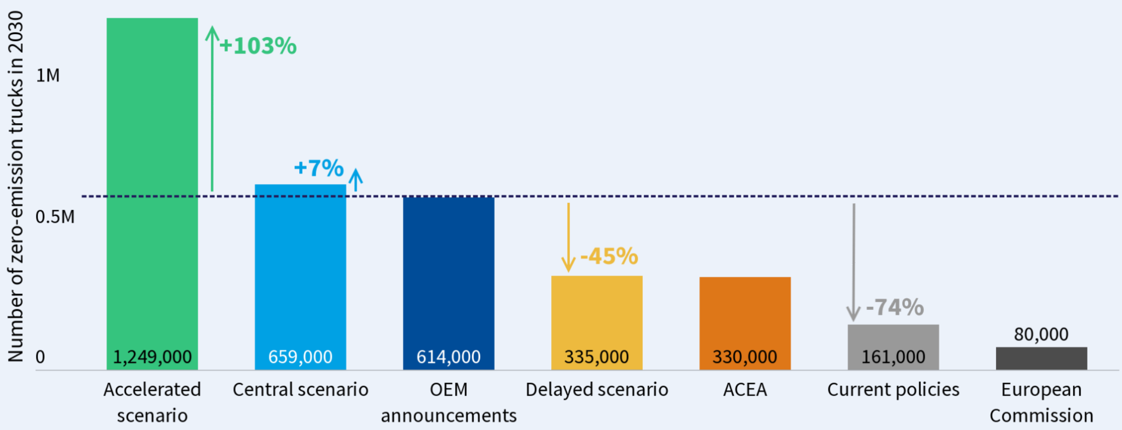



**Source:** Additional cumulative emissions in the EU by 2050 from EUTRM. Annual road transport emissions by country in 2019 from UNFCCC. (2022). National Inventory Submissions 2022.

**The need for action before 2030**

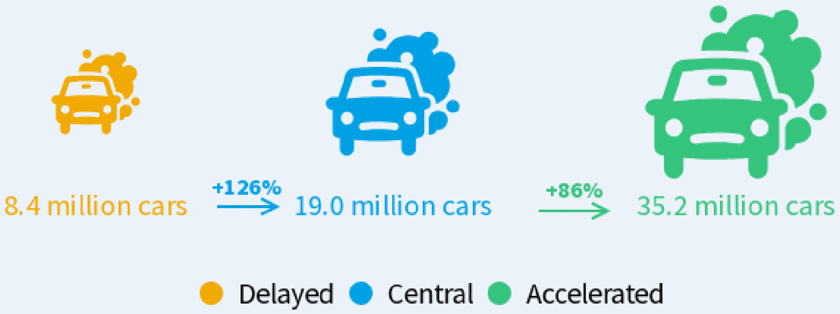
Early action is needed to ensure zero-emission trucks and buses are already on the road in 2030, thereby reducing emissions and saving oil. If we keep the current 2030 target as it is, there would be less than half as many zero-emission trucks (ZETs) on the road in 2030 as what ACEA, the truckmakers' lobby, is expecting. Raising the 2030 target in line with a **2035 end date** for the sale of polluting HDVs on the other hand would deliver **659,000 ZETs by 2030, or just 7% more than what truckmakers themselves have announced.** This means that the regulation would do exactly what a regulation should do: ensure the industry delivers on their announcements, while pushing them to be slightly more ambitious. As shown below, the Delayed scenario would provide no such incentive. Truckmakers would need to bring 45% fewer ZETs on the road than what they have already announced.

## Zero-emission trucks on the road in 2030 in the EU+UK




Compared to current policies, the **$CO_2$ emissions savings** in 2030 would be **equivalent to 35 million cars taken off the road in the Accelerated scenario, 19 million cars in the Central scenario, and 8 million cars in the Delayed scenario**.

## The Central scenario saves twice as much $CO_2$ in 2030 as the Delayed scenario




**Strong climate targets in the 2020s also help reduce oil consumption.** Relative to 2021 levels, diesel consumption in 2030 is cut in both the Central and the Accelerated scenarios, by 9% and 25% respectively. This would allow the EU to reduce its dependency on Russia for HDV diesel by -39% under the Central scenario and to completely cut it under the Accelerated scenario. In contrast, the **Delayed scenario increases HDV diesel consumption by almost 2%, creating challenges for the EU to divert away from Russian imports**.

In summary, to achieve the EU's climate goals, **all new freight trucks and buses need to be zero-emission by 2035 at the latest**, as is the case for cars and vans, with ambitious targets before then (mainly a -65% $CO_2$ reduction target for medium and heavy trucks in 2030). Vocational trucks — mostly construction trucks responsible for 1% of HDV emissions — can achieve 100% zero-emission sales in 2040 without jeopardising Europe's climate objectives. Urban buses on the other hand can go faster, achieving 100% zero-emission sales in 2027.

T&E urges the European Commission to include the following key elements in the upcoming proposal for the revision of the HDV $CO_2$ standards (more detail in the position paper):

- Set a 100% $CO_2$ emissions reduction target in 2035 for all small, medium and heavy trucks;
- Raise the ambition of the 2030 $CO_2$ reduction target to -65% for medium and heavy trucks;
- Set a 100% zero-emission sales target in 2027 for urban buses, in 2035 for coaches and in 2040 for vocational trucks;
- Introduce interim targets in 2027 to accelerate the transition;
- Introduce energy efficiency standards for trailers.

# 1. The heavy-duty climate threat

**Despite making up only 2% of the fleet[1], trucks and buses caused 28% of all road transportation emissions in the EU in 2020**[2]. HDVs today emit 28% more $CO_2$ than in 1990[3]. And a trend reversal is not in the making. The European Commission expects truck **activity to further grow by 44% between 2020 and 2050**, while activity from **buses and coaches would grow by 72%** in that same period[4]. Under current policies, the growth of $CO_2$ emissions from heavy-duty vehicles (HDVs) will **eat up the entire emissions savings from electrifying cars and vans until 2030**. Fully decarbonising the fleet by 2050 thus requires a rapid shift away from conventional diesel trucks and buses towards zero-emission powertrains. In addition, cutting diesel consumption from HDVs can contribute to reducing EU dependence on Russian oil imports.

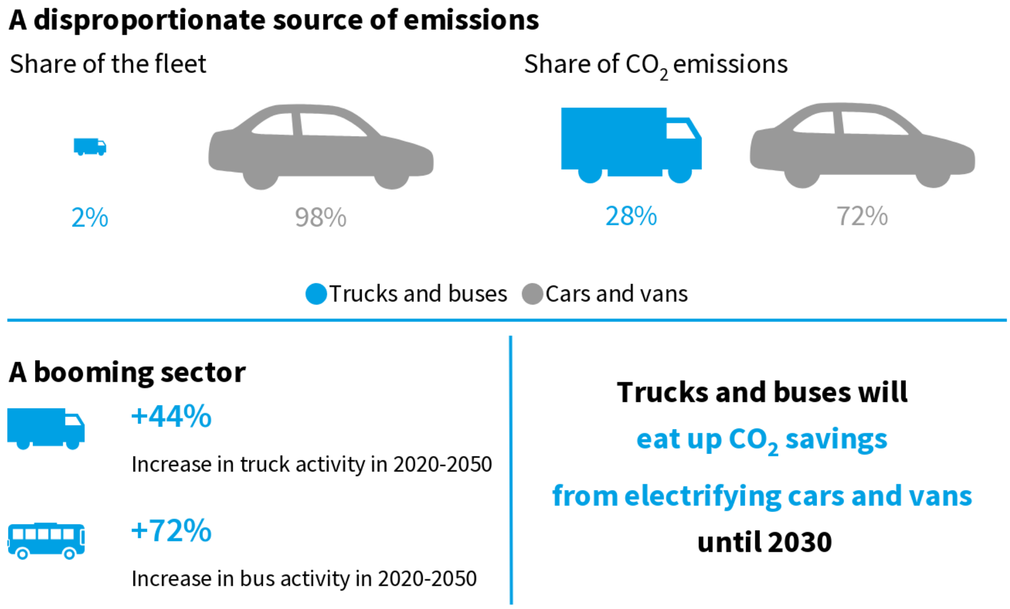



Figure 1. The HDV climate problem

The **forthcoming 2022 review of the heavy-duty vehicle $CO_2$ standards is the key opportunity to finally put a stop to these growing emissions** from trucks and buses. While light-duty vehicles have now started their transition to zero-emission, reaching 9% battery-electric cars and 3% battery-electric vans in 2021[5][6], the share of electric trucks remains virtually null: 0.47% in 2021[7]. By adopting strong $CO_2$

[1] ACEA. (2022). Report – Vehicles in use, Europe 2022. Link
[2] In 2019, HDVs caused 27% of road transport emissions. UNFCCC. (2022). National Inventory Submissions 2022. Link
[3] 2019 numbers. In 2020, HDVs emitted 18% more than in 1990. UNFCCC. (2022). National Inventory Submissions 2022. Link
[4] EC. (n.d.). EU Reference Scenario 2020. Energy. Link
[5] ACEA. (2022). Fuel types of new cars: battery electric 9.1%, hybrid 19.6% and petrol 40.0% market share full-year 2021. Link
[6] ICCT. (2022). Market monitor: European passenger car and light commercial vehicle registrations, January–December 2021. Link
[7] ACEA. (2022). Fuel types of new trucks: diesel 95.8%, electric 0.5%, alternative fuels 3.6% share full-year 2021. Link

standards for heavy-duty vehicles, the EU can **replicate the success of the cars and vans $CO_2$ standards**, and put trucks and buses on a similar path to zero-emission.

The current HDV $CO_2$ standards were adopted in 2019, and seek to reduce average fleet emissions from new heavy trucks (excluding vocational vehicles) by 15% in 2025 and by 30% in 2030, relative to 2019/20[8]. T&E has previously shown that the current targets standards are too low to drive the uptake of zero-emission HDVs (ZE-HDVs)[9]. The Commission's proposal, due in November 2022, is expected to raise the ambition of the 2030 reduction target, set post-2030 targets for heavy trucks, and introduce $CO_2$ standards for all types of heavy-duty vehicles (namely the currently excluded small, medium and vocational trucks, trailers, buses, and coaches).

### Why aren't e-fuels and biofuels credible solutions for trucks and buses?

The objective of climate-neutrality by 2050 is at the heart of the European Green Deal. T&E holds the view that sectors which can switch to zero-emission powertrains should do so, leaving climate-neutral fuels for hard-to-decarbonise sectors. Trucks and buses can go to zero-emission using both battery-electric and hydrogen powertrains. Battery-electric tractor-trailers will likely achieve total cost parity with diesel in the 2020s in Europe depending on the policy incentives[10]. In addition, biofuels and e-fuels are not credible solutions to decarbonise heavy-duty vehicles.

