

Review of decarbonisation policies for heavy-duty transport: recommendations for a successful transition



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Background

The ERCST project strongly supports the EU's ambition to transition to a net zero energy system and vehicle sector by 2050. Zero emission vehicles are seen as the main technology destination to support this ambition. The project's aim is to consider the proposed legislative pathways from today to reach this ambition. It seeks to assess the robustness of the current policies, the impacts on stakeholders, the economic, environmental, and social consequences of the policy and to explore multiple pathways to efficiently reach the target.

The first report sets the analytical framework and addresses the question: what influences the determination of pathways for mobility decarbonisation?

This second report analyses the current decarbonisation solutions for heavy duty road transport considering the new circumstances and recommendations for new pathways complementary and/or alternative to the existing ones.

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1. Introduction

1.1. Legislative overview

The European Climate Law, one of the cornerstones of the European Green Deal, formalises the EU's commitment to achieve climate neutrality by 2050 and the intermediate goal of lowering net greenhouse gas (GHG) emissions by at least 55% by 2030 compared to 1990. Achieving these legally binding goals requires a 90% reduction in GHG in the transport sector. Against this backdrop, the European Commission (EC) presented its *"Sustainable and Smart Mobility Strategy"* together with an Action Plan¹ that laid the foundation for a fundamental transport transformation encompassing all modes of transport for a system that is greener and more resilient to future crises.

In August 2019, Regulation (EU) 2019/1242² entered into force setting CO₂ emission performance standards for new heavy-duty vehicles (HDV). It amended Regulations (EC) 595/2009 and (EU) 2018/956 by establishing that, from 2025 onwards, manufacturers will have to meet the targets set for the fleet-wide average CO₂ emissions of their new lorries registered in a given calendar year. The Regulation required the EC to assess the effectiveness of the Regulation in 2022, with a view towards its possible extension to buses and other types of heavy-duty vehicles, and emission reduction targets for 2035 and 2040. The CO₂ emission standards for HDV build upon the CO₂ Certification Regulation (EU) 2017/2400 and the Monitoring and Reporting Regulation (EU) 2018/956.

In January 2020, Regulation (EU) 2019/631³ entered into force setting CO₂ emission performance standards for new passenger cars and vans ('light commercial vehicles' (LCV)) and foreseeing EU fleet-wide CO₂ emission targets applying from 2020, 2025 and 2030 which included a mechanism to incentivise the uptake of zero- and low-emission vehicles. Within the 'Fit for 55' package presented in July 2021, the EC proposed to revise these rules and increase the ambition. On April 2023, the European Parliament and the Council adopted Regulation (EU) 2023/851 amending Regulation (EU) 2019/631 to strengthen the CO₂ emission performance standards for new LCV in line with the EU's increased climate ambition. In particular, the amendment strengthens the emission targets applying from 2030 and sets a 100% reduction target from 2035 onwards.

Recently, on 14 February 2023, the EC tabled a legislative proposal to revise Regulation (EU) 2019/1242 on heavy duty as well, especially to expand the scope of the Regulation (including urban buses, coaches, trailers and other types of lorries) and increase emission reduction targets (45 % from 2030, 65 % from 2035, and 90 % from 2040 onwards). The proposal sets CO₂ requirements for new trailers and targets 100% of newly registered urban buses to be zero-emissions vehicles from 2030. Zero-emission vehicles currently include battery electric vehicles, fuel-cell and other hydrogen-powered vehicles only.

¹ European Commission (2020), Sustainable and Smart Mobility Strategy: [EUR-Lex - 52020DC0789 - EN - EUR-Lex \(europa.eu\)](#).

² REGULATION (EU) 2019/1242 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 setting CO₂ emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC: [EUR-Lex - 32019R1242 - EN - EUR-Lex \(europa.eu\)](#).

³ REGULATION (EU) 2019/631 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 April 2019 setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011: [EUR-Lex - 02019R0631-20210301 - EN - EUR-Lex \(europa.eu\)](#).

