BRIEFING - FEBRUARY 2025

Truck weights and dimensions: more cargo, lower costs, less road wear

How to enable the shift to zero-emission trucks while safeguarding Europe's road infrastructure

Summary

The European Commission proposed to review the Weights and Dimensions (W&D) directive in July 2023. By setting vehicle weight and length limits, the W&D directive is critical to support the industrial transition to zero-emission vehicles (ZEVs). Currently, the W&D directive allows ZEV combinations to weigh up to 2 additional tonnes compared to diesel trucks, while both share the same driving axle limit.

Current total weight and axle limits can lead to payload losses in some use cases, at least in the short and medium term, thereby penalising ZEVs. The 2-tonne weight allowance is not always sufficient to compensate for the added weight of some zero-emission models in long-distance trucking, therefore delaying their adoption. Additionally, a ZEV may reach the 11.50-tonne driving axle limit before fully utilising the 2-tonne additional weight allowance for the entire vehicle (i.e. before reaching the permitted total weight of 42 tonnes). This can happen because battery packs are typically mounted along the chassis, adding extra weight to the driving axle. As a result, part of the 2-tonne allowance remains unusable, placing ZEVs at a payload disadvantage compared to diesel trucks.

To tackle payload issues, **the Commission proposed to increase the weight allowance for ZEVs from 2 to 4 tonnes,** raising their total permissible weight to 44 tonnes**, alongside an increase of their driving axle weight limit from 11.50 to 12.50 tonnes.** However, high axle weights can have an adverse **impact on road infrastructure**, **and this 1-tonne increase in the driving axle weight has become one of the most contested elements** in the political discussions. A year and a half after the proposal came out, EU Member States have yet to reach a common position.

A new consultancy report carried out by the consultancies Apollo Vehicle Safety & Research Driven Solutions **outlines how the W&D** review **can support** the transition to **ZEVs while safeguarding Europe's roads and bridges**. Apollo Vehicle Safety examined possible alternative weight increases that would ensure a level playing field for ZEVs while minimising any negative effects on Europe's road infrastructure. The analysis quantifies the resulting road infrastructure costs due to the changes in vehicle and axle weights for three example countries (Germany, Poland and Romania) and projects those for the timeframe 2025 - 2040 based on the expected ZEV sales and fleet uptake in each of those markets. Research Driven Solution assessed ZEVs' impact on several bridge forms and lengths.

Slightly reducing the proposed weight allowances for 5-axle combinations would ensure that most ZEVs currently on the market can achieve payload parity with 40-tonne diesel trucks. Costs for Germany's road network would rise by just 1.41% compared to the current situation, saving €400 million compared to the Commission proposal over 2025 - 2040. In Poland and Romania, the increase could be limited to 0.72% each, with savings of €20 million each compared to the proposal. **Shifting more of Europe's trucking fleet to an**

increased share of 6-axle combinations would significantly decrease road infrastructure costs compared not only to the Commission proposal, but also **to current W&D rules**. Germany alone would save €2.67 billion, while Poland and Romania €150 million each.

Delays in reaching an agreement threaten the road freight sector's transition to ZEVs. Based on the analysis carried out by Apollo Vehicle Safety and Research Driven Solution, we propose the following policy recommendations to find a balanced compromise that enables the successful transition to zero-emission trucks while safeguarding Europe's road infrastructure:

- **Reach an enabling review of the W&D directive as soon as possible**. While the European Commission proposed the review already a year and a half ago, and the European Parliament adopted its position in March 2024, EU Member States have yet to reach a general approach. We urge Member States to adopt a position as soon as possible and call on EU policymakers to swiftly finalise interinstitutional negotiations once Member States have reached their compromise.
- **Reduce the proposed ZEV allowance from 4 to 3 tonnes for 5-axle combinations.** This would ensure a level playing field with diesel trucks and minimise road infrastructure costs for Member States. By reducing the total vehicle weight, the impact on bridges would also further decrease and become negligible.
- **Reduce the proposed driving axle limit from 12.50 to 11.75 tonnes.** Increasing the current limit by just 250 kg is sufficient to fully make use of a 3-tonne weight allowance for the entire vehicle. Road infrastructure costs would be minimised compared to the Commission proposal.
- **Maintain the proposed ZEV allowance of 4 tonnes for 6-axle combinations.** These combinations reduce road wear by distributing weight across an additional axle on the tractor. Retaining the proposed 4-tonne ZEV allowance would offset the added axle weight and support their market uptake. For 6-axle combinations, this can be achieved without increasing the total 19-tonne weight limit of the two rear axles.
- **Remove the proposed weight restrictions for ZEVs on the TEN-T core network**. In its latest draft compromise, the Council proposed to restrict ZEVs to only a limited share of the TEN-T core network and ban them from the majority of Europe's roads. Our analysis shows how a combination of policy options can prevent any adverse impacts for Europe's road infrastructure. However, weight allowances are beneficial as long as ZEVs are allowed to circulate on EU roads. As **these restrictions are not necessary and even detrimental to the transition of Europe's commercial vehicle industry**, we urge Member States to remove them.

1. Weights and dimensions: the missing piece to clean up trucks

Heavy-duty vehicles (HDVs) - or all road vehicles with a gross vehicle weight (GVW) from 3.5 tonnes moving goods and passengers - are responsible for 28% of greenhouse gas (GHG) emissions from road transport in Europe. This is despite HDVs making up only 2% of the vehicles on European roads. Over 90% of these emissions are caused by trucks and less than 10% by buses and coaches. If no action is taken, these emissions will continue to grow as truck activity in the EU is expected to grow by 40% and bus activity by 10% until 2050. It is therefore crucial to speed up the industrial transition to zero-emission vehicles (ZEVs) to reach climate neutrality by 2050.

Key regulations to spur the uptake of clean trucks were adopted during the 2019-2024 EU legislative cycle. The new Eurovignette directive introduced CO_2-based tolling to incentivise the shift from polluting diesel trucks to zero-emission vehicles (ZEVs), while the Alternative Fuels Infrastructure Regulation (AFIR) mandates EU member states to roll out a public charging and refuelling network for HDVs. The revision of the CO_2 emission standards for HDVs requires vehicle manufacturers to increase cleaner vehicle sales, and pricing road transport emissions via the Emissions Trading System 2 (ETS2) creates market incentives for reducing the use of fossil fuels. However, one and a half years after the Commission proposal came out, the EU still has to agree on the review of the Weights and Dimensions (W&D) directive (see Figure below).

Weights and Dimensions: left behind in the 2019–2024 mandate

Law	Purpose	Adoption year
Eurovignette directive	CO2-based road tolls for trucks	2022
Alternative Fuels Infrastructure Regulation (AFIR)	Roll-out of public charging and refuelling infrastructure for HDVs	2023
Emissions Trading System 2 (ETS2)	Cap and trade carbon pricing for CO2 emissions from road transport and building	2023
CO2 emission standards for HDVs	Average fleet reduction targets for new vehicle sales	2024
Weights and Dimensions Directive	Level-playing field for zero-emission HDVs by revising weight and length limits	?

By setting vehicle weight and length limits, the W&D directive is critical to improve the operability of ZEVs. EU law defines ZE-HDVs as battery-electric (BEVs), hydrogen fuel cell (FCEVs) or hydrogen combustion vehicles (H2-ICEs). While battery-powered trucks face challenges in regard to their increased weight due to the batteries, hydrogen-driven vehicles require increased length limits to accommodate hydrogen storage tanks behind the driver cab.

The current version of the W&D directive allows heavy vehicle combinations with ZE technology to weigh up to 2 additional tonnes, whereas it did not increase the weight limit for the driving axle which bears the majority of the tractor weight and is particularly affected by battery packs

placed along the chassis. While this situation is sufficient for urban and regional delivery applications as well as many long-haul use cases already today, it may put some ZEVs operating on long distances at a payload disadvantage compared with diesel trucks, at least in the short- and mid-term.

At the same time, member states have raised legitimate concerns about the potentially adverse road wear impact from increased vehicle and axle weights as part of the proposed revision. In light of this, we have commissioned 'Apollo Vehicle Safety' to examine possible alternative weight increases that would address operational disadvantages for operators while minimising negative effects on Europe's road infrastructure. This briefing outlines the key findings of the technical report and presents the key policy recommendations to advance negotiations on the directive's revision.