Food and feed biofuels are linked to deforestation[11], and cause more emissions than they save. While advanced biofuels based on wastes and residues exist, waste and residue volumes are necessarily limited[12], making it impossible to scale advanced biofuels to the levels required to make a dent in truck greenhouse gas emissions. Advanced biofuels are also in high demand in sectors where no alternative exists to liquid and gaseous fuels.

On e-fuels, T&E has shown that cars running on a blend of fossil and synthetic petrol emit more $CO_2$ than battery-electric cars over their lifecycle[13], and do little to reduce air pollution[14]. Due to their limited availability[15], synthetic fuels should be reserved for hard-to-decarbonise sectors, e.g. shipping and aviation, where direct electrification and hydrogen are difficult. Lastly, trucks running on e-fuels cost more over their lifetime than battery-electric or fuel cell trucks[16]. This is still the case in 2050, and even if e-fuels are produced cheaper in North Africa.

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[8] EC. (n.d.). Reducing $CO_2$ emissions from heavy-duty vehicles. Link
[9] T&E. (2021). Easy Ride: why the EU truck $CO_2$ targets are unfit for the 2020s. Link
[10] ICCT. (2021). Total cost of ownership for tractor-trailers in Europe: battery electric versus diesel. Link
[11] T&E. (2021). Biofuels. Link
[12] ICCT. (2021). The paradox of sustainable biomass. Link
[13] T&E. (2022). Update — T&E's analysis of electric car lifecycle emissions. Link
[14] T&E. (2021). Magic green fuels: Why synthetic fuels in cars will not solve Europe's pollution problems. Link
[15] T&E. (2020). E-fuel would be wasted on cars while it's badly needed to decarbonise planes and ships – study. Link
[16] T&E. (2021). How to decarbonise long-haul trucking in Germany. An analysis of available vehicle technologies and their associated costs. Link

## 2. Presentation of the four policy scenarios

In this study, T&E has modelled four policy scenarios to assess the climate impact of different levels of ambition for the revision of the HDV $CO_2$ standards. The four policy scenarios investigated are the following:

- The **Current policies** scenario models the existing HDV $CO_2$ standards to serve as a baseline.
- The **Accelerated** scenario considers a **100% $CO_2$ reduction target in 2030** (except for vocational trucks, for which the 100% ZEV target is set in 2035), in line with what the long lifespan of trucks and buses would require. On average, trucks in the EU are retired after more than 18 years on the road, and buses after 20 years[17]. For context, cars and vans are retired after 14 years on average[18]. In addition, the Accelerated scenario raises the 2025 $CO_2$ reduction target, and introduces intermediate $CO_2$ and ZEV targets in 2027.
- The **Central** scenario considers a **100% $CO_2$ reduction target in 2035** for all trucks and buses except vocational trucks (100% ZEV in 2040), in line with the date set for cars and vans, as well as a $CO_2$ reduction target of -65% in 2030 for medium and heavy trucks. Intermediate $CO_2$ and ZEV targets are also introduced in 2027.
- The **Delayed** scenario looks at a **100% $CO_2$ reduction target in 2040** for all trucks and buses, close to the European Automobile Manufacturers' Association's (ACEA) ambition which envisions 100% fossil-free sales in 2040[19]. The 2030 $CO_2$ reduction target is also raised to -45%[20] for medium and heavy trucks.

Table 1 and 2 below show an overview of the 2030 $CO_2$ reduction targets in each scenario and the resulting year in which all sales will be zero-emission. See Annex 2 for the modelled targets in 2025, 2027, 2030 and 2035 under each scenario.

Table 1. $CO_2$ reduction target in 2030 for medium and heavy trucks

| HDV categories | Current policies | Delayed | Central | Accelerated |
|---|---|---|---|---|
| Medium trucks | - | -45% | -65% | -100% |
| Heavy trucks | -30% | -45% | -65% | -100% |

Table 2. Year all new sales are zero-emission by HDV category and policy scenario

| HDV categories | Current policies | Delayed | Central | Accelerated |
|---|---|---|---|---|
| Freight trucks and coaches | - | 2040 | 2035 | 2030 |
| Urban buses | - | 2030 | 2027 | 2027 |
| Vocational trucks | - | 2040 | 2040 | 2035 |

[17] ICCT. (2022). Survival curves of EU heavy-duty vehicles.
[18] For context, cars and vans are retired after 14 years on average. See Ricardo-AEA. (2015). Improvements to the definition of lifetime mileage of light duty vehicles. Link
[19] ACEA. (2020). All new trucks sold must be fossil free by 2040, agree truck makers and climate researchers. Link
[20] This is in line with the increase in ambition observed for the car $CO_2$ standards. The European Commission proposed raising the 2030 target for cars from -37.5% to -55%, i.e. a +47% increase in ambition. For heavy trucks, this corresponds to going from a -30% target to a -44% target.

Most HDVs are regulated through a $CO_2$ emissions reduction target, including medium trucks where $CO_2$ emissions have been monitored and reported since 2020. However, the emissions of new small trucks and vocational trucks will not be certified under VECTO, so they cannot be regulated by means of $CO_2$ reduction targets. As to buses and coaches, heavy buses are now included in the VECTO certification procedure. However, the accuracy of the simulation results appears insufficiently robust for urban buses. In addition, the multi-stage production process is also very common for urban buses and coaches where different manufacturers are responsible for the base vehicle and the superstructure. Applying a $CO_2$ reduction target based on VECTO certification would lead to additional regulatory complexity due to shared responsibilities. This creates technical barriers to introducing $CO_2$ reduction targets. From a regulatory feasibility perspective, zero-emission vehicle (ZEV) targets are thus preferable for small and vocational trucks, and buses and coaches so that is what this paper assumes. In addition, trailers are assumed to be regulated through an energy efficiency standard. Annex 1 contains details regarding the scope of the current $CO_2$ standards and the targets modelled for each HDV category in all policy scenarios.

## 3. Uptake of zero-emission HDV sales under each scenario

Based on the $CO_2$ and ZEV targets assumed in each scenario, the uptake of zero-emission vehicles in each vehicle category is modelled. The data and methodology used are detailed in Annex 2. Figure 2 shows the overall ZEV uptake of all HDV categories combined, including categories which are subject to $CO_2$ targets, not ZEV targets. Annex 3 presents how $CO_2$ targets are converted into ZEV uptake, and the resulting ZEV uptake for each HDV category. In the Accelerated scenario, almost half of new HDV sales are zero-emission in 2027, climbing to 94% in 2030, and 100% in 2035. In the Central scenario, a quarter of new HDVs are ZEVs in 2027, rising to 59% in 2030, 98% in 2035, and finally 100% in 2040. In the Delayed scenario, sales of new zero-emission HDVs (ZE-HDVs) remain under 40% in 2030, leaving more than half of the decarbonisation efforts to be achieved in the 2030s, but reach 74% in 2035 and 100% in 2040.

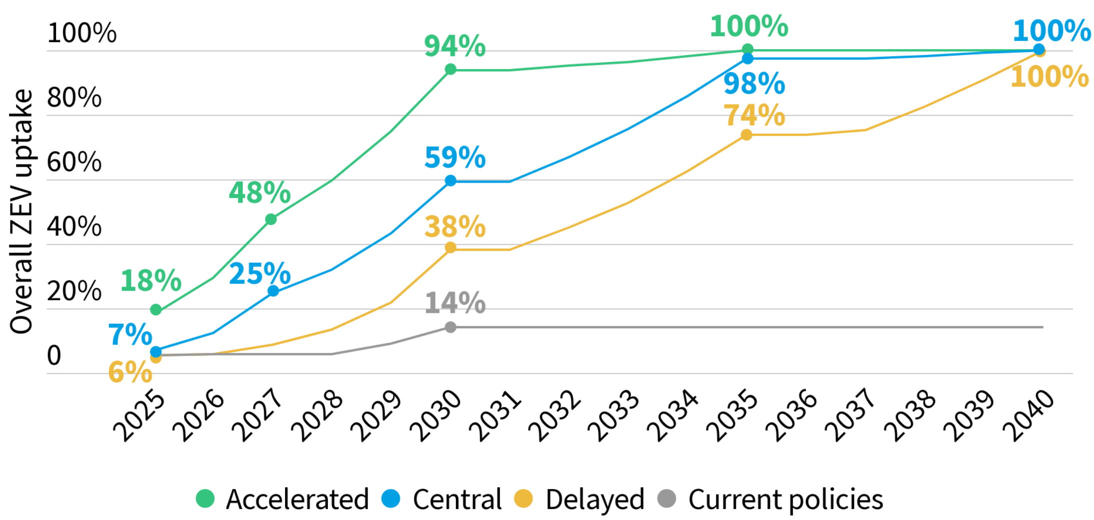



Figure 2. Average ZE-HDV uptake across all categories under each policy scenario

Figure 3 shows how each policy scenario modelled in this study compares with existing estimates of the number of zero-emission trucks (ZETs) in operation in 2030. These projections include, from lowest to highest:

- the European Commission estimates there will be 80,000 ZETs on EU roads in 2030[21],
- ACEA projects there will be 330,000 ZETs operating in the EU+UK in 2030[22],
- based on truckmakers' announcements — and assuming truckmakers who have not set ZEV targets limit themselves to complying with existing $CO_2$ standards — T&E calculates there will be 614,000 ZETs in the EU+UK in 2030.

In the Accelerated scenario, 1.2 million ZETs would be in operation in the EU+UK in 2030, more than double the amount announced by original equipment manufacturers (OEMs). In the Central scenario, there would be 659,000 ZETs in the EU+UK in 2030, or only 7% more than what has been publicly announced by truckmakers. In the Delayed scenario, 335,000 ZETs would be in use in 2030, or 2% more than the estimate from ACEA but 45% less than what OEMs themselves forecast. Lastly, in the Current policies scenario, there would be 161,000 ZETs in the EU+UK in 2030, more than double the estimate from the Commission, but less than half of the forecast from ACEA, and 74% less than OEM announcements.