1.2. Heavy-duty sector idiosyncrasies

HGVs are an important element in fighting climate change as the heavy-duty sector is responsible for more than a quarter of the greenhouse gas (GHG) emissions from road transport in the EU, and for over 6% of total EU GHG emissions⁴. Despite having achieved significant energy efficient improvements in fuel consumption, emissions are still rising due to the constant increase of road freight traffic.

HGVs are essential for the European economy and for the functioning of the EU internal market. Today, there are more than 6.2 million trucks in circulation throughout the EU.⁵ The logistics chain is made up in large part by trucks, which carry 70% of all freight moved over land in the EU⁶. For the great majority of goods and freight, trucks continue to be the most flexible, cost-effective, and responsive means of transportation.

With over 600,000 businesses across the EU employing almost 3 million people, the road freight and passenger transport sector is predominantly made up of SMEs⁷. The total number of HGVs operating in the EU is around 7 million with a quarter of a million newly registered vehicles in 2022, ironically the Member State with the most HGVs is Poland who also have the highest CO₂ grid intensity.

While choices regarding passenger cars are to a large extent personal (including the acceptance of higher prices) and can often be replaced with other alternatives (e.g., by public transport), the HGV sector is far more cost sensitive and challenging in terms of interchangeability, because of the competitive nature of the HGV sector with low margins. HGVs and commercial transport operators invest in vehicles based on profitability considerations for their operations, considering the total cost of ownership (TCO).

In addition, HGVs have complex and diverse applications and means as they are used to move goods (i.e., trucks) or people (i.e., urban buses or coaches), regionally and internationally, over medium, or long distances. They require significantly more energy and time to recharge than a light vehicle⁸. Considering their diversity and complexity, some are easier to charge overnight (i.e., urban buses) than others (for instance coaches or trucks on long haul operations which will require charging during a working shift) – making the accessibility of charging infrastructure more critical. Thus, there must be coordination in the deployment of infrastructures in each Member State to avoid differing business opportunities resulting from fragmented access to charging infrastructures across the EU.

In conclusion, the framework to support the transition of the HGV sector to climate neutrality must be bespoke and not merely mirror the LCV framework.

⁴ European Commission. Reducing CO₂ emissions from heavy-duty vehicles. from https://climate.ec.europa.eu/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/reducing-co2-emissions-heavy-duty-vehicles_en.

⁵ ACEA Fact sheet (November 2022).

⁶ European Commission (2017), EU transport in figures – statistical pocketbook 2017, https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en.

⁷ European Commission, Directorate-General for Climate Action (2018); *Impact Assessment accompanying the proposal for a Regulation of the European Parliament and of the Council setting CO₂ emission performance standards for new heavy-duty vehicles*.

⁸ The capacity of batteries for HGV long-haul applications is 400 kWh and could soon reach 700 to 1000 kWh, while it is only 40 to 100 kWh for passenger cars.

2. Gaps in the CO₂ standards for HDVs identified in the first report

The objective of this first section is to identify, through the lenses developed in ERCST's first report, the main gaps in the proposed pathway to decarbonise HDVs.

2.1. *Limits to the tank-to-wheel approach*

In regulating the emissions of a vehicle from the tailpipe only (tank to wheel approach TtW), any emissions generated or abated during the production of the vehicle or fuels are unaccounted for. A clear example of emissions abated during the fuel production is given by the CO₂ absorptions obtained during the growth of feedstocks used to produce biofuels; while fuel upstream emissions are, for example, those related to the electricity generation, still based mostly on fossil fuels in the EU Countries. Emissions generated during the production phase include emissions from mining of raw materials – overwhelmingly mining is carried out using fossil fuel powered machinery; emissions from vehicle production – emissions generated during battery production which are known to be considerably higher than emissions from manufacturing ICE vehicles; emissions from transporting battery raw materials – 75% of global battery raw materials are processed and produced in China and shipped across the world.