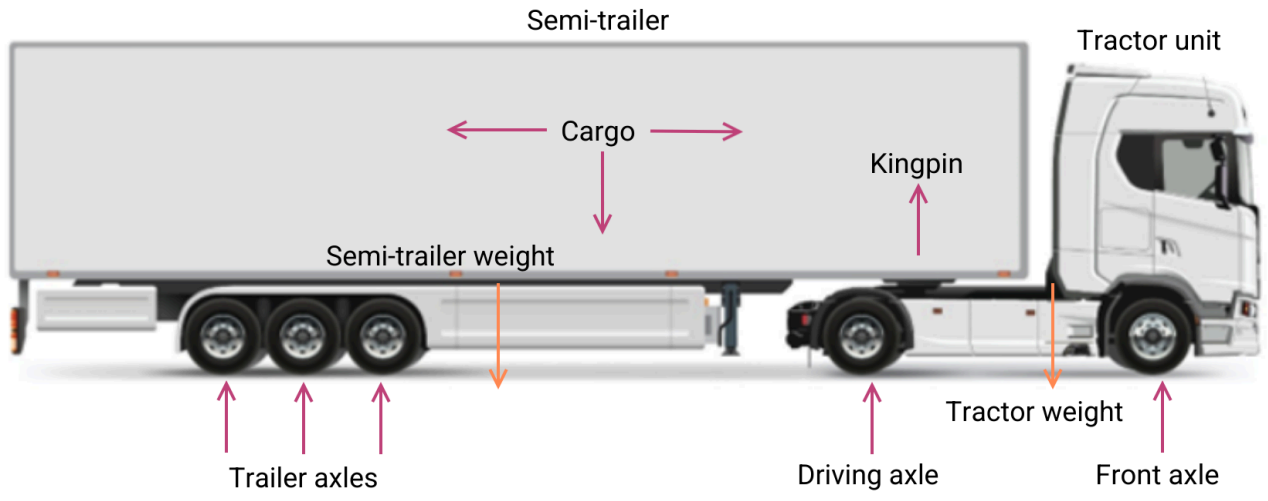
2. Barriers due to the current directive

Companies will only replace long-haul diesel trucks in weight-sensitive applications if there is no significant reduction in cargo capacity. This section summarises the main barriers that the current W&D directive poses to transitioning Europe's HDV fleet to ZEVs.

2.1. Total weight limit of vehicle combinations

The current W&D directive sets a 40-tonne weight limit for 5- and 6-axle vehicle combinations for cross-border traffic in the EU. These vehicle combinations are in most cases a 2- or 3-axle tractor unit towing a 3-axle semi-trailer (see image below). If the tractor is zero-emission, the vehicle combination can weigh up to two tonnes more. This results in a total permissible weight of 42 tonnes. For national traffic, some EU countries derogate from these limits, with several already permitting 44-tonne (diesel) trucks.

Illustration of load distribution



Zero-emission vehicles require sufficient autonomy to carry out road freight operations smoothly. Battery packs of the early generation of electric trucks — which came to market in recent years — weigh between 3,000 and 5,500 kg. Even after taking into account the net weight savings of around 1,250 kg from replacing the heavier internal combustion engine with an electric drivetrain, and the 2-tonne weight allowance currently granted to ZEVs, some of these first vehicles with higher ranges can suffer from payload losses. Although newly arriving e-truck generations and ongoing technological and energy density improvements will considerably decrease battery weight, the current W&D rules can still penalise ZEVs in some cases. This could hamper their uptake in the next few years which are essential to the transition.

2.2. Axle weight limit of vehicles

On a 5-axle vehicle combination, the additional weight of the ZE technology is distributed to the 2 axles on the tractor unit (see Figure above). How much gets applied on the steering axle located at the front versus the driving axle at the rear depends on where the batteries, the inverter, motors and gearbox are positioned along the chassis.

Currently, legacy truck manufacturers place battery packs along the sides of the chassis — where diesel tanks are typically located for traditional trucks. Some of them also use the space under the cab where the engine used to be for one or two packs and other electric components. For other components, the difference between manufacturers is more substantial. Some manufacturers position electric motors just behind the cab's rear wall, with the gearbox behind it. Others place a so-called 'front box' — which houses a large number of key auxiliaries — in the former combustion engine space.

Meanwhile, most truckmakers are exploring the use of an e-axle which integrates the electric motor, power electronics and gearbox into the driving axle. An e-axle is more efficient, lighter and frees up more space for batteries along the chassis and behind the cab. However, it also shifts weight from the front to the rear axle.

Current rules limit the driving axle weight to 11.50 tonnes, restricting the individual axle load which can be distributed to the rear of the chassis. Batteries as well as integrated electric drivetrains place additional weight on the driving axle due to their positioning along the chassis, making the current driving axle weight limit challenging for certain vehicle configurations.

A ZEV may already reach the 11.50-tonne driving axle limit even while not fully using the existing 2-tonne allowance for the entire vehicle (i.e. not yet reaching a total weight of 42 tonnes). When this occurs, part of the additional weight allowance becomes unusable, effectively reducing the payload capacity. In short, it is predominantly the axle weight restrictions which prevent the operator from making use of the higher total weight limits, inadvertently reinforcing the market dominance of diesel trucks.

While European legacy truckmakers face these challenges due to their decision to design their first ZEVs based on the traditional diesel design, new market entrants from the US and China are designing their electric trucks from the ground up. This enables them to optimise vehicle design and produce lighter, more efficient ZEVs, thereby reducing payload penalties. The W&D review is therefore also crucial to support the competitiveness of EU-made trucks with an enabling legislative framework.

3. Challenges due to the newly proposed directive

To address these barriers, the European Commission brought forward a legislative proposal to review the directive back in July 2023. This chapter summarises the main elements of this proposal and the concerns it raised among Member States.

3.1. Summarising the Commission proposal

The Commission proposed a 4-tonne weight allowance for 5- and 6- axle ZEV combinations which represents an increase of 2 tonnes compared to the current framework. As a result, they would be allowed to weigh 44 tonnes in total when crossing borders. The additional weight is proposed to be granted regardless of the weight of the ZE technology used. This means that as battery technology advances and becomes lighter, operators can use the saved weight to gain additional payload capacity, further improving the business case of ZEVs.

Since most battery packs are mounted along the chassis and put weight on the driving axle, the Commission also proposed to raise the driving axle weight limit from 11.50 to 12.50 tonnes. With this increase, the Commission wants to ensure truckmakers can fully use the 4-tonne weight allowance. However, higher axle weights can have an adverse impact on road infrastructure and the 1-tonne increase for the driving axle has become one of the most contested elements in the political discussions.

The Commission also proposed to increase the maximum permissible length of ZEVs by the additional space required to accommodate ZE technology and especially hydrogen storage tanks behind the cab. This allows manufacturers to increase the vehicle length by up to 90 cm. However, the proposal maintains that any extension beyond the standard maximum length must not increase the vehicle's (i.e. trailer's) loading length.

Additionally, the proposal includes a provision requiring EU countries that derogate from W&D limits by allowing 44-tonne (diesel) trucks within their national borders to also permit the entry and transit of 44-tonne (diesel) trucks from neighboring countries with the same rules. This proposed change would incentivise operators to continue using 44-tonne diesel trucks for many years to come instead of transitioning to ZEVs faster. The Commission proposed that cross-border operations at 44 tonnes shall be limited to ZEVs from 2035 onwards.

3.2. State of play of the political discussions

The Commission proposal was published in July 2023. The European Parliament agreed its position on the file between March and April 2024 and the new legislature elected in June 2024 approved the mandate to enter into trilogues in October 2024. The Parliament's position aligns closely with the Commission's proposal and maintains most of the elements including the weight increases mentioned above.

Member States, on the other hand, have yet to reach a general approach. They failed to agree on the compromise texts tabled by the Spanish and Belgian Council Presidencies (July - December 2023 and January - June 2024, respectively). Among other objections are mainly concerns over increased road infrastructure costs due to the proposed higher vehicle and axle weights. Negotiations are expected to resume under the current Polish Presidency (January - June 2025), as outlined in the Presidency's programme. Given the urgent need to establish the necessary planning and investment certainty for manufacturers, it is high time for Member States to reach an agreement as quickly as possible.

3.3. Concerns about adverse infrastructure impacts

The proposed weight increases, particularly the higher driving axle limit, may have increased adverse impacts on road infrastructure and bridges and thereby lead to higher infrastructure costs. The degree of road wear depends heavily on the individual axle weight. The heavier the load on each axle, the greater the impact on the road surface.

For bridges, the overall vehicle weight is more critical than the individual axle weight. While modern bridges are designed to withstand significant stress, many bridges across Member States are no longer in optimal condition due to their advanced age. For analysing the impact of higher weights on bridges, it is the worst case that is most important to consider, not the typical high frequency condition. The analysis assumed two fully-loaded trucks travelling side by side, on different bridge forms and lengths.