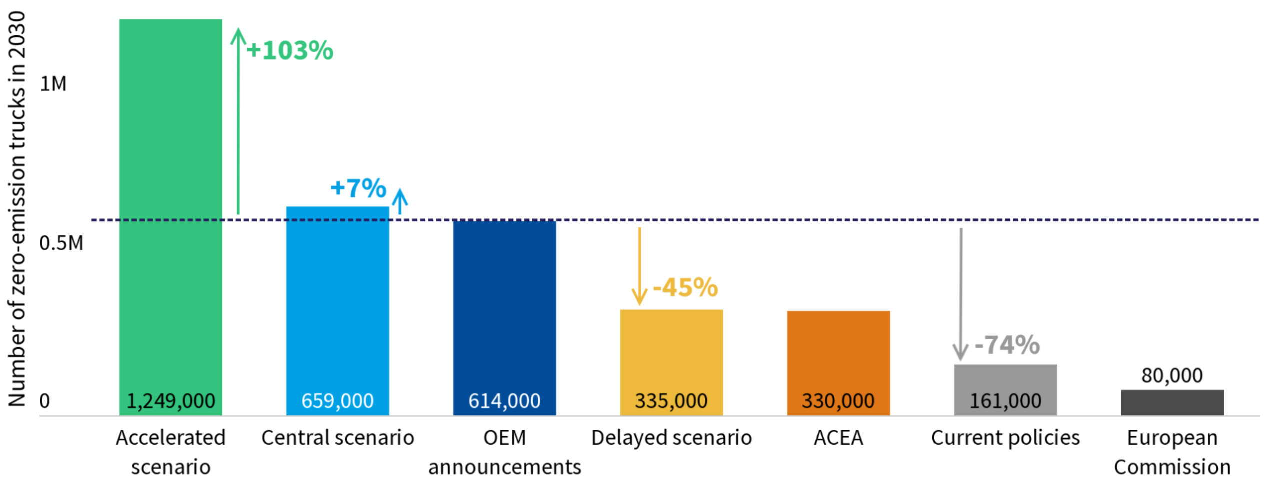



Figure 3. Number of zero-emission trucks on the road in the EU+UK in 2030

## 4. Contribution to the EU's climate targets

The EU HDV fleet is modelled based on the ZEV uptake in each scenario, and projected activity growth for trucks and buses (see Annex 3 for information on data and methodology). This section presents the impacts of each scenario on future $CO_2$ emissions and oil demand.

[21] EC. (2020). Questions and Answers: Sustainable and Smart Mobility Strategy Link
[22] ACEA. (2021). ACEA Position Paper. Heavy-duty vehicles: Charging and refuelling infrastructure requirements. Link

Based on the outcome of this modelling, T&E shows that, **from a climate perspective, both the Central and Accelerated scenarios are suited to reach our climate goals** while the **Delayed scenario would fall short**. This assessment is based on the evaluation of **three criteria**.

- The first criterion considers how close to **zero-emission** the fleet is **by 2050**. This takes into account two elements: the $CO_2$ reduction brought about by the $CO_2$ standards, and the number of remaining diesel vehicles in use in 2050.
- The second criterion looks at **near-term and overall $CO_2$ savings**. This accounts for whether HDVs contribute to the EU's objective of reducing emissions by 55% in 2030 relative to 1990, as well as for the share of the remaining carbon budget eaten up by cumulative emissions in each scenario.
- The third criterion looks at **near-term oil savings**, as cutting oil demand is crucial to become independent from imports of Russian oil.

## 4.1. Achieving zero-emission in 2050

Under the **current existing HDV $CO_2$ standards** emissions would **increase by 30% in 2050** relative to 1990 (Figure 4). This is due to already-high emissions relative to 1990 (+28% in 2019, +18% in 2020)[23] and a projected boom in activity (+44% for trucks, and +72% for buses between 2020 and 2050)[24]. Reaching 100% ZEV sales by 2040 reduces emissions by **89%** relative to 1990. This falls short of the objective set in the European Climate Law of reducing transport emissions by 90% in 2050 relative to 1990. In addition, road transport should be as close as possible to zero-emission in 2050 in order to compensate for aviation and shipping's own decarbonisation challenges. The Central and Accelerated scenarios respectively cut emissions by **95%** and **98%**, bringing HDVs close to full decarbonisation.

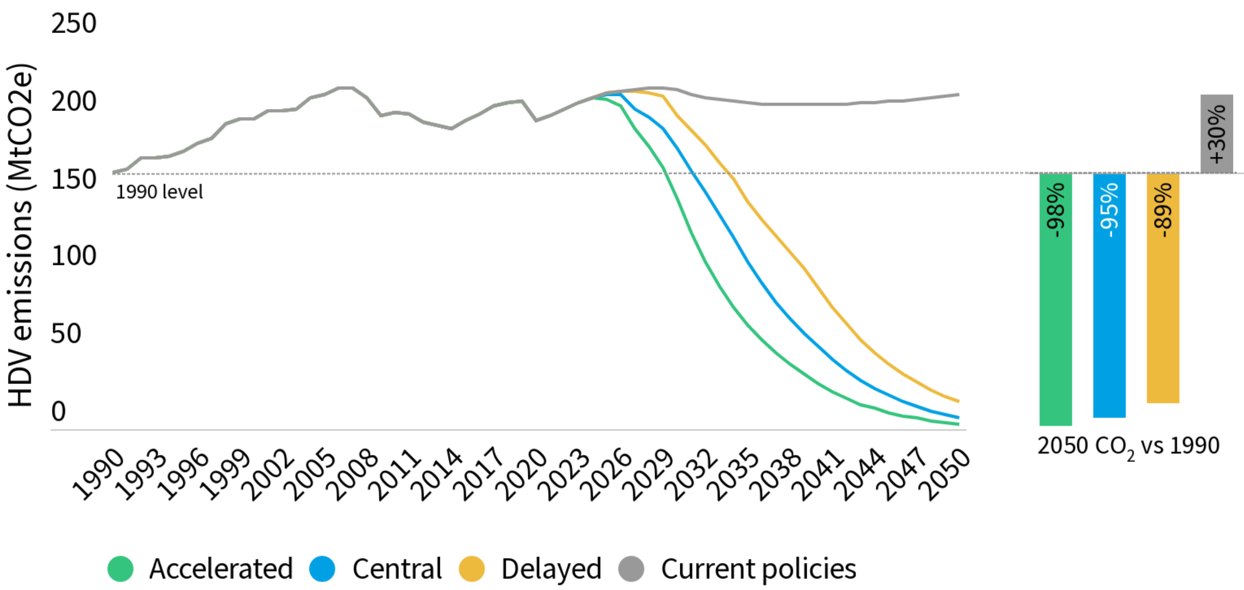



Figure 4. Emissions trajectories by scenario until 2050

[23] UNFCCC. (2022). National Inventory Submissions 2022. Link
[24] EC. (n.d.). EU Reference Scenario 2020. Energy. Link

Looking at the legacy ICE fleet on the road in 2050, the Accelerated scenario scores best: only 8% of the HDV fleet still runs on diesel in 2050 (Figure 5). Remaining diesel vehicles are also 24 years old on average, which is 4–6 years older than the average retirement age.

Similarly, only 13% of the HDV fleet is still diesel in 2050 in the Central scenario. The legacy diesel fleet is 21 years old on average — again older than average retirement age by 1–3 years.

**In the Delayed scenario however, one-fifth of the HDV fleet is still diesel in 2050**, with 1.4 million diesel HDVs still driving on EU roads. Here the legacy diesel fleet is 18 years old on average, which is slightly below the average retirement age. Removing them entirely from the fleet by 2050 would pose significant legislative and practical challenges, likely **requiring strict restrictions due to the scale of the additional transformation still needed**.

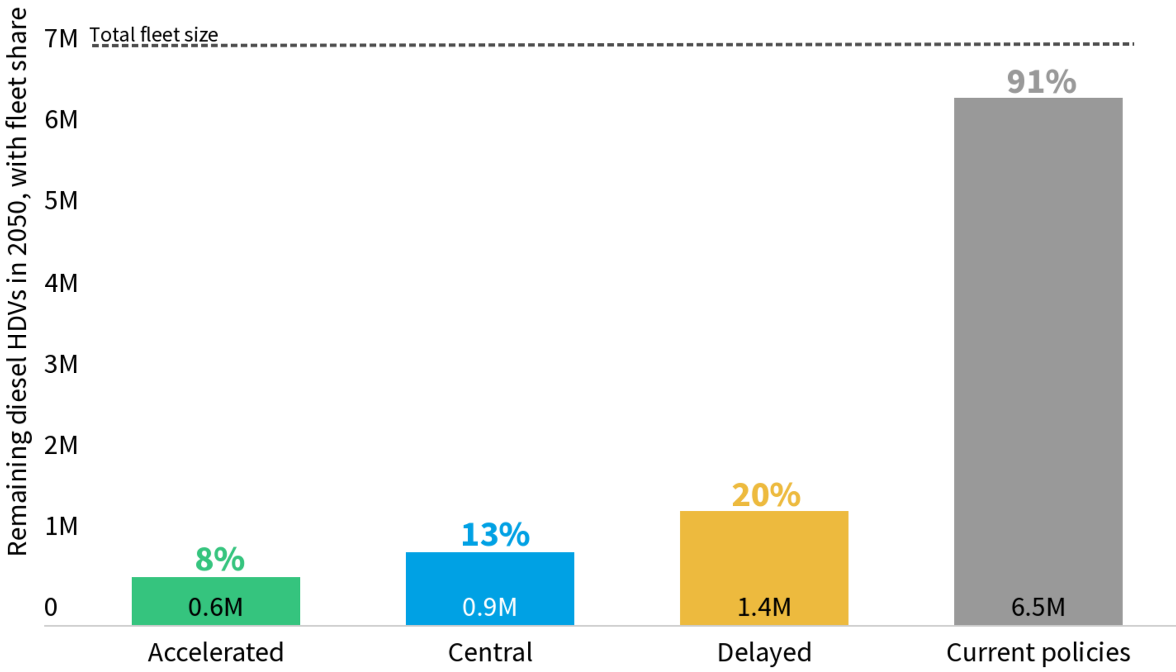



Figure 5. Legacy diesel fleet in 2050

In summary, **both the Accelerated and the Central scenario can achieve zero-emission in 2050**. In both scenarios, the $CO_2$ standards achieve large emission reductions relative to 1990 (respectively, -98% and -95%), and **the legacy diesel fleet may be naturally retired as the remaining diesel vehicles make up 9%–13% of the fleet and are older than average retirement age by several years.** In the Delayed scenario, the $CO_2$ standards are insufficient to set the sector on a credible path towards full decarbonisation by 2050.