Not only are these upstream emissions not considered in the proposed regulations, but it is also likely that emissions from the supply chain of electric vehicles, dominated by China, are underreported or underestimated. Raw materials from under-developed economies are also highly susceptible to underreporting of emissions from mining activities. There is a documented history of poor reporting in many areas including covid statistics, GDP statistics, palm oil utilisation data etc. China's expansion of activities into developing nations (lithium triangle Bolivia-Chile-Argentina) to capitalise on natural resources brings further questions on sustainability and emissions reporting amongst other social factors.

Without a full Life Cycle Assessment (LCA) approach the proposed regulation blinds itself to many upstream production emissions. Also, in only regulating emissions from the tailpipe during the use phase, emissions from energy production are unaccounted for in this specific regulation. The carbon intensity of local electrical grids is not considered despite a wide variation in GHG intensity of electric production currently seen across the various member states. In 2021, Poland had the highest electricity generation carbon intensity in the EU with 721g CO₂e/kWh which is 90 times more than its counterpart Sweden which has the lowest GHG intensity for its electric production with 9g CO₂e/kWh. Whilst energy production is covered under the ETS regulation, it does not guarantee renewable energy will be available, rather it seeks to use financial incentives to encourage growth of renewable energy.

In limiting the regulation to only consider direct tailpipe emissions, the policy de-facto requires the entire existing vehicle fleet to be replaced to achieve the target emission reductions by 2050. There is a twofold problem with this approach; firstly, it includes an inherent risk that older vehicles will be operated for longer periods before replacement, negatively impacting CO₂ reduction potential and secondly it prevents any future purchased ICE vehicles from contributing towards the reduction of CO₂ emission targets.

Again, without a full LCA approach, the potential of current and future ICE vehicles to reduce CO₂ emissions through *renewable fuels* is missed. Particularly considering renewable fuels potential contribution to reduce CO₂ emission from HDV in the short and medium term is considerable. Throughout this report, the umbrella term "*renewable fuels*" is used to refer to any liquid or gaseous combustion fuel that is not derived from fossil fuels. In this sense, any non-fossil fuel can be considered

a renewable fuel. However, while the definition of a renewable fuel includes any fuel that can be viewed as renewable, two fuels in particular offer the best potential to help the freight transport sector decarbonise, i.e., the waste-derived fuels (i) biomethane; and (ii) HVO. Both biomethane and HVO offer advantages in terms of affordability, flexibility, scalability, and overall greenhouse gas reduction potential. Thus, the discussion on this report generally revolves around these.

Renewable fuels are not without their own concerns and are not being proposed as an alternative and exclusive solution but as a complimentary one. Some potential issues with the deployment of renewable fuels are well-known, namely regarding: (i) scale – it is unclear how much total feedstocks are available and how much competition there will be from other sectors for this resource; (ii) verification – methods will need to be developed to prevent fraudulent use of fossil fuels in vehicles designated as renewable fuel vehicles; and (iii) air quality – renewable fuels are not considered desirable for use in urban areas due to their air quality related emissions (this is being tackled by Euro7 and not the CO₂ standards regulation for HDV).

LCA is theoretically the desirable method to fully assess the contribution of technological solutions to the problem of CO₂ reduction. Many independent bodies have carried out publicly available LCA analysis. This was the previously used approach of the Commission prior to the recent proposed changes and an LCA tool is already utilised in other policy areas within the EU.

Nevertheless, knowing that well-performed LCA can be hugely challenging and complex in practice (methodology, liability, who is responsible, when and for what, etc.), a well-to-wheels (WtW) approach – which includes two components: well-to-tank (WtT) and tank-to-wheels (TtW) – can be used as a substitute for LCA.

Overall: decarbonisation is not possible through definitions alone; it is only possible with a full account of emissions from every aspect of the supply and use phases using actual energy consumption – the current proposal uses averages for energy consumption and only considers the use phase.

2.2. Resilience of the proposed pathway to decarbonise HDVs

The HDV sector is an integral part of the EU economy, every product and many services are reliant on the efficient and effective capability of the sector to move goods. Anything that affects the HDV sector has downstream impacts on nearly every other sector. These impacts include cost, reliability of supply chains and other operational restrictions.