4. Analysis: ZEVs can gain payload without increasing road wear

Member States and co-legislators need to find a working compromise which enables a rapid uptake of zero-emission trucks while safeguarding European roads and bridges. To this end, we commissioned the consultancies Apollo Vehicle Safety & Research Driven Solutions to:

- Analyse how the driving axle weight interacts with the total weight of a battery electric truck to determine how many additional tonnes (e.g. 3 or 4 tonnes) for ZEVs could be acceptable depending on the weight limit of the driving axle;

- Calculate the payload loss or gain of 5-axle and 6-axle vehicle combinations under various weight scenarios and identify the vehicle and axle weight limits needed to eliminate any cargo losses while protecting road infrastructure;
- Quantify the resulting road infrastructure costs due to the changes in vehicle and axle weights for three example countries (Germany, Poland and Romania) and project those into the future based on the expected ZEV sales and fleet uptake in each of those markets;
- Assess any adverse impact from changing the weight limits on bridges.

As part of the consultant report, Apollo Vehicle Safety carried out the vehicle dimensioning and fleet modelling (first three bullet points above), while Research Driven Solutions assessed the impact of ZEVs on various bridge types (last bullet point above). Apollo Vehicle Safety was already involved in the impact assessment work for the Commission's W&D proposal as part of the consortium which was responsible for the support study.

4.1. Scope and approach of the analysis

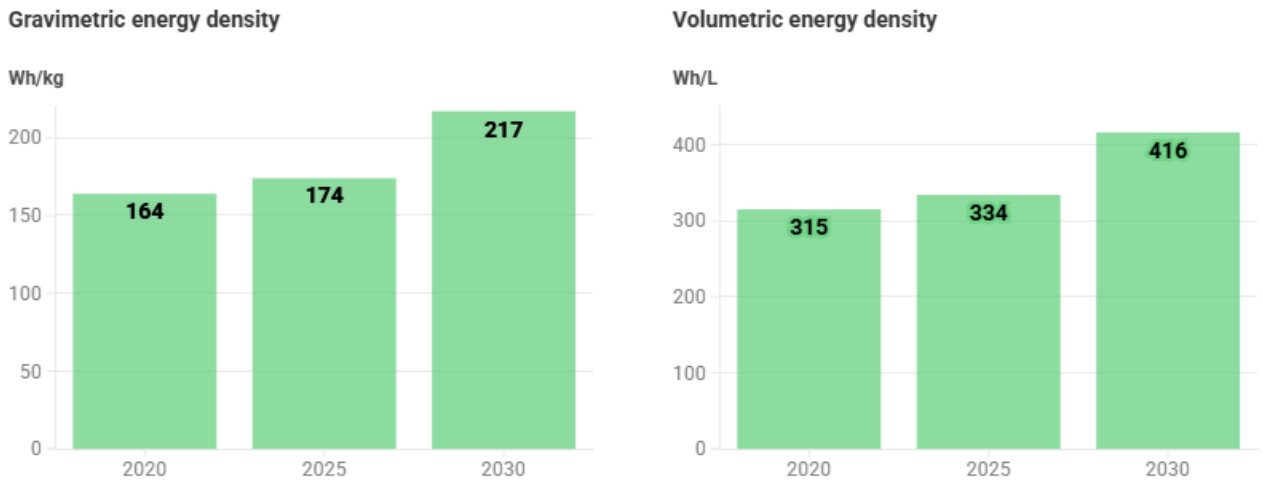
4.1.1. Assessing the impact of increased weights on roads

The analysis used a 40-tonne diesel truck as the main reference vehicle. The diesel vehicle archetype was derived from the current generation DAF XF3 and Volvo FH4, with the longest wheelbase offered in either version (3.8m) in order to be most comparable to ZEVs. A semi-trailer archetype was based on published specifications for a Krone Profiliner.

On this basis, Apollo Vehicle Safety developed a vehicle dimensioning model to assess several weight scenarios, such as the unladen axle weights of the vehicle combination, as well as the total laden weight and axle weight under different loading conditions. These take into consideration different commodity types of goods (with varying density in mass and volume), their share of total road freight movements as well as different options to distribute the load and centre of gravity across the tractor and semi-trailer.

Building on this, Apollo Vehicle Safety configured an equivalent battery electric truck, factoring in key technology differences such as battery mass and the weight difference between the electric driveline which replaced the internal combustion engine (ICE) and related parts. The analysis also accounted for ongoing energy density improvements of batteries (see Figure below) which are gradually reducing the weight of electric trucks. In terms of battery chemistries, the current market share of nickel-based (NMC and NCA) as well as iron-based (LFP) battery cells in the heavy-duty segment was quantified based on current truckmaker plans. The energy density values were then weighted for the respective chemistry mix.

Energy density of batteries is expected to steadily increase



Source: T&E calculations based on BNEF (2024) • Refers to energy density at the battery pack level. Gravimetric density refers to how much energy can be stored relative to weight. Volumetric energy density refers to how much energy can be stored relative to volume. Assuming chemistry split based on industry announcements.

Besides the expected development of battery density improvements, vehicle design changes were considered. Zero-emission trucks will evolve across generations, with models entering series production in 2025 already differing from the initial generation of e-trucks and those planned towards the end of the second half of the decade advancing further. Based on this logic, three generations of e-trucks (so-called 'Gen') were configured:

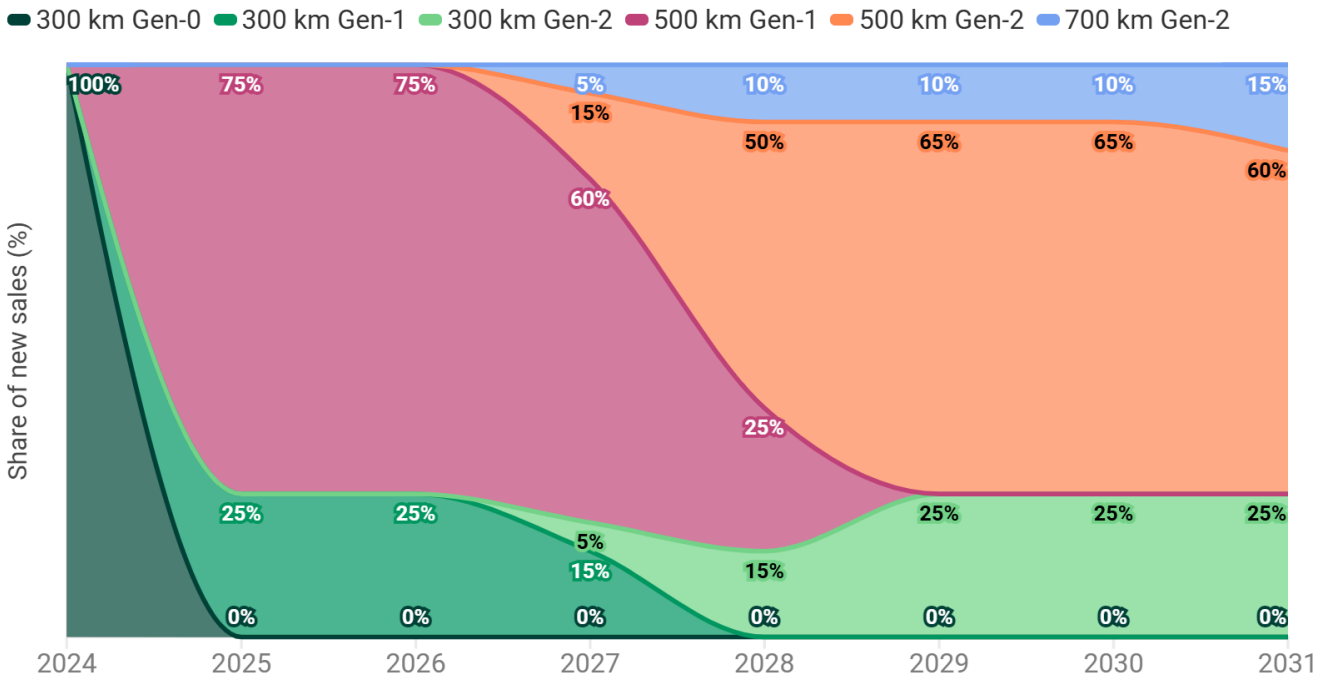
- Gen-0 ZEVs, the first on the market, were assumed to be equipped with an electric motor and gearbox just behind the cab which are powering a classical axle via a drift shaft, and with battery packs being placed alongside the chassis plus where the ICE used to be under the driver cab. Energy densities were based on the 2020 values.
- Gen-1 ZEVs represent the most recent and imminent vehicle releases which are currently entering mass production in Europe. It was assumed that the drivetrain is either moved further to the rear of the tractor to free up additional space, or it is already replaced by an integrated e-axle. Energy densities were based on the 2025 values.
- Gen-2 ZEVs represent vehicles that will reach the market by the second half of the decade. Besides fundamental vehicle and cab design changes, the base architecture and layout is assumed the same as Gen-1 with options for e-axles or rear based motors and drive shafts. Energy densities were based on the 2030 values.