## 4.2. Emissions savings before 2050

**All scenarios fail to reduce $CO_2$ emissions in 2030 by 55%** relative to 1990 — the 2030 EU-wide objective set out in the European Green Deal[25]. This is **mainly due to the lack of HDV $CO_2$ targets before 2025**, which leaves only five years to negate the +28% rise in emissions observed since 1990, let alone further reduce emissions by at least 55%. Emissions in 2030 are 32% above 1990 level in the Current policies scenario, 22% above in the Delayed scenario, 10% above in the Central scenario and 10% below in the Accelerated scenario, as shown in Figure 6.

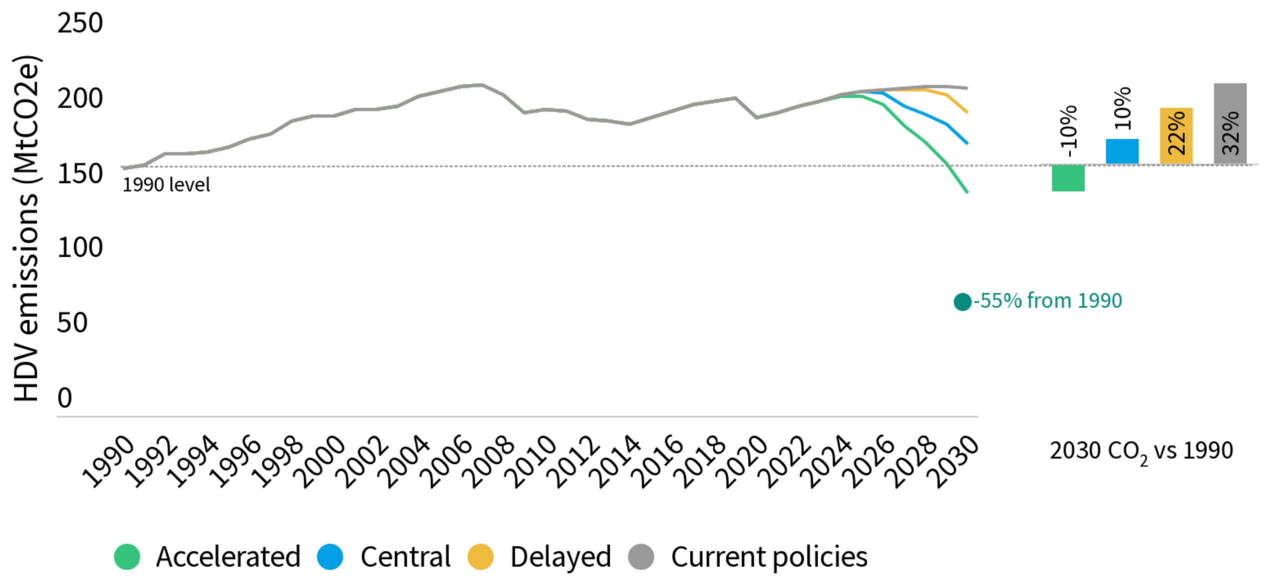



Figure 6. Emissions trajectories by scenario until 2030

Although HDVs cannot come close to doing their fair share to meet the EU's economy-wide 2030 target, it is important to reduce their emissions in the near-term as much as possible. Otherwise other sectors will need to pick up the slack and reduce their own emissions even faster. Compared to the Current policies scenario, the $CO_2$ emissions savings in 2030 would be equivalent to **35 million cars taken off the road in the Accelerated scenario, 19 million cars in the Central scenario, and only 8 million cars in the Delayed scenario** (Figure 7)[26]. By 2030, the Central scenario would thus more than double the emissions savings from the HDV $CO_2$ standards compared to the Delayed scenario.

[25] EC. (n.d.). 2030 Climate Target Plan. Link

[26] Based on average annual emissions of 1.97 $tCO_2$ per car. Estimate calculated from total EU car fleet $CO_2$ emissions of 480.42 $MtCO_2$ in 2019 (UNFCCC. (2022). National Inventory Submissions 2022. Link) and EU fleet size of 243.5 million cars in 2019 (ACEA. (2022). Vehicles in Use. Link). Data for 2020 is available but not used, as car-related travel dropped in 2020 due to the COVID-19 pandemic, which distorted the relation between vehicle stock and emissions.

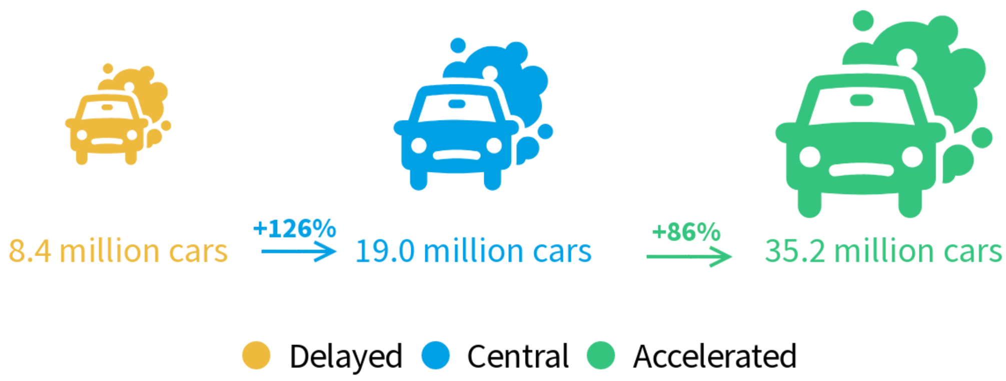



Figure 7. Emissions savings by scenario in 2030, expressed in number of ICE cars off the road

The cumulative $CO_2$ emissions emitted between today and 2050 are shown in Figure 8. In the Current policies scenario, 6.2 $GtCO_2e$ are emitted between 2022 and 2050. To put this into perspective, the EU's entire remaining carbon budget at the start of 2022 is 15 $GtCO_2e$ to have a 67% chance of limiting global warming to 1.5°C above pre-industrial levels and not correcting for historical emissions[27][28]. This means that between 2022 and when the EU becomes climate-neutral, all EU sectors combined need to emit less than 15 $GtCO_2e$. In other words, in the Current policies scenario, trucks and buses alone would eat up 41% of the entire EU's carbon budget by 2050, and even then still keep polluting afterwards.

In the **Delayed scenario**, HDVs emit 3.8 $GtCO_2e$ by 2050, or **25% of the EU's carbon budget, and may continue to emit afterwards**, unless additional policy measures are implemented. In the **Central scenario**, HDVs emit 3.1 $GtCO_2e$, or **21% of the EU's carbon budget, but then reach full decarbonisation**. Under the Accelerated scenario, HDVs emit 2.5 $GtCO_2e$ by 2050, thus consuming 17% of the EU's remaining carbon budget before becoming fully decarbonised. For comparison, trucks and buses emitted around 6% of the total EU greenhouse gas emissions in 2020[29]. This means that **even in the most ambitious scenario, HDVs use up a disproportionately high share of the carbon budget.**

The difference in cumulative emissions between the Delayed scenario and the Central scenario is 644 $MtCO_2e$. This is equivalent to the total road transportation emissions in 2019 of the six largest European markets: Germany (159 $MtCO_2e$), France (126 $MtCO_2e$), UK (111 $MtCO_2e$), Italy (98 $MtCO_2e$), Spain (85 $MtCO_2e$), Poland (65 $MtCO_2e$)[30]. The difference in cumulative emissions between the Central and Accelerated scenario is 578 MtCO2e, equal to the total road transport emissions in 2019 of Germany, France, the UK, Italy, and Spain.

[27] ICCT. (2021). Transport could burn up the EU's entire carbon budget. Link
[28] IEA. (2022). Global $CO_2$ emissions rebounded to their highest level in history in 2021. Link
[29] UNFCCC. (2022). National Inventory Submissions 2022. Link
[30] UNFCCC. (2022). National Inventory Submissions 2022. Link

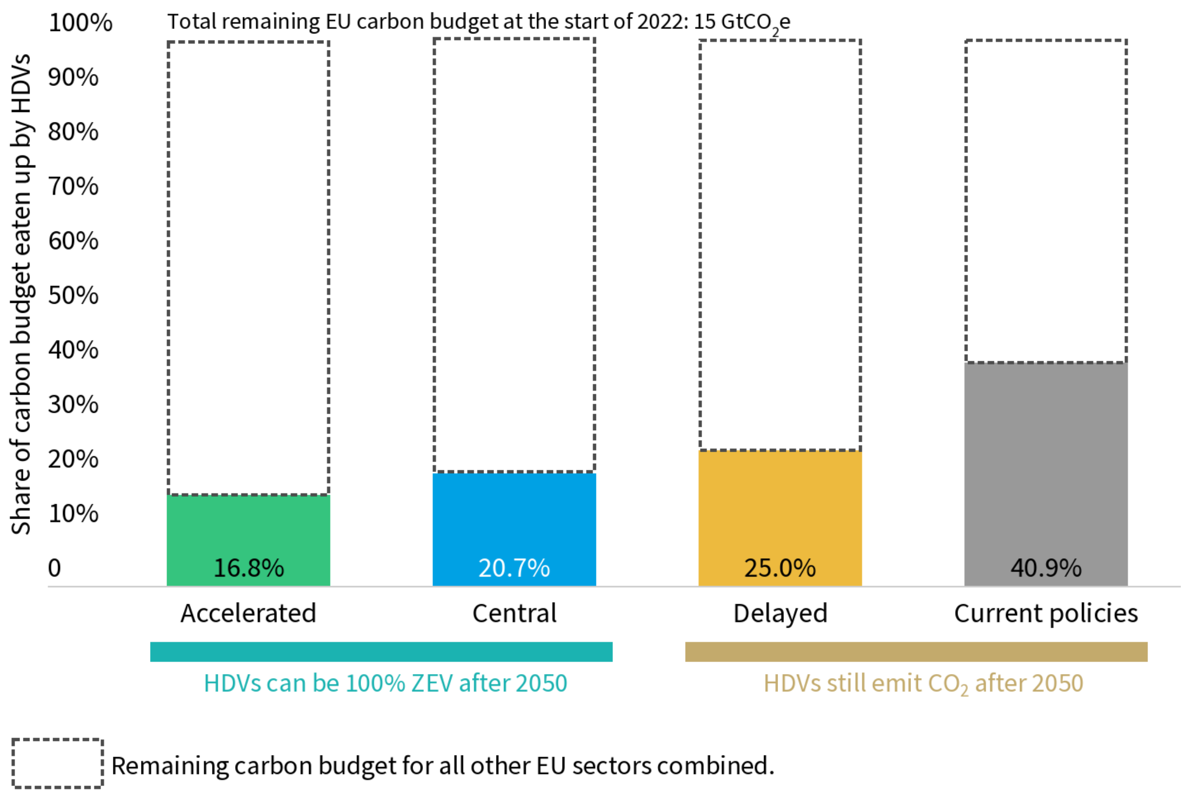



Figure 8. Cumulative HDV emissions in 2022–2050 in each scenario compared to the remaining EU's carbon budget