Currently, the supply of vehicles to the HDV sector is mostly sourced from EU member states, from raw material extraction and processing to manufacture. Where activities are outside of the EU there is sufficient diversity in supply chains to avoid over reliance on any particular region or country. The supply of energy to the sector for ICE vehicles is mostly from non-EU regions with oil derivatives providing the majority of energy. The diversity in supply of oil-based products ensures no over reliance on a particular region.

The proposed wholesale shift towards ZEV changes the paradigm from one of mostly internal supply to produce vehicles to external supply with China as the main producer of batteries and battery materials. The energy needed to power ZEVs shifts from external supply (oil based) to internal supply renewable electricity from hydro, wind, solar and renewables. However, the energy infrastructure (solar panels and wind turbines) is also predominantly supplied by China.

In preceding years, the EU has suffered the consequences of over reliance on one specific country, namely Russia, for gas. The Repower EU initiative was established specifically to limit the damage caused by this over reliance and to diversify supply to wider and more politically stable regions.

In exclusively limiting the pathway to decarbonise HDVs to ZEVs, a similar over reliance on a particular country (i.e., China) is emerging, at least in the beginning. Again, this over reliance is focused on a non-democratic country and carries all of the same risks as the previous reliance on Russia only this time vehicle production and energy production such as solar panels, wind turbines and battery storage, are both locked in to this one region.

The potential risks of supply restrictions include: (i) total production capacity risks i.e., (in)sufficient materials for the transition of several sectors across the world at once; (ii) sanctions being imposed on China on a number of different fronts that could disrupt supply; (iii) price gouging if demand outstrips supply; and (iv) raw materials being used as a lever to penetrate EU HDV markets with complete products, thus putting the survival of some of the oldest and most globally respected EU automotive brands at risk of non-competitiveness or even failure.

The EU has lost 25% of the bus market to Chinese brands and truck products from the region are beginning to emerge in EU markets at lower prices than locally produced vehicles. In response, the Commission is launching an anti-subsidy investigation into electric vehicles coming from China.

The ultimate aim of the EU should be to ensure long term resilience in the supply of vehicles and the necessary materials for the transition to Net Zero. With other global regions having begun this journey several years ago, the EU is on the back foot, and this must be acknowledged when creating a pathway to decarbonise HDVs. Without a more flexible pathway, the EU may lose many of its competitive advantages as the market needs time to adapt and the new technology to mature.

Greater resilience and flexibility could be built into the regulations by ensuring provisions that allow a pathway for renewable combustion fuels to serve as a complimentary route to decarbonisation as new technology based production and economies are built up within the EU. This approach could foster investment and development in new technologies as well as ensuring the correct regulatory oversight of the production processes and subsequent emissions.

The regulations preference for ZEVs not only creates a strong dependence on raw materials availability it also relies on rapid growth in the entire recharging ecosystem both of which are outside of the control of vehicle producers and operators. These enabling conditions (detailed later in this report) if not met pose a high risk of targets not being achieved. By excluding multiple or complementary pathways any shortfalls in infrastructure roll-out, grid decarbonisation or materials shortage will result in additional diesel vehicle sales.

If the regulation provides a pathway for renewable fuels, any shortfalls in enabling conditions resulting in fewer ZEVs being registered would not impact the CO₂ reduction imperative as the ZEV shortfall could be made up of renewable fuel powered vehicles.

EU Industrial Policy should work in harmony with the CO₂ regulations to provide adequate local control and manufacturing development of ZEVs and batteries. The proposed pathway of emissions reductions through a restricted technological approach does not allow the industrial policy time to scale-up.