To calculate payload and driving axle weight, the analysis also considered different vehicle range configurations as trucks with longer ranges require larger batteries and weigh more, thereby affecting payload capacity. Three range categories - 300, 500, and 700 km on a single charge - were defined. The expected market share for each generation, depending on their

range, is detailed in the Figure below and reflects what transport operators will likely require to fulfil the common range and flexibility needs.

Tractor-trailers in Europe drive around 530 km per day on average. Operators are expected to reconcile cost savings from rightsizing the battery with any flexibility concerns due to changing use cases or infrastructure gaps during the early market uptake. Given these considerations, we expect e-trucks with a 500 km range on a single charge to dominate sales in the foreseeable future.

Electric trucks with 500 km range projected to dominate vehicle sales



Source: T&E assumptions based on NOW GmbH (2024) • Gen-0 represents the series production of the first generation of e-trucks which is currently being phased out. Gen-1 refers to the current vehicle generation. Gen-2 comprises e-trucks of the next generation with optimised vehicle design and efficiency. Assumptions take into account the expected range, flexibility and infrastructure requirements of transport operators.

Apollo Vehicle Safety then analysed how payload would change under different vehicle and driving axle weight limits. The analysis was carried out for the first ZEVs that came to the market (Gen-0), for most recent or imminent releases (Gen-1) and for those on the market towards the end of the decade (Gen-2). Both 5- and 6-axle vehicle combinations were considered, as well as all range classes described above.

5- and 6-axle vehicle combinations analysed for roads

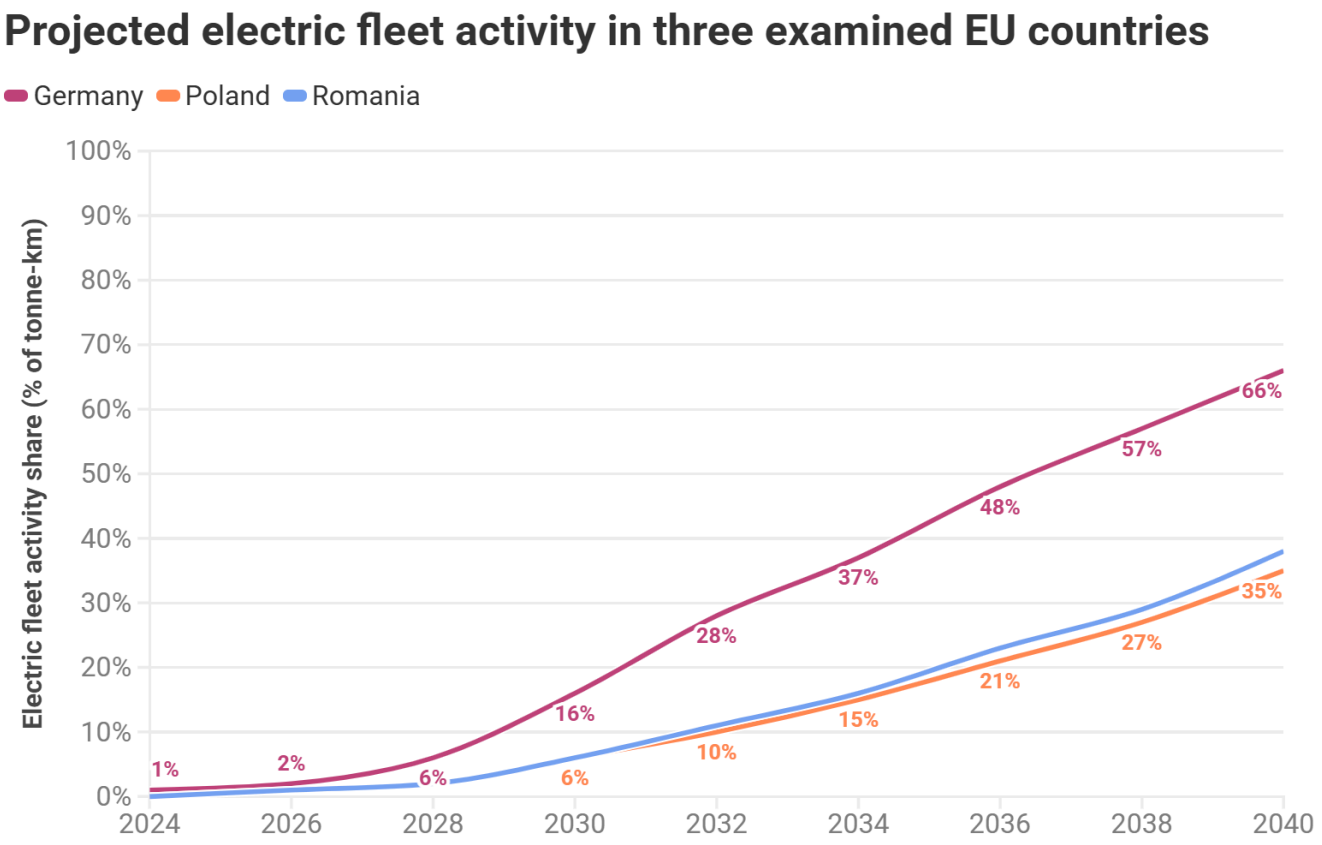
Description	5-axle combinations		6-axle combinations	
	Total vehicle weight (tonnes)	Driving axle weight (tonnes)	Total vehicle weight (tonnes)	Sum of rear axle weight (tonnes)
Current rules for diesel vehicles	40.00	11.50	40.00	19.00
Current rules for ZEVs	42.00	11.50	42.00	19.00
Commission proposal	44.00	12.50	44.00	19.00
T&E proposal 1	43.00	11.75	43.00	19.00
T&E proposal 2	43.00	11.75	44.00	19.00

Source: Knight and O'Brien (2025).

After assessing the payload impact, Apollo Vehicle Safety examined the road wear impact of a 40-tonne diesel truck and different ZEV configurations. The vehicle weight impact from electrifying buses and coaches as well as hydrogen-powered vehicles is considered to be negligible and was therefore not further considered for this work. The analysis incorporated Eurostat data on the number of kilometers that a vehicle travels in different states of load (e.g. empty, 10% load, 20% load, etc). Apollo Vehicle Safety also considered the influence of different commodity densities on road wear, examining them for empty runs and for different loading factors.

The analysis subsequently estimated the financial impact from transitioning the current trucking fleet to different ZEV configurations for the road networks in Germany, Poland and Romania. The evaluation period considered was 2025 - 2040. T&E's EU Transport Roadmap Model (EUTRM), which models the projected market uptake of ZEVs in the EU based on regulatory requirements and industry announcements, was used to quantify the expected electrically-driven truck activity on the territory of the three examined countries.

The ZEV uptake was considered to be slightly faster in Germany compared to Poland and Romania to adequately reflect the different maturity of these markets (see Figure below). For Germany, the expected fleet turnover was based on the recently updated so-called 'cleanroom talks' between the German government and the European vehicle manufacturers. For Poland and Romania, the analysis used the minimum ZEV sales required under the EU's CO_2 standards for HDVs.



Source: EUTRM (2024) • Refers to the projected future fleet activity share by battery electric trucks on the repective territory. Variations among countries arise from the expected difference in ZEV adoption speed.

The expected electric truck activity between 2025 - 2040 was then split across the different ZEV vehicle generations and range classes listed above (Gen-0, Gen-1 and Gen-2 as well as 300, 500 and 700 km on a single charge). Finally, Apollo Vehicle Safety combined the different vehicle configurations and electric fleet uptake in the three examined EU countries with infrastructure cost data from the Organisation for Economic Co-operation and Development (OECD) and German road tolling reports to quantify the expected financial impact stemming from the different vehicle and axle weight scenarios. The results are presented in the sections below.