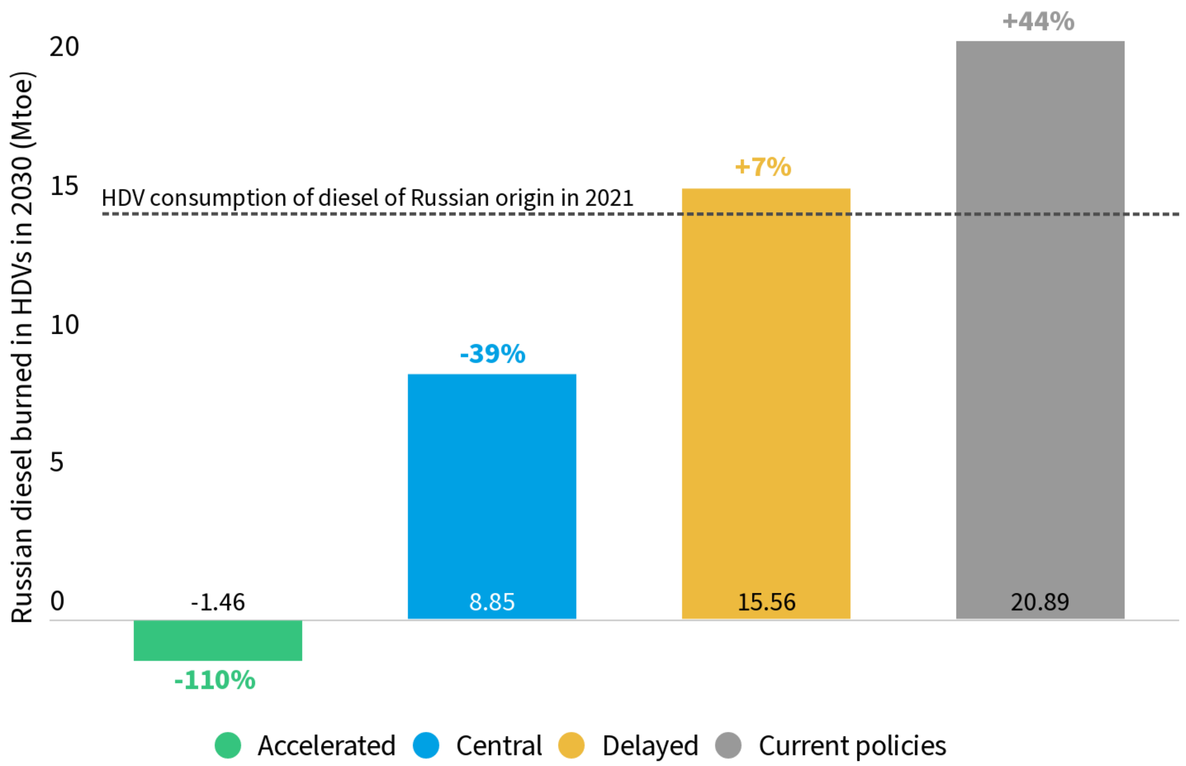
## 4.3. Oil demand reduction

Trucks and buses in the EU consumed 64 million tonnes of oil equivalent (Mtoe) worth of diesel in 2021, or 42% of diesel burned by road transport in the EU. **In a do-nothing-scenario,** diesel consumption from HDVs would rise by 10% (6 Mtoe) by 2030. The **Delayed scenario** fails to fully reverse this trend: **HDVs would eat 2%** (1 Mtoe) **more oil than they do today**. However, both the Central and Accelerated scenarios reduce HDV diesel consumption in 2030: by 9% and 25% (i.e. 6 and 16 Mtoe) respectively relative to 2021.

For context, **23% of diesel consumed in 2020[31] in the EU was of Russian origin** — either directly imported as diesel from Russia, or refined in Europe from Russian crude oil. Assuming the same share for 2021, this means HDVs in the EU burned approximately 15 Mtoe of Russian diesel in 2021. Therefore, in the Accelerated scenario, HDVs in the EU could be fully free from Russian diesel in 2030 (Figure 9). In the **Central scenario, EU HDVs reduce their reliance on Russian diesel by 39% in 2030, and could be free from it in 2032**. In the Delayed scenario, HDVs burn more oil in 2030 than in 2021, but they could be free

[31] In 2019, 22% of the EU's diesel supply was of Russian origin. Eurostat. (2022). Imports of oil and petroleum products by partner country [nrg_ti_oil] and Complete energy balances [nrg_bal_c]

from diesel of Russian origin in 2035. In the Current policies scenario, diesel consumption from HDVs remains higher than 2021 level through 2050.




Note: Assumes all change in HDV diesel consumption come from change in supply of diesel of Russian origin.

Figure 9. Change in Russian diesel demand in 2030 by scenario

## 5. Conclusions and policy recommendations

Both **the Central and Accelerated scenarios can achieve full decarbonisation by 2050, while this is unlikely in the Delayed scenario**. The Accelerated scenario has additional benefits, such as lower cumulative emissions, larger oil savings and quicker independence from Russian diesel. However, it is unlikely that the transformation to zero-emission can be achieved at this pace without disruption — notably because of infrastructure deployment and ZEV production capacity ramp-up — and that political agreement can be found for such high ambition.

Table 3. Summary of the results of all three policy scenarios

| | Accelerated | Central | Delayed |
|---|---|---|---|
| $CO_2$ emissions in 2050 (relative to 1990) | -98% | -95% | -89% |
| Remaining diesel vehicles in 2050<br>– Number (fleet share)<br>– Average age (years) | <br>0.6 million (8%)<br>24y | <br>0.9 million (13%)<br>21y | <br>1.4 million (20%)<br>18y |
| ZEV market share in 2030 | 94% | 59% | 38% |
| $CO_2$ emissions in 2030 (relative to 1990) | -10% | +10% | +22% |
| Annual $CO_2$ savings in 2030 expressed in cars off the road (relative to current policies) | 35.2 million | 19.0 million | 8.4 million |
| Oil consumption in 2030 (relative to 2021) | -25% | -9% | +2% |
| Russian oil consumption in 2030 (relative to 2021) | -110% | -39% | +7% |
| Share of EU's carbon budget eaten up by 2050 by HDVs alone | 17% | 21% | 25% |

The **Central scenario also achieves rapid emissions and oil savings, while having a smoother and non-disruptive transition path**[32]. As a result, T&E recommends to align the ambition of the review of the HDV $CO_2$ standards with the targets modelled in the Central scenario. T&Es' position paper on the HDV $CO_2$ standards presents these targets in more detail alongside T&E's in-depth recommendations on the revision[33]. T&E's recommended $CO_2$ targets for medium and heavy trucks are shown in Figure 10 (dark green), with the resulting ZEV uptake (light green). For other HDV categories, T&E's recommended zero-emission sales targets are presented in Figure 11.

[32] Detailed T&E analysis on the techno-economic and market potential of ZETs will be published later this year.
[33] T&E. (2022). Truck $CO_2$: Europe's chance for leadership. Position paper on the review of the HDV $CO_2$ standards Link

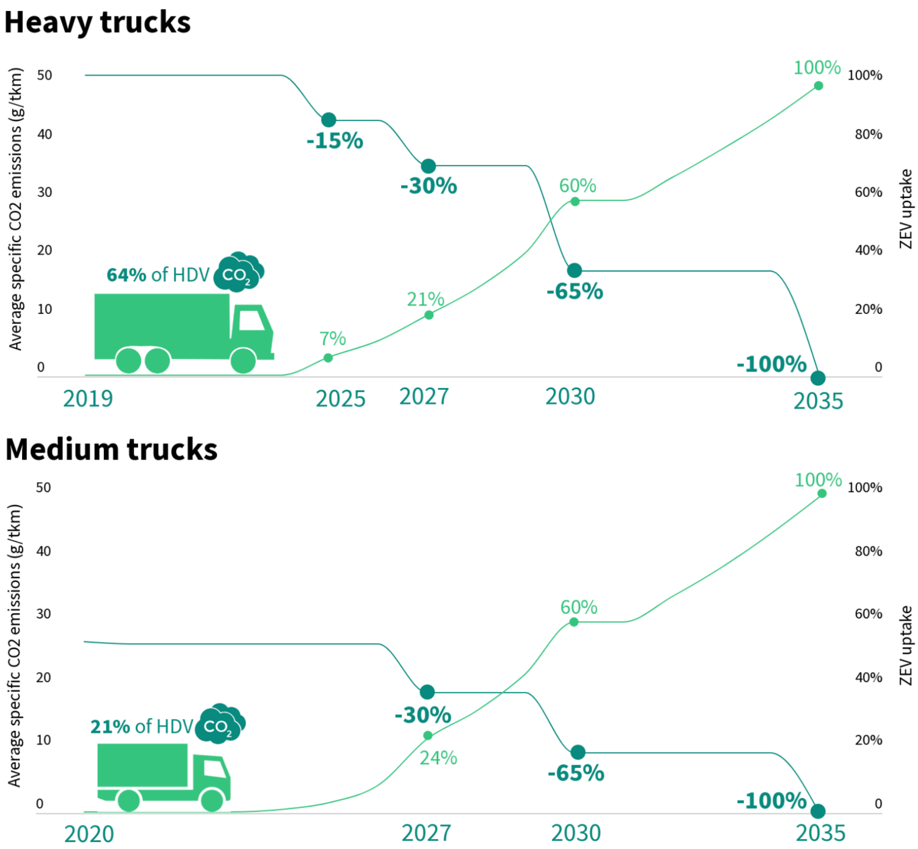



Figure 10. T&E's recommended $CO_2$ reduction targets for medium and heavy trucks