Aside from supply related risks, operational compatibility assessments and cost/affordability comparisons must be robust to translate policy into real world action. The parallel shift in energy provision and vehicle technology is enormous and cannot be overestimated. The commercial vehicle market is a rational B2B market – which means that it will adopt the most cost-effective solution to any problem. While it is true that regulations may have a driving role – i.e., the regulation will push OEMs to price in the different compliance options and that will change the TCO; it is also true that if

ZEVs can be operated competitively against ICE vehicles the market will move to ZEV naturally (otherwise the market may resist the transition).

Due to the low energy density of battery technology compared to liquid and gaseous renewable fuels, there are many vehicle models, options, use cases and body types that are currently not available today and may not be possible unless battery density improves. These include three axle artics compatible with full length trailers (as used in Ireland), short wheelbase tippers, AILs (abnormal indivisible loads), some road sweeping and specialist municipal applications. Battery density has been improving for many years and will likely continue with new technologies such as solid-state batteries, however, limitations exist that suggest the energy density of renewable fuels will never be matched by batteries.

The impact assessments on the competitiveness of ZEVs against ICEs must be robust. Several assumptions are included in the impact assessment that could be questioned – these include the energy price assumptions of both electricity and diesel into the future, the assumed continued reducing of battery material costs and battery cost, the continued improvements to battery energy density and charging times and the availability of models in ZEV format with the necessary options and configurations to suit every type of operation and superstructure. The impact assessment must also compare the WtW benefits of renewable fuels such as biomethane which can be carbon negative depending on feedstock or HVO which is not included in the calculations at all.

Additionally, the impact assessment compares ZEVs and ICEs using a total cost of ownership model (TCO). This is a theoretical calculation based on several cost assumptions for vehicle cost, energy cost, depreciation, maintenance, and interest cost. TCO is a widely used approach by operators when comparing alternative brands of ICE vehicles however, when used to compare different technologies it becomes less useful because it does not take into consideration any infrastructure costs or power network upgrade costs. TCO is just a theoretical prediction of cost parity, it overlooks the real-world situation where up to three times the value of funding must be sourced to cover the additional vehicle costs by SME vehicle operators.

If operators cannot afford to purchase ZEVs in the volumes required, the targets will be at risk. Whilst new assets can be financed to spread out costs across the operating period, the availability and cost of funding is limited by the financial strength of the purchaser.

The majority of HDV operators are small and medium businesses with low operating margins and are already highly geared or leveraged financially. The increased capital, the extended operating periods, the unknown future values, uncertain energy costs and the liquidity of operators are all factors which will impact the cost of funding and the availability of funding, only operators with very strong balance sheets will be able to secure the necessary credit to upgrade their fleets. This will lead to a dramatic restructuring of the sector with wild ranging social impacts.

2.3. Societal impacts of the zero tailpipe proposed pathway

The proposal for decarbonising heavy-duty transport in the EU by adopting zero-emission vehicles (ZEVs) could present multifaceted societal impacts. One of the most immediate areas of concern is the potential implications in the affordability of goods and services.

Given the pivotal role of trucks and buses in supply chains, any rise in operational expenses would be passed down to the end consumer. The critical task is to achieve parity in the TCO between ZEVs and traditional vehicles, yet this remains uncertain. The interplay of factors such as the cost of electricity and the availability of essential raw materials could exert an influential sway over TCO.

The uncertainty in the TCO may slow down the rate of ZEV adoption and the initial higher capital outlay required for ZEVs in comparison to their internal combustion engine counterparts places a financial strain on operators and thus on end-consumers.

In the absence of sufficient financial incentives or strong support from EU member states, operators may be reluctant to bear these additional costs, which could act as a bottleneck to the widespread adoption of low-consumption electric vehicles or have an impact on the final price of goods transported.

The availability of ZEVs could also serve as a potential limitation. If the availability of ZEVs is limited, either due to production constraints or inadequate charging infrastructure, it could lead to higher costs associated with ZEVs, making transport services expensive or restricted, impacting businesses and individuals alike.