4.1.2. Assessing the impact of higher vehicle weights on bridges

The consultancy Research Driven Solution assessed the impact of ZEVs on bridge stress, in particular on bending moments and shear forces. The former refers to how much the bridge bends at a certain point due to the vehicle's weight, while the latter is the force that tries to shear or slice through the bridge, caused by the vehicle's weight pressing down against the support.

The analysis took into consideration requirements for bridges built to the most recent design standards and those that were designed to earlier, less demanding, standards. It assumed two fully-loaded trucks passing each other side by side, on different bridge types and lengths. In

each case, the maximum stress was calculated for the vehicle combinations permitted under the current W&D directive (first two rows of the Table below), the Commission proposal based on 44 tonnes and 12.50 tonnes (third row) as well as our proposal based on 43 tonnes and 11.75 tonnes (last row). Since for the bridge analysis it is the rarely occurring worst case that is most important to consider, the load distribution of the vehicles was based on the most forward load position in the semi-trailer that results in the highest driving axle load.

5-axle vehicle combinations analysed for bridges

Description	Total weight (tonnes)	Driving axle weight (tonnes)
Current rules for diesel vehicles	40.00	11.50
Current rules for ZEVs	42.00	11.50
Commission proposal	44.00	12.50
T&E proposal	43.00	11.75

Source: Knight and O'Brien (2025).

4.2. Findings: Weights can be increased, infrastructure costs even reduced

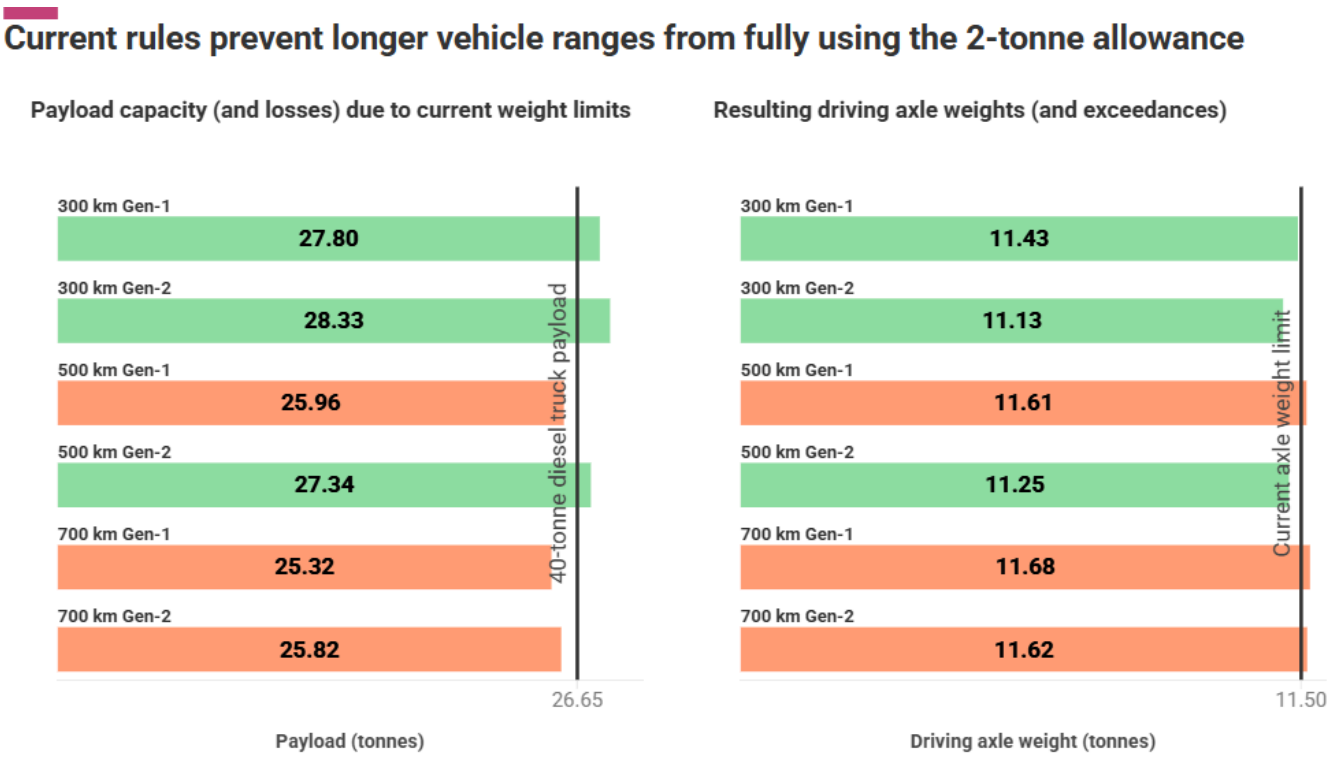
4.2.1. Current rules prevent full use of the 2-tonne allowance for longer vehicle ranges

Existing rules (up to 42-tonne vehicle weight coupled with an 11.50-tonne driving axle limit) create an uneven playing field for certain ZEV use cases. As explained above, payload capacity is constrained not only by the total vehicle weight limit but also by the driving axle weight limit.

Since ZE technologies are accommodated along the tractor chassis in a way which puts a larger share of the weight on the rear axle, ZEVs may easily exceed the 11.50-tonne limit. Once this happens, part of the existing 2-tonne weight allowance for ZEVs becomes unusable, effectively reducing payload capacity compared to diesel trucks.

For vehicle ranges of 300 km, those Gen1 ZEVs which have most recently entered the market already get close to the axle weight limit. In long-haul applications with 500 km ranges on a single charge, they can already exceed it in some cases, preventing them from fully utilising the additional 2 tonnes and putting them at a disadvantage compared to diesel trucks.

Thanks to technological and energy density improvements, ZEVs reaching the market by the second half of the decade (Gen-2) will be able to stay within the current driving axle weight limit while maintaining a comparable payload capacity to diesel trucks for 500 km vehicle ranges. However, as shown in the chart below, Gen-2 electric trucks with a range of 700 km would still exceed the driving axle limit before fully utilising the 2-tonne weight allowance, resulting in a payload disadvantage compared to diesel trucks.



Source: Knight and O'Brien (2025).

4.2.2. Commission proposal solves all payload issues but leads to more road wear

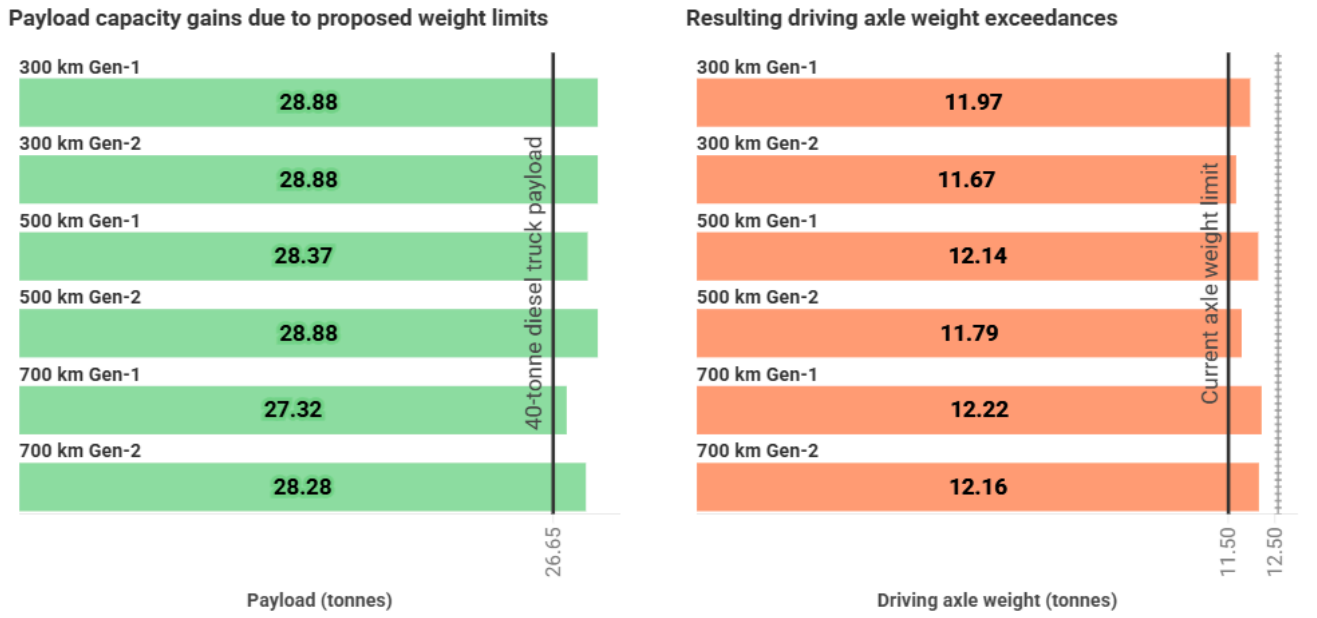
To tackle the payload issues, the Commission proposed to increase the weight allowance for ZEVs from 2 to 4 tonnes, raising their total permissible weight to 44 tonnes, alongside an increase of their driving axle weight limit from 11.50 to 12.50 tonnes. These adjustments would enable more ZEVs to not lose payload and sometimes even benefit from additional cargo capacity compared to diesel vehicles, creating a strong commercial incentive for operators to switch to clean trucks.