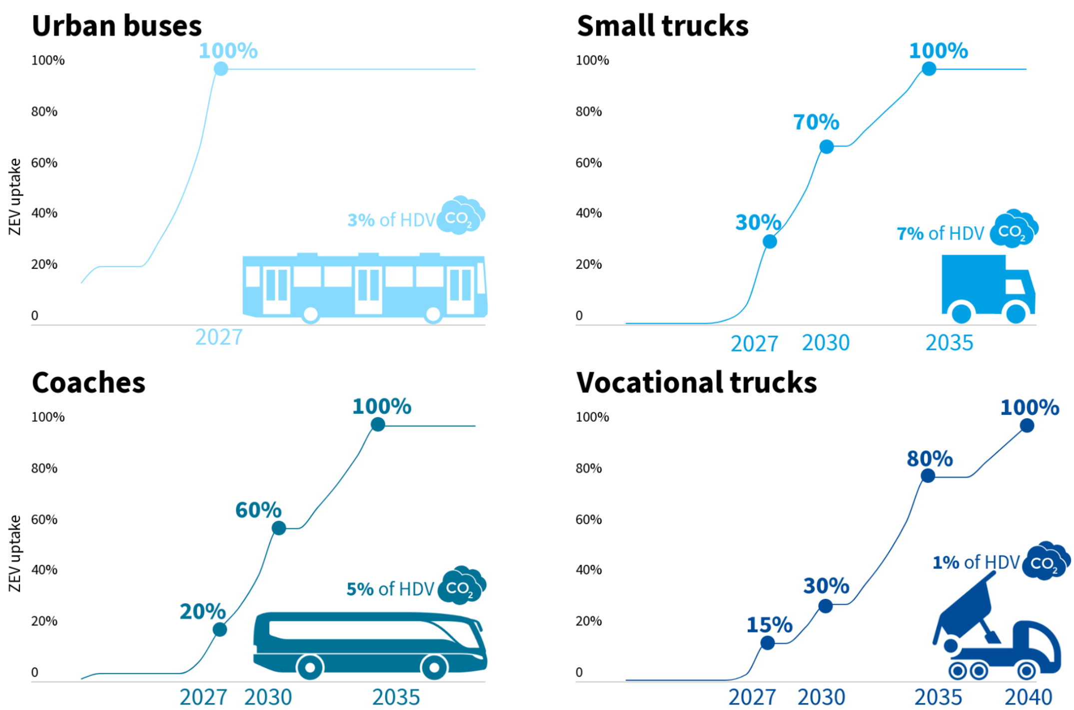



Figure 11. T&E's recommended ZEV sales targets

## Further information

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# Annex 1: Vehicle groups

Currently, the HDV $CO_2$ standards only apply to 61% of new HDVs, responsible for 63% of HDV emissions from new sales in 2019. Included are trucks above 16 tonnes with a 4x2 axle configuration, either rigid (VECTO group 4) or articulated (VECTO group 5), and trucks of all weights with a 6x2 axle configuration, either rigid (VECTO group 9) or articulated (VECTO group 10). The Regulation exempts trucks included in these categories which are certified as vocational, meaning trucks which are not used for goods delivery. Some trucks with a 6x4 axle configuration, either rigid (VECTO group 11) or articulated (VECTO group 12), are certified for long-haul operation, although their $CO_2$ emissions are not yet regulated. T&E groups these together with regulated trucks under the category of **heavy trucks** as their duty-cycle characteristics are very similar. In total, heavy trucks made up 62% of new HDV sales in 2019.

Smaller trucks, accounting for 16% of new sales in 2019, are not yet included in the $CO_2$ standards. T&E classifies them into two categories: **small trucks**, which weigh between 3.5 and 7.4 tonnes (VECTO group 0); and **medium trucks**, which weigh between 7.4 and 16 tonnes, (VECTO groups 1, 2, and 3). $CO_2$ emissions of medium trucks have been certified as well as monitored and reported since January 2020, and can thus serve as a baseline for future reduction targets. However, small trucks are not yet considered by the certification regulation, a prerequisite for being subject to $CO_2$ standards. This means that other regulatory instruments, such as targets for the uptake of zero-emission vehicles, are necessary.

Table A1.1 Characteristics of HDV categories

| HDV category | VECTO groups | Description | Share of new HDVs | Share of CO2 emissions from new sales | Share of CO2 emissions from HDV fleet |
|---|---|---|---|---|---|
| Small trucks | 0 | Trucks between 3.5 and 7.4 tonnes, and N1 vans classified as HDVs | 11% | 7% | 11% |
| Medium trucks | 1, 2, 3 | Trucks between 7.4 and 16 tonnes, with a 4x2 axle configuration | 5% | 21% | 24% |
| Heavy trucks - regulated | 4, 5, 9, 10 (excluding vocational) | Trucks above 16 tonnes with a 4x2 axle configuration, and trucks of all weights with a 6x2 axle configuration (excluding vocational trucks) | 61% | 63% | 54% |
| Heavy trucks - unregulated | 11-LH, 12-LH | Trucks of all weights with a 6x4 axle configuration, used for long-haul transport | 1% | 1% | 1% |
| Vocational lorries | 4v, 5v, 6, 7, 8, 11v, 12v, 13-17 | Trucks used mainly for uses other than goods transport | 12% | 1% | <1% |
| Buses | | Urban buses | 4% | 3% | 4% |
| Coaches | | Long-distance coaches | 6% | 5% | 5% |

*Shares may not add up to 100% due to rounding.

**Vocational trucks** comprise all trucks which are used for uses other than long-haul, regional, or urban delivery, such as for construction works or garbage collection. They comprise VECTO groups 4v, 5v, 6, 7, 8, 11v, 12v, and 13–17. So far, they have been exempt from the HDV $CO_2$ standards. While emissions from new vehicles in VECTO groups 11, 12, and 16 have been certified, monitored and reported since January

2020, the remainder of vocational trucks are not considered by the certification regulation. This means that ZEV targets are the preferable regulation for vocational vehicles. Overall, vocational trucks account for 12% of new HDV sales.

In order to reduce emissions from tractor-trailers, the HDV $CO_2$ standards should also be extended to **trailers**, in the form of an energy efficiency standard. Trailers have the potential to reduce the energy consumption from tractor-trailers through improved aerodynamics, rolling resistance reduction, and lightweighting.

Other than trucks, heavy-duty vehicles also include buses and coaches. **Buses** are the fastest vehicle segment at going zero-emission, with 23% of new city buses in 2021 being zero-emission, up from 16% in 2020[34]. **Coaches**, used for long-distance passenger transport, are decarbonising at a slower pace, with ZEVs making up an estimated 3% of new coaches in 2021, up from 1% in 2020[35][36].

[34] Chatrou CME Solutions. (2022). City buses registrations in 2019-2021. In the first half of 2022, 30% of new urban buses were zero-emission. The 2022 data was not included in the modelling, as it was not yet published at the time. Sustainable Bus. (2022). 30% of city buses registered in Europe is now zero emissions. VDL lead the e-bus market in the first half of 2022. Link

[35] ACEA. (2022). Fuel types of new buses: electric 10.6%, alternative fuels 10.5%, hybrid 10.1%, diesel 68.8% share in 2021. Link

[36] Chatrou CME Solutions. (2022). City buses registrations in 2019-2021.

# Annex 2: Policy scenarios

This Annex presents the targets associated with each scenario and broken down by HDV category (see Annex 1 for vehicle group classification).

The targets modelled in the **Accelerated scenario** are shown in Table A2.1. This scenario models $CO_2$ reduction targets for new medium and heavy trucks reaching zero-emission in 2030, as well as ZEV targets reaching 100% for new small trucks and coaches in 2030. For new buses — 23% of which were already zero-emission in 2021[37] — 100% zero-emission sales are reached in 2027. However, new vocational trucks fully reach zero-emission in 2035, with only half of new vocational trucks being zero-emission in 2030. In addition to the targets for trucks and buses, a trailer efficiency standard is introduced. This further reduces energy consumption from regional delivery semi-trailers by 5% in 2027 and 7% in 2030, and from long-haul semi-trailers by 7% in 2027 and 10% in 2030. The level of ambition is determined by the potential in the 2020s for energy consumption reduction from improved aerodynamics, tyres, and lightweighting based on work from the ICCT[38].

Table A2.1 Targets modelled in the Accelerated scenario

| Vehicle category | Regulation | 2025 | 2027 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| Small trucks | ZEV targets | 25% | 55% | 100% | | |
| Medium trucks | CO2 targets | -25% | -55% | -100% | | |
| Heavy trucks | CO2 targets | -25% | -55% | -100% | | |
| Vocational trucks | ZEV targets | 5% | 20% | 50% | 100% | |
| Buses | ZEV targets | | 100% | | | |
| Coaches | ZEV targets | 15% | 40% | 100% | | |

The **Central scenario** targets, corresponding to T&E's recommendations, are presented in Table A2.2. This scenario models $CO_2$ reduction targets for new medium and heavy trucks reaching 100% zero-emission in 2035, as well as ZEV uptake targets reaching 100% zero-emission for new small trucks and coaches in 2035. For new buses, internal combustion engines are phased out in 2027. However, for vocational trucks, only 80% are zero-emission in 2035, and a full ICE phaseout is implemented in 2040. In addition to the targets for trucks and buses, a trailer efficiency standard is introduced. This further reduces energy consumption from regional delivery semi-trailers by 5% in 2027 and 7% in 2030, and from long-haul semi-trailers by 7% in 2027 and 10% in 2030.

Pre-2035 targets are informed by the pace at which each category can decarbonise (based on internal T&E market analysis), and the need for a gradual transition which does not leave all efforts to the last minute. The introduction of 2027 targets ensures that some $CO_2$ emissions cuts occur already in the 2020s, and that supply of zero-emission HDVs is progressively scaled up.

[37] Chatrou CME Solutions. (2022). City buses registrations in 2019-2021.
[38] ICCT. (2017). Fuel Efficiency Technology in European Heavy-Duty Vehicles: Baseline and Potential for the 2020–2030 Time Frame. Link

Table A2.2 Targets modelled in the Central scenario

| Vehicle category | Regulation | 2025 | 2027 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| Small trucks | ZEV targets | | 30% | 70% | 100% | |
| Medium trucks | CO2 targets | | -30% | -65% | -100% | |
| Heavy trucks | CO2 targets | -15% | -30% | -65% | -100% | |
| Vocational trucks | ZEV targets | | 15% | 30% | 80% | 100% |
| Buses | ZEV targets | | 100% | | | |
| Coaches | ZEV targets | | 20% | 60% | 100% | |

The **Delayed scenario** targets are presented in Table A2.3 This scenario models a complete 100% zero-emission sales in 2040 for all categories, except buses, for which 100% are reached in 2030. Decarbonising sales by 2040 is closer to what ACEA envisions, i.e. 100% "fossil-free" sales by 2040[39]. Such targets would thus follow existing voluntary announcements and merely raise ambition by setting a 100% zero-emission, not "fossil-free"[40], target in 2040. For trailers, an efficiency standard is introduced to reduce energy consumption from regional delivery tractor-trailers by 5% in 2030 and 7% in 2035, and from long-haul tractor-trailers by 7% in 2030 and 10% in 2035.