Another area in which the transition to ZEVs could impact is the manufacturing supply chain and the associated employment landscape. The truck and bus manufacturing sector and heavy-transport operations support intricate supply chains and numerous jobs. Thus, shifting toward electrification will might disrupt this established value chain, especially considering the EU's present lag in battery production when compared to internal combustion engines (ICEs). This transformation raises the spectre of potential job losses across sectors interconnected with the manufacturing of conventional vehicles. As the transition prompts a shift from labour-intensive processes toward more automated and streamlined manufacturing, there is a potential for job losses. In order to mitigate this potential fallout, considerable efforts and investments in workforce reskilling and development are imperative.

Energy poverty stands as another challenge intertwined with the success of ZEV adoption. The efficacious integration of ZEVs into the transportation system hinges upon the widespread deployment of renewable energy sources to power these vehicles. Yet, a lack of significant strides in the realm of renewable energy might culminate in higher energy costs and subsequent energy poverty. The consequences could disproportionately impact marginalized communities, thereby exacerbating existing societal disparities.

The introduction of a pathway for renewable fuels should be considered as an opportunity to de-risk investments in the long term against adverse external events and reduce both job losses and mass re-skilling of highly specialized workers. It can foster the bio-refining conversion of existing assets and the development of new / innovative facilities, as well as grant a future for the ICE value chain (e.g. engine equipment producers). In the 93 refineries currently active in Europe about 120,000 people are directly employed, including employees and contractors, while the sector's indirect jobs are about 1.2 million. The entire automotive sector (including components companies, services and construction) has about 12.7 million employees (of which about 3.5 million directly employed). Employment effects are directly related to GDP and if the EU manufacturers will not be able to gain the lead in BEV and FCEV production, a one-technology approach can put at risk the whole EU economy.⁹

In conclusion, while the zero-tailpipe emission pathway for decarbonising heavy-duty transport through electrification offers significant environmental benefits, its societal impacts must be carefully considered and managed. Policy measures that address these challenges, such as supporting battery production, ensuring electricity affordability and availability, and facilitating workforce reskilling, will be essential to foster a just and equitable transition. It is also worth noting that a more technology-

⁹ ACEA.

neutral transition may avoid some of the more radical consequences of a rapid transition to ZEVs and ensure a smoother integration of this transformative shift.

2.4. *Enabling conditions identified as the main gap for the proposed pathway*

Electrification and hydrogen (H2) emerge as the long-term solutions for the road transport sector's decarbonisation. However, the realisation of this transformation depends on the establishment of a comprehensive set of enabling conditions.

Foremost among these is the deployment of an extensive network of charging infrastructure to ensure seamless refuelling options for EVs and H2-powered transport, a task made especially complex by the high energy needs and cross-border nature of HDVs. The diversity of applications within this sector - encompassing goods and passenger transportation, regional and interregional routes, spanning medium and long distances - inevitably results in a market that is intrinsically fragmented and therefore requires diverse charging infrastructure requirements.

The extensive reach of HDVs and their cross-border nature adds complexity to the setting up of a coherent charging infrastructure network. Unlike their light counterparts, HDVs require much more energy and time to recharge, increasing their dependence on uninterrupted energy availability and efficient charging facilities along their routes. As the accessibility of charging infrastructure in the EU becomes a key determinant of the viability of electrified HDVs, strategic planning must harmonize efforts across borders, recognising the transnational essence of this sector to ensure the functioning of the EU internal market. Distribution systems in many EU MS are inadequate and the complexity of upgrading them to support high-speed chargers should not be underestimated.

The stability and resilience of the electricity grid is paramount, necessitating substantial investments in grid upgrades and expansion to accommodate the augmented demand resulting from widespread electrification. Regulatory processes and permitting procedures must be streamlined across EU member states to expedite the rollout of charging stations and refuelling points. The battery ecosystem constitutes a linchpin, demanding a holistic approach encompassing access to essential raw materials, robust recycling mechanisms, expanded production capacity, and the establishment of secure supply chains. These conditions are imperative to mitigate potential bottlenecks and vulnerabilities, ensuring a sustainable and uninterrupted transition to electrified heavy transport as electrification will be predominant.