Gen-1 trucks with a 500 km range could use the full 4-tonne weight allowance without exceeding the proposed 12.50-tonne axle limit. For trucks entering the market in the second half of this decade (Gen-2), the additional weight allowance would also be fully usable, with the driving axle remaining under 12 tonnes. However, ZEVs equipped with larger battery capacities for 700 km range would exceed the 12-tonne mark.

Importantly, while ZEVs would have a payload advantage over standard 40-tonne diesel trucks, several Member States already grant a derogation from the standard 40-tonne (cross-border) limit by allowing 44-tonne diesel vehicles on their domestic territory. The Commission also proposed permitting these heavier diesel trucks for cross-border operations between those countries which both allow 44 tonnes domestically until a sunset clause taking effect in 2035. This means that in EU countries where 44-tonne diesel trucks are already permitted to circulate

domestically (and in the future between those), the payload advantage from the 4-tonne ZEV allowance is *de facto* significantly reduced if not completely eliminated.

Commission proposal solves all payload losses, but leads to more road wear



Source: Knight and O'Brien (2025).

As shown in the Figure above, the full benefits of the proposed 4-tonne allowance result in a driving axle weight which is well exceeding the current 11.50 tonnes for long-haul operations. From a vehicle and operator perspective, the Commission proposal would remove any weight-related barriers to the adoption of ZEVs for pretty much all road freight use cases and duty cycles.

However, due to the increased vehicle and axle weights, the Commission proposal would also lead to adverse road wear implications, and the associated infrastructure costs is what is preventing it from being politically accepted amongst Member States. Road infrastructure costs vary across EU countries depending on the vehicle fleet, road construction and maintenance methods as well as the expected ZEV uptake rate.

The analysis shows that, under the existing W&D framework, Germany's road infrastructure costs are projected to reach €47.35 billion between 2025 and 2040, with Poland and Romania expected to incur €5.58 billion and €5.49 billion, respectively. In Germany, where truck traffic is particularly dense and road maintenance costs are high, the Commission proposal is estimated to increase road infrastructure costs by 2.3% compared to the current situation. In Poland and Romania, costs are forecasted to rise to €5.64 billion and €5.55 billion, representing increases of 1.07% and 1.09%, respectively.

These results confirm that some of the concerns from Member States justify the need for an alternative solution which reconciles the objective of transitioning the fleet to zero-emission trucks with limiting the adverse impact on national budgets.

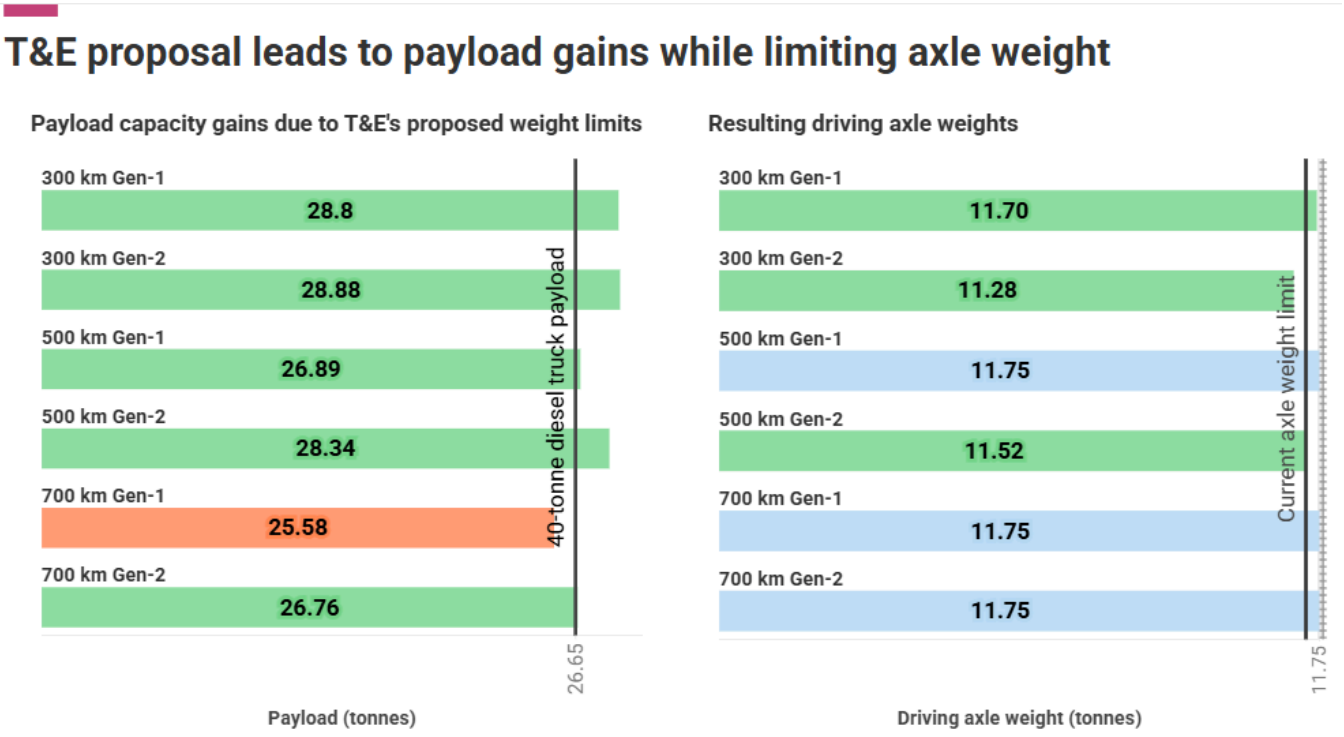
4.2.3. T&E proposal leads to payload gains in the long-term, while limiting axle weight

Both the currently existing weight rules as well as the proposed weight increase by the Commission pose significant challenges. The existing W&D limits fail to create a level playing field for ZEVs, while the Commission proposal places excessive infrastructure costs on Member States. Based on the analysis, we have identified two alternative proposals that would both accelerate ZEV adoption while minimising, or even reducing the financial impact on Member States.

According to the undertaken modelling, the solution lies in reducing the proposed 4-tonne ZEV allowance to 3 tonnes and in limiting the driving axle weight increase to 11.75 tonnes (instead of 12.50 tonnes), a modest increase of 250 kg compared to the current legislation. This would mean ZEVs were allowed to weigh 43 tonnes in total with an individual axle limit of no more than 11.75 tonnes.

This proposal would ensure that most ZEVs currently on the market (Gen-1) can achieve payload parity with 40-tonne diesel trucks with just a 250 kg increase in the driving axle weight. In practice, the modest increase of the driving axle limit by 250 kg would enable the full use of our proposed 3-tonne ZEV allowance.

Such a minimal adjustment would also facilitate a cost-effective use of vehicles with 700 km range in the mid- and long-term. While Gen-1 trucks would still fall short of payload parity for 700 km under an 11.75-tonne axle limit, Gen-2 ZEVs which will come to market towards the end of this decade, would fully close the gap and reach payload parity with diesel vehicles.



Source: Knight and O'Brien (2025).

This proposal would significantly reduce infrastructure costs. Limiting vehicle weight combinations to a total weight of 43 tonnes and an 11.75 tonnes for the axle would result in only negligible cost increases. Costs for Germany's road network would rise by just 1.41% compared to the current situation, with savings amounting to €400 million compared to the Commission proposal over the time frame 2025 - 2040. In Poland and Romania, the cost increase could be limited to 0.72% each, with savings of €20 million each compared to the proposal.

4.2.4. T&E's alternative proposal achieves payload gains while reducing road wear

We also examined an alternative proposal where an increasing share of the trucking fleet is assumed to shift from 5- to 6-axle vehicle combinations. 6-axle vehicle combinations consist of a 3-axle tractor unit and a 3-axle semi-trailer. By adding an additional rear axle to the tractor and distributing the weight across a higher number of axles, road wear can be significantly reduced compared to 5-axle vehicle combinations.