Table A2.3 Targets modelled in the Delayed scenario

| Vehicle category | Regulation | 2025 | 2027 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| Small trucks | ZEV targets | | | 45% | 80% | 100% |
| Medium trucks | CO2 targets | | | -45% | -80% | -100% |
| Heavy trucks | CO2 targets | -15% | | -45% | -80% | -100% |
| Vocational trucks | ZEV targets | | | 20% | 50% | 100% |
| Buses | ZEV targets | | | 100% | | |
| Coaches | ZEV targets | | | 30% | 70% | 100% |

Lastly, the $CO_2$ standards modelled in the **Current policies** scenario are shown in Table A2.4 In addition to the current $CO_2$ standards, baseline ZE urban bus uptake also accounts for the Clean Vehicles Directive (CVD), which sets targets for the procurement of clean buses, at least half of which must be zero-emission. Averaging national targets (weighted by urban bus sales in 2021), the CVD mandates that at least 31% new urban buses should be zero-emission over 2026–2030.

Table A2.4. Targets modelled in the Current policies scenario

| Vehicle category | Regulation | 2025 | 2026 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| Heavy trucks | CO2 targets | -15% | | -30% | | |
| Urban buses | Clean Vehicles Directive | | 31% | | | |
| Other categories | None | | | | | |

[39] ACEA. (2020). All new trucks sold must be fossil free by 2040, agree truck makers and climate researchers. Link
[40] Unlike a 100% zero-emission target, a 100% fossil-free target leaves room for new ICE vehicles powered by biofuels or synthetic fuels. See the infobox in the introduction for more information.

# Annex 3: Converting $CO_2$ targets into ZEV market shares

For categories subject to ZEV sales targets, the ZEV uptake in target years is equal to the target as truckmakers are assumed not to overachieve targets. For medium and heavy trucks, where $CO_2$ emissions reduction targets are set instead of a ZEV mandate, the uptake of zero-emission vehicles depends on future fuel efficiency improvements and assumes that manufacturers comply with the target without overachieving it.

For regulated categories, fuel efficiency is assumed to improve by 1.3% annually. This is based on the estimated potential for fuel efficiency improvements in the 2020s from the ICCT[41]. For non-regulated categories, such as medium trucks in the baseline scenario, fuel consumption is assumed to decrease by 0.5% annually[42].

Furthermore, the uptake of zero-emission trucks is also influenced by regulatory flexibilities. The current regulation includes a mechanism to incentivise the sales of zero- and low-emission vehicles (ZLEV) by rewarding ZLEV sales with an on-paper $CO_2$ emissions reduction. This mechanism is hereafter referred to as the ZLEV benchmark. For heavy trucks, manufacturers' average specific $CO_2$ emissions are artificially reduced by 3% in 2025–2029. This is because ZEV uptake is expected to exceed 5% in all scenarios, so manufacturers would easily benefit from the full ZLEV benchmark credits. For medium trucks, a ZLEV benchmark appears unnecessary because of the higher feasibility to electrify, as a result the mechanism is not extended to this category. It is assumed that the ZLEV benchmark will be phased out in 2030 (as it has been proposed for cars and vans). In addition, the current regulation includes a banking and borrowing mechanism. Its impact on emissions trajectories are out of the scope of this briefing, and no emissions banking or borrowing was modelled.

Between the years when the targets are set, ZEV uptake is assumed to be constant until sales increase at a constant growth rate up to 3 years before the next target. This is designed to model the gradual and anticipated market adoption of ZEVs in a context of 3 or 5 years gap between targets. If the gap between two targets is inferior to ten percentage points, then no anticipated ramp-up is considered necessary. ZEV supply is assumed to ramp up over one year if the gap is above 10 pp but inferior to 20 pp, over two years if the gap is between 20 and 30 pp, and over three years if the gap is over 30 pp. During the ramp-up period, ZEV sales growth is modelled with a constant growth rate.

In addition to future ZEV uptake, the model also takes into account historical ZEV shares[43][44]. Lastly, baseline ZE bus uptake also accounts for the CVD, as described in Annex 2. The resulting ZEV uptake modelled by HDV category is presented in Figures A3.1 and A3.2.

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[41] ICCT. (2017). Fuel Efficiency Technology in European Heavy-Duty Vehicles: Baseline and Potential for the 2020–2030 Time Frame. Link
[42] ICCT. (2022). The $CO_2$ standards required for trucks and buses for Europe to meet its climate targets. Link
[43] ACEA. (2022). Registrations of vehicles - Trucks - Press releases. Link
[44] Chatrou CME Solutions. (2022). City buses registrations in 2019-2021.

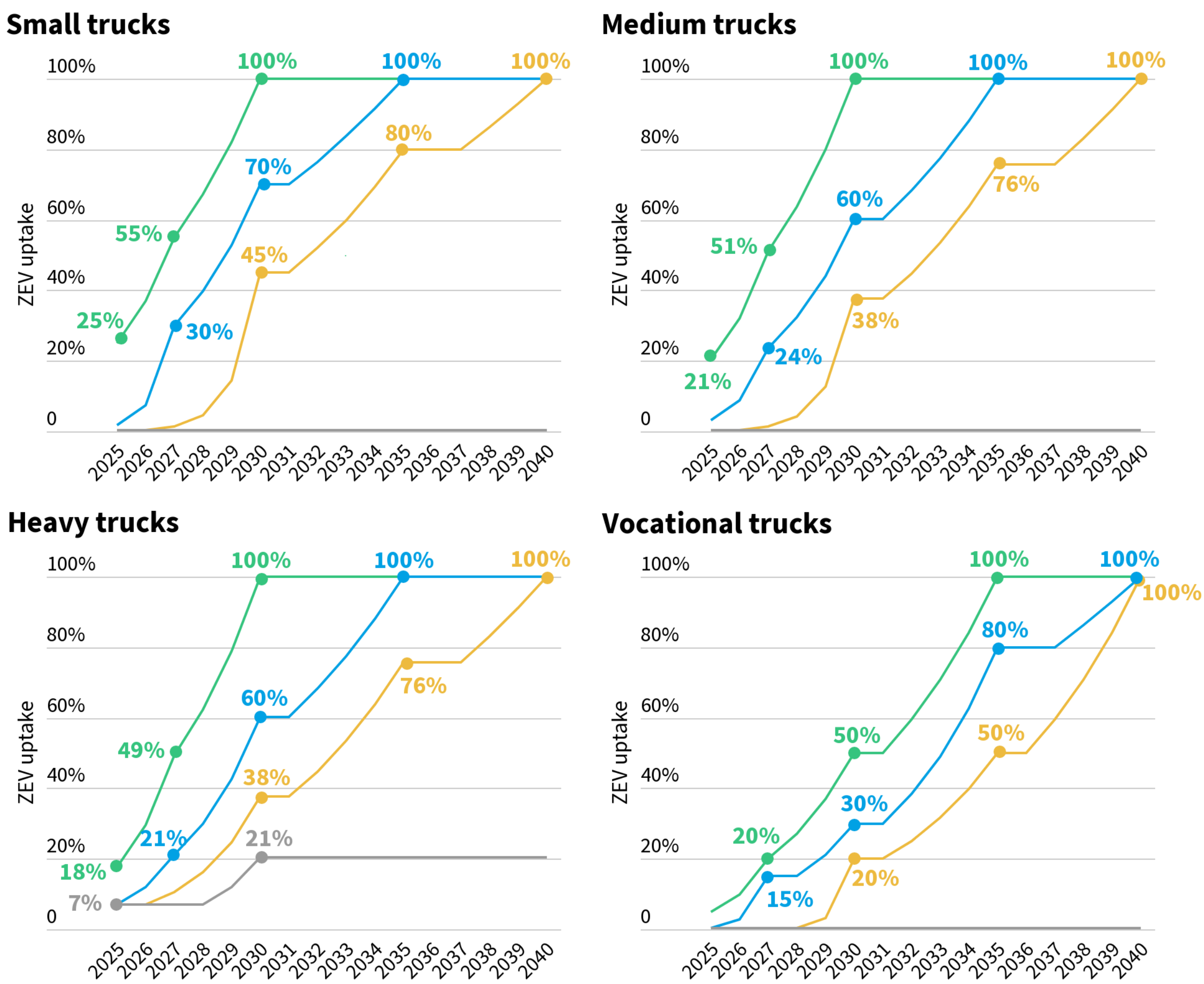


Figure A3.1 ZE truck uptake under each policy scenario

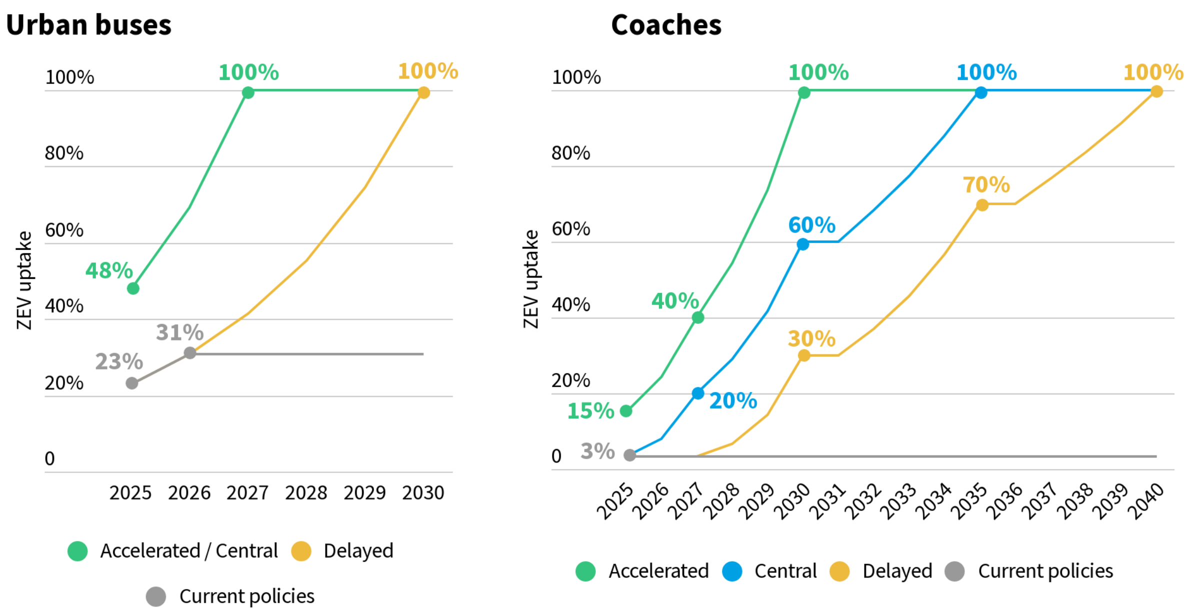


Figure A3.2 ZE bus and coach uptake in each policy scenario

# Annex 4: Modelling the HDV fleet with the EUTRM

T&E's EU Transport Roadmap Model (EUTRM) models the EU's fleet of light-duty and heavy-duty vehicles, and is used to assess the impact of the $CO_2$ standards on fleet composition, energy and oil consumption, and $CO_2$ emissions. In order to model the heavy-duty vehicle segment, the EUTRM has been expanded to include all six HDV categories presented in Annex 1: small, medium, heavy, and vocational trucks, buses, and coaches.