All these challenges will be further discussed and assessed in the 3rd part of this report.

3. Technology neutrality versus a technology mandate approach

This section examines the current proposal for HDV regulation through the prism of technology neutrality – to what degree the proposal allows for other options and to what degree it actually focuses on a particular solution.

3.1. *What defines a technology neutral and a technology specific regulatory approach?*

Technology neutrality is a widely accepted regulation principle in the EU that was first introduced in 2002¹⁰ within the electronic communications framework. The principle ensures that no individual

¹⁰ Directive 2002/21 on a common regulatory framework for electronic communications networks and services (Framework Directive) [2002] OJ L108/33.

organisation or technology is discriminated against, and manufacturers, suppliers, distributors and developers all face the same opportunities to comply with regulations. It also provides social assurance that economic consideration and market forces continue to play a significant role in the EU economy, at a time when markets are increasingly replaced by state regulation.

The technology neutrality principle is aligned with free market economics and whilst free markets also create winners and losers, the process is driven by consumer preference, affordability, practicality, and it drives innovation and naturally favours the best solutions. Winners and losers in free markets are organic which generally limits any structural obsolescence, large scale disruption to supply and demand cycles and corresponding financial shocks.

To achieve technology neutrality targets and objectives should be set that do not favour any particular approach to reaching these goals. An example of technology neutral regulation in the environmental sphere is the regulations that banned the use of CFC gasses in aerosols. The regulation here did not ban the use of aerosols altogether, but banned the use of CFCs in aerosols, and planned the systematic removal of these gasses. Had the regulation banned aerosols altogether this would not have met the technology neutrality principle. By banning the undesired product rather than the technology that uses it the market was able to find alternatives without compromising existing businesses.

It is sometimes suggested that a structured or planned economy is able to transition or react faster than an open economy to changing market conditions, such as the necessary environmental changes required to transition to a renewable energy economy. However, planned or structured economies too often stifle innovation and fail to adequately mobilize market forces. The more structured or planned the economy, the higher the likelihood of requiring innovation to be imported and the higher the risk of market failures requiring the ever-increasing involvement of governments and regulations. Market failures become the responsibility of the regulator as citizens may look to the State for compensation in the event of company or sector failure, which can create political tensions and lead to civil unrest.

3.2. *Technology neutrality of the proposed approach?*

The proposed approach fails to meet the technology neutrality principle because of two main assertions:

Firstly, considering emissions from HDVs as only those emitted directly from the vehicle tailpipe as relevant in defining ZEVs.

Secondly, assuming that all CO₂ emissions from a vehicle's tailpipe are anthropogenic emissions contributing to climate change (i.e., it does not make a distinction between ICE vehicles running on fossil-based fuels and ICE vehicles running on renewable fuels).

As a result of point one above, a narrow technological pathway is defined contrary to the technology neutrality principle. The regulation effectively outlaws climate friendly technology solutions utilising renewable combustion fuels which do not contribute to global warming.

LCA is the globally recognised methodology to accurately measure CO₂ emissions and the only way to truly evaluate technological approaches to reduce those emissions. Only by using an LCA approach can CO₂ reductions be measured effectively against targets and only this approach observes the technology neutrality principle.

Both assertions above create a technology bias and preference for electric powered vehicles, be they direct battery powered or fuel cell/battery powered, as well as for combustion engines utilising

hydrogen (H₂ICE) only. To reasonably be considered technology neutral, the definition of a ZEV within the regulation should be expanded to include vehicles with combustion engines using renewable fuels, which implies getting closer to the LCA approach.

Renewable fuels avoid the release of previously sequestered CO₂ into the atmosphere by utilising CO₂ captured from the atmosphere by the feedstock, therefore adding no additional CO₂ to the problem. If the ZEV definition included vehicles that emit 'zero fossil tailpipe emissions' or 'zero anthropogenic emissions', the contribution of ICE vehicles utilising renewable fuels would count towards manufacturer targets.

Expanding the definition of ZEVs would, of course