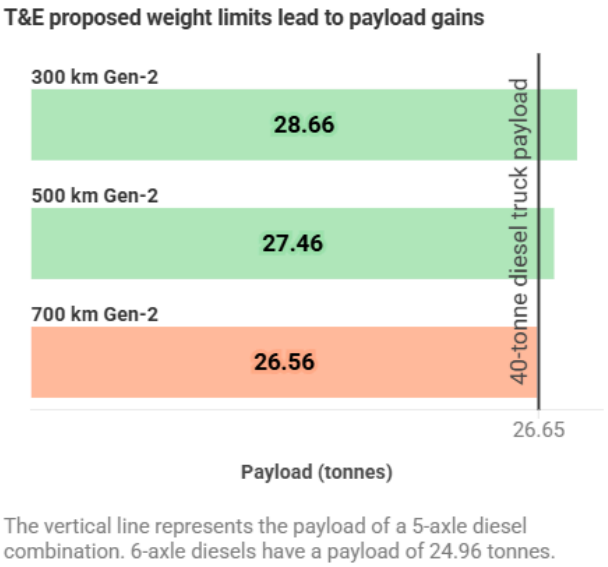
The additional rear axle also adds extra curb weight to the vehicle which results in reduced payload capacity compared to 2-axle tractors. The analysis shows that some 6-axle diesel combinations can have a payload capacity of around 25 tonnes which is more than one and a half tonnes less than their 5-axle equivalent. Additional challenges may arise from shifting the EU market to a higher share of 6-axle combinations:

- 2-axle tractors are subject to higher mileage factors under the EU's CO_2 emission standards for HDVs compared to 3-axle tractors and are therefore more heavily weighted when calculating the manufacturers' average fleet emissions from new vehicle sales. This means that selling 2-axle tractors helps truck makers more to achieve regulatory compliance than shifting their sales to tractors with three axles.
- Currently, EU countries do not grant any payload, tax or tolling incentives for tractors with three axles which would further help incentivise transport operators to increase the share of 6-axle vehicle combinations in their fleets.
- Adding a third axle to the tractor reduces the space for battery packs along the chassis for legacy manufacturers and results in higher vehicle purchase costs, as well as higher energy consumption due to the increased rolling resistance from the extra tyres.

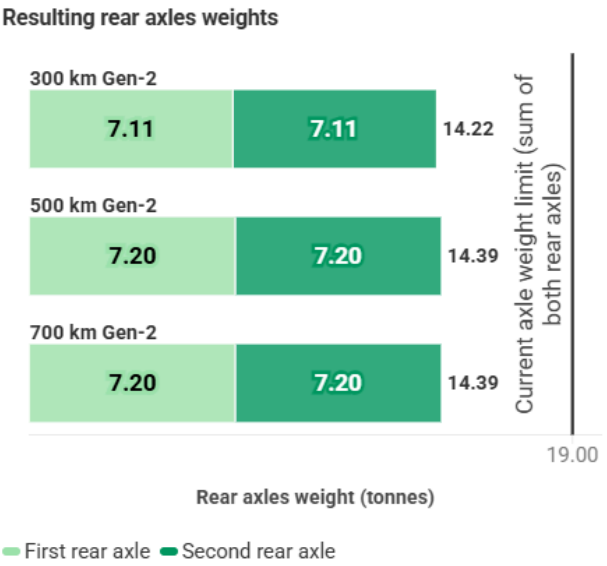
Notwithstanding these considerations, the W&D review offers a unique opportunity to shift Europe's trucking fleet to an increased share of 6-axle vehicle combinations and thereby significantly reduce infrastructure costs. To offset the additional curb weight from the third tractor axle, we therefore propose to grant the proposed 4-tonne ZEV allowance in full to 6-axle combinations (instead of limiting it to 3 tonnes as we propose for 5-axle combinations above).

Due to vehicle and chassis design constraints, the analysis focused on ZEVs on the market by the end of the decade (Gen-2). Granting ZEVs a total weight of 44 tonnes would ensure they can compete with diesel trucks on payload in both short- and long-haul operations. Notably, for 6-axle combinations, this can be achieved without increasing the total weight of the two rear axles, which should remain at a combined 19 tonnes as under current W&D rules.

Shifting to 6-axle ZEVs solves payload issues and reduces road wear



The vertical line represents the payload of a 5-axle diesel combination. 6-axle diesels have a payload of 24.96 tonnes.



Source: Knight and O'Brien (2025).

The Figure above should be interpreted with an important caveat: While the 4-tonne allowance would enable 6-axle ZEV combinations to largely recover the payload lost due to the additional axle compared to 5-axle diesel trucks, ZEV combinations with 5 axles could offer a higher payload capacity than with 6 axles, depending on how the industry utilises 3-axle tractors. As a result, hauliers have less of an incentive to adopt 6-axle ZEV combinations configurations, despite their advantages in weight distribution and reduced road wear.

To encourage transport operators to increasingly shift to 6-axle ZEVs, governments would also need to introduce new regulatory and fiscal incentives in addition to the proposed changes under the W&D directive. One option would be to differentiate road tolls according to the difference in the number of axles so that transport operators who opt for an additional tractor axle for ZEVs benefit financially. Another option could be to differentiate vehicle registration and circulation taxes depending on the number of tractor axles as it has been done in the UK.

4.2.5. Higher vehicle and axle weights will have no adverse impact on bridges

Unlike for road wear, the total weight of a vehicle combination is far more relevant than the axle weight when it comes to bridge stress. In the impact assessment accompanying the legislative proposal, the Commission did not identify 44-tonne ZEVs as the worst case for bridges. The present analysis by Research Driven Solutions finds that, based on the proposed 3-tonne ZEV allowance which results in a total ZEV combination weight of 43 tonnes, the impact on bridges is very limited.

On bridges designed according to modern standards, the stress increase (i.e. the bending stress and shear stress) caused by a 43-tonne ZEV compared to current weight limits ranges from 0.80% to 3.10%, depending on the bridge length and form, with the latter being the less likely case. This is significantly lower than the Commission proposal, which would increase stress between 2.20% to 8.70%. However, most cases fall well below the maximum, with the majority of the increase being below 5% for all bridges. For bridges designed under older standards, the margin of safety remains virtually unchanged, as 43-tonne ZEVs result in only negligible stress increases.

4.3. Summary: payload parity and reducing road wear is possible

The existing rules on truck weights and dimensions fail to create a level playing field between polluting diesel trucks and ZEVs. To address this and accelerate the transition to clean trucking, the Commission proposed to increase the vehicle and driving axle weight limits of ZEVs. However, this has encountered major resistance from Member States, due to the road wear it would cause and the associated infrastructure costs.

With the present analysis, we show that there are solutions which can reconcile both objectives, both to accelerate the industrial transition to ZEVs as well as minimising (or even reducing)

infrastructure costs. The Table below summarises the different scenarios and the associated infrastructure cost changes for the three examined countries Germany, Poland and Romania.

T&E proposals can reduce road infrastructure costs

Country	Policy Scenario	Absolute values (€billion)	Relative to the baseline (€billion)	Relative to the baseline (%)
Germany	Existing framework (baseline)	47.35	-	-
	Commission proposal	48.43	+ 1.07	+ 2.28
	T&E proposal 1	48.02	+ 0.67	+ 1.41
	T&E proposal 2	44.68	- 2.67	- 5.63
Poland	Existing framework (baseline)	5.58	-	-
	Commission proposal	5.64	+ 0.06	+ 1.07
	T&E proposal 1	5.62	+ 0.04	+ 0.72
	T&E proposal 2	5.43	- 0.15	- 2.68
Romania	Existing framework (baseline)	5.49	-	-
	Commission proposal	5.55	+ 0.06	+ 1.09
	T&E proposal 1	5.53	+ 0.04	+ 0.72
	T&E proposal 2	5.33	- 0.15	- 2.91

Source: Knight and O'Brien (2025).