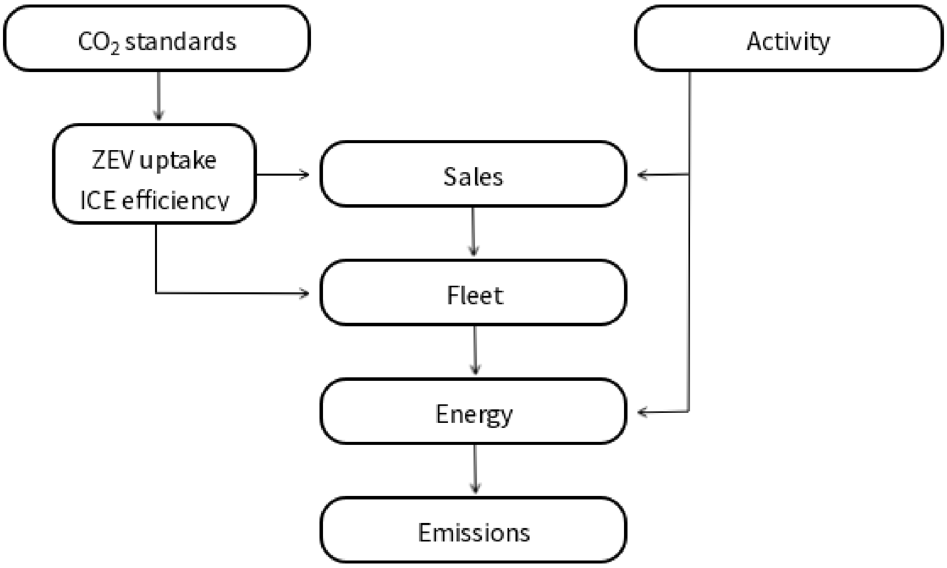


Figure A4.1 Simplified representation of the EUTRM

Historical data on activity and growth projections (in tonne-kilometres for trucks and passenger-kilometres for buses and coaches) are extracted from the EU Reference Scenario[45], and split across categories using the proportions from TRACCS data relative to the 2005-2010 period[46]. Since both sources refer to activity as per country where the vehicles are registered, a matrix switching from registration to territorial activity has been applied to the dataset using data from the EU Statistical Pocketbook[47].

Given the activity and load factor—the average tonnes of cargo carried per vehicle for trucks, and average number of passengers carried for buses—the model calculates the fleet composition per each country: vehicle stock, new sales and second hand sales. This only occurs for future years (2021-2050), while historical stock and sales are used for the model's calibration. Load factor is used to calibrate modelled emissions to historical emissions from UNFCCC over the 2000-2020 period[48]. For the year 2021, the factor

[45] EC. (n.d.). EU Reference Scenario 2020. Energy. Link
[46] EC. (2013). Transport data collection supporting the quantitative analysis of measures relating to transport and climate change (TRACCS). Link
[47] Eurostat. (n.d.). Statistical pocketbook 2021. Chapter 2.2: Performance of Freight Transport expressed in tonne-kilometres. Link
[48] UNFCCC. (2022). National Inventory Submissions 2022. Link

is calibrated to match registrations from ACEA, such value being then held constant for all future years. Survival curves, showing the percentage of active vehicles per year of age, are applied to the fleet together with data on annual distance accumulation (i.e. the ratio of distance travelled by vehicles of a given age over the mileage of a new vehicle) in order to get its turnover across time. Both datasets come from the ICCT[49]. Total sales are calculated as the vehicles needed to fill the gap between annual activity and mileage travelled by the existing fleet. The split between new and secondhand vehicles comes from bilateral trade matrices extracted from TRACCS data. Secondhand sales are only modelled within the 30 countries under consideration, as scope is limited to territorial emissions.

Given each country's fleet composition and activity for the whole 2000–2050 period, activity share by engine type is calculated. Each scenario contains different trajectories for future new ZEV sales, which determine stock composition and hence the mileage per engine type. Then, the model finds the average fuel consumption for both ICEs and ZEVs. In the former case, the dataset combines TRACCS estimates (2005-2010) and official measurements (2020) on fuel efficiency for new vehicles. Fuel consumption values are assumed to be constant over the 2000-2016 period and equal to the 2005-2010 average[50]. Then, the values between 2017-2019 are linearly interpolated. From 2020 on, a 1.3% improvement in fuel consumption per year is assumed for heavy trucks and 0.5% p.a. for the other categories until 2030, and then constant until 2050 (see Annex 3). Energy consumption for zero-emission powertrains was obtained from Earl et al. (2018)[51] and assumed constant throughout the entire period. The measure is also affected by trailers' efficiency improvements for the Accelerated, Central and Delayed scenarios, as shown in Annex 2. No trailer improvements are expected to occur under the Current policies scenario.

Annual distance travelled, activity shares by engine type and average fuel consumption are then used to calculate tank-to-wheel energy consumption. A country's energy consumption in a given year is obtained by multiplying each powertrain's activity by average fuel consumption and summing them up.

In calculating energy consumption, fuel blends such as low sulphur diesel, vegetable oil diesel and cellulose waste oil diesel are also taken into account. The share of such fuels in conventional diesel is taken from the 7% scenario from GLOBIOM[52]. $CO_2$ emissions are calculated from tank-to-wheel energy consumption from emitting powertrains using a conversion factor from US EPA MOBILE6[53]. This represents the average lifetime emission factor and includes deterioration over the life of the vehicle. Total greenhouse gas emissions are obtained by summing $CO_2$, methane, and nitrogen dioxide emissions, each multiplied by its 100-year global warming potential[54].

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[49] ICCT. (2022). Survival curves of EU heavy-duty vehicles.
[50] ICCT. (2017). Shell game? Debating real-world fuel consumption trends for heavy-duty vehicles in Europe. Link
[51] Thomas Earl, Lucien Mathieu, Stef Cornelis, Samuel Kenny, Carlos Calvo Ambel, James Nix. (2018). Analysis of long haul battery electric trucks in EU.Link
[52] IIASA. (2016). Global Biosphere Management Model (GLOBIOM). Link
[53] US EPA. (2004). MOBILE6. Link
[54] IPCC. (2007). AR4 2.10.2 Direct Global Warming Potentials. Link

## Annex 5: Comparison with existing modelling

The ICCT published last March their own modelling of how HDV emissions would evolve under four different policy scenarios: Adopted Policies, Sustainable and Smart Mobility Strategy, Manufacturer-Aligned Zero-Emission Targets and European Climate Law[55]. T&E ran these scenarios using the EUTRM to see whether the ICCT results could be replicated.

Table A5.1 compares the ICCT results to the T&E results obtained with the EUTRM. Both studies find similar results. Note that change is relative to 2019, rather than to 1990, as used throughout this briefing. For Adopted policies, the ICCT forecasts $CO_2$ emissions will grow by 8% in 2050 relative to 2019, compared to only 1% using the EUTRM. The difference in prediction is likely due to the difference in survival curves. The ICCT have significantly updated their survival curves since they published their analysis. The EUTRM uses the newer set of survival curves. Other potentially different inputs are emission factors and the ratio of new to secondhand sales.

For the three other scenarios modelled, the difference between ICCT and T&E modelling is one percentage point. This confirms the EUTRM validity.

Table A5.1 Emissions difference in 2050 compared to 2019 ($CO_2$ equivalent)

| Scenario | ICCT result | T&E result | Difference |
|---|---|---|---|
| Adopted policies | +8% | +1% | 7 pp |
| Sustainable and Smart Mobility Strategy | -78% | -77% | 1 pp |
| Manufacturer Aligned Zero Emission Targets | -96% | -95% | 1 pp |
| European Climate Law | -98% | -97% | 1 pp |

[55] ICCT. (2022). The $CO_2$ standards required for trucks and buses for Europe to meet its climate targets. Link

## Annex 6: Data for major European markets

Table A6.1 Data on the HDV climate threat for the six largest European HDV markets

| | France | Germany | Italy | Poland | Spain | UK |
|---|---|---|---|---|---|---|
| HDV share of road vehicles[56] | 1% | 2% | 2% | 4% | 2% | 2% |
| Share of road transport emissions in 2020[57] | 29% | 31% | 20% | 34% | 28% | 23% |
| Change in HDV emissions in 2019 vs 1990[58] | +13% | +36% | -31% | +298% | +29% | -13% |
| Share of road diesel burned by HDVs in 2021[59] | 35% | 49% | 28% | 53% | 37% | 32% |
| Expected change in truck activity in 2020-2050[60] | +29% | +37% | +54% | +73% | +40% | - |
| Expected change in bus activity in 2020-2050[61] | +102% | +41% | +76% | +55% | +201% | - |
| Year $CO_2$ savings from electrifying cars and vans are no longer undone by the rise in emissions from HDVs[62] | 2021 | 2021 | 2021 | post-2050 | 2036 | 2021 |

[56] ACEA. (2022). Report – Vehicles in use, Europe 2022. Link
[57] UNFCCC. (2022). National Inventory Submissions 2022. Link
[58] UNFCCC. (2022). National Inventory Submissions 2022. Link
[59] T&E modelling using the EUTRM
[60] EC. (n.d.). EU Reference Scenario 2020. Energy. Link
[61] EC. (n.d.). EU Reference Scenario 2020. Energy. Link
[62] T&E modelling using the EUTRM. For cars and vans, the $CO_2$ targets proposed by the Commission for the review of the LDV $CO_2$ standards are assumed. For trucks and buses, the current regulation is assumed. The $CO_2$ savings from electrifying cars and vans are defined as the cumulative change in $CO_2$ emissions from cars and vans since 2020. The year when they are no longer undone by the rise in emissions from HDVs is the first year that the cumulative change in LDV emissions since 2020 plus the cumulative change in HDV emissions since 2020 is negative.