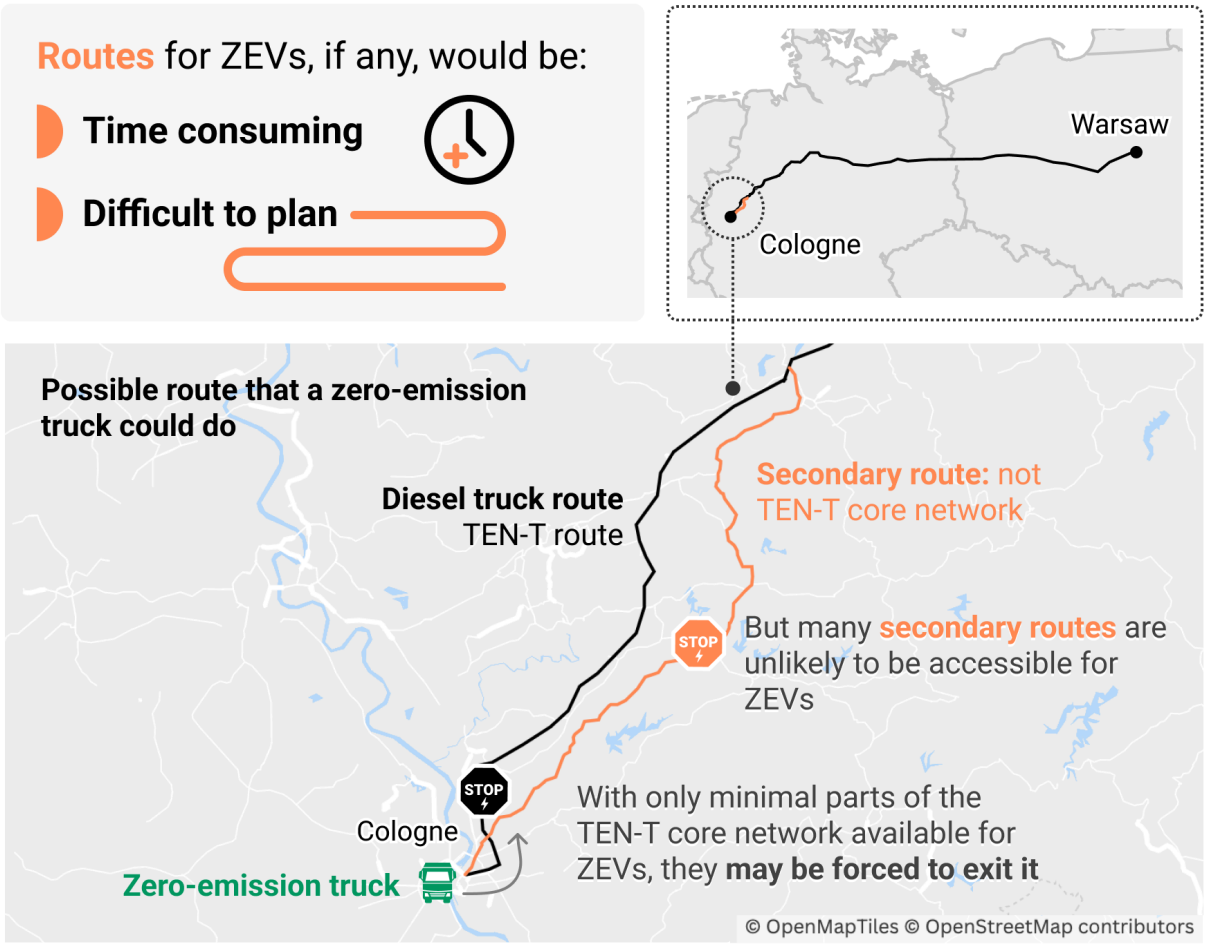
5. TEN-T restrictions are harmful and should be scrapped

Three compromise texts were tabled under the Belgian Council Presidency, but Member States failed to agree on the proposed texts. Two of them included a proposal to limit the circulation of 44-tonne ZEVs to only parts of the TEN-T core network, effectively banning them from the majority of Europe's roads. The proposed limitation would allow Member States with a domestic weight limit of 40 tonnes for diesel vehicles (such as Germany, Poland and Romania)

to restrict ZEVs with 44 tonnes to 25% of their TEN-T core network by 2030, 50% by 2035 and 100% in 2040 and to fully restrict their access to the rest of the road network.

Even worse, this would give Member States the option to severely restrict the current 2-tonne ZEV allowance which permits the circulation of 42-tonne ZEVs across the total network. This would risk creating a complicated patchwork of weight access restrictions throughout the EU's single road haulage market and make any seamless operation of ZEVs all but impossible.

TEN-T restrictions would threaten ZEVs viability and favour diesel trucks



44-tonne ZEVs would need to deviate to secondary routes or, in the worst case, not be able at all to reach their destination due to access restrictions on all possible (non) TEN-T routes, while diesel trucks could continue to use the shortest and most economical routes.

Our analysis shows how small increases for ZEVs as well as an increased shift to 6-axle ZEV combinations would not lead to adverse impacts for Europe's road infrastructure. With modest weight increases for ZEVs, the impact on road and bridges would be minimised and even reduced compared to the existing rules. We therefore think that the proposed TEN-T restrictions for ZEVs are not only detrimental to the transition but also not necessary to reconcile the interests of Member States, industry, and the climate.

6. Policy recommendations

Delays in reaching an agreement threaten the road freight sector's transition to ZEVs. Based on the analysis carried out by Apollo Vehicle Safety and Research Driven Solution, we propose the following policy recommendations to find a balanced compromise that enables the successful transition to zero-emission trucks while safeguarding Europe's road infrastructure:

1 Reach an enabling review of the W&D directive as soon as possible

Current W&D rules can penalise ZEVs in some cases, hampering their uptake in the next few years which are essential to the industrial transition. By setting vehicle weight and length limits, the W&D directive is critical to support truckmakers and the road freight sector in transitioning to ZEVs. While the European Commission proposed a review of this directive a year and a half ago, and the European Parliament adopted its position in March 2024, EU Member States have yet to reach a general approach. We urge Member States to adopt an enabling general approach as soon as possible and call on EU policymakers to swiftly finalise interinstitutional negotiations once Member States have reached their compromise.

2 Reduce the proposed ZEV allowance from 4 to 3 tonnes for 5-axle combinations

The current 42-tonne weight limit under the W&D penalises ZEVs in some cases, making it harder for them to compete with diesel trucks. While the Commission proposal addresses this barrier, the additional 4 tonnes could only be fully used with a significant increase in the driving axle weight, which would cause increased road wear. To ensure a level playing field with diesel trucks and minimise road infrastructure costs for Member States, we propose lowering the weight allowance for 5-axle combinations to 3 tonnes. By reducing the total vehicle weight, the impact on bridges would even further decrease and remain negligible.

3 Reduce the proposed driving axle limit from 12.50 to 11.75 tonnes

Payload capacity is constrained not only by the total vehicle weight limit but also by the driving axle weight limit. A ZEV may already reach the 11.50-tonne axle limit even while not fully using the existing 2-tonne allowance for the entire vehicle (i.e. not yet reaching a total weight of 42 tonnes). When this occurs, part of the additional weight allowance becomes unusable, effectively reducing the payload capacity and inadvertently reinforcing the market dominance of diesel trucks. However, excessive axle weights increase road wear. Lowering the axle weight limit to 11.75 tonnes — 750 kg less than the Commission's proposed limit — would be sufficient to fully apply a 3-tonne weight allowance for the entire vehicle. This modest weight increase would ensure a level playing field with diesel trucks while minimising road infrastructure costs.

4 Maintain the proposed ZEV allowance of 4 tonnes for 6-axle combinations

6-axle vehicle combinations reduce road wear by distributing weight across an additional axle on the tractor unit. The W&D review offers a unique opportunity to shift Europe's trucking fleet to an increased share of 6-axle combinations and thereby significantly reduce infrastructure costs. To offset the added axle weight, we propose to grant the proposed 4-tonne ZEV allowance in full to 6-axle combinations (instead of limiting it to 3 tonnes as we propose for 5-axle combinations above). Notably, for 6-axle combinations, this can be achieved without increasing the total weight of the two rear axles, which should remain at a combined 19 tonnes as under current W&D rules. By supporting the shift to 6-axle combinations, the W&D review would significantly reduce road wear and lower road infrastructure costs compared to the current rules.

5 Remove the proposed weight restrictions for ZEVs on the TEN-T core network

Our analysis shows a combination of policy options can prevent any adverse impacts for Europe's road infrastructure. In fact, incentivising a shift from 5- to 6-axle vehicle combinations could actually reduce overall road wear and relieve national budgets. However, in its latest draft compromise, the Council proposed to restrict ZEVs to only a limited share of the TEN-T core network and ban them from the majority of Europe's roads. This would severely undermine the transition to zero-emission trucks. As the proposed TEN-T restrictions are not necessary and even detrimental to the transition of Europe's commercial vehicle industry, we urge Member States to remove them.

Further information

Bernardo Galantini

Freight & Climate Officer

T&E

bernardo.galantini@transportenvironment.org

Mobile: +32(0) 490 16 47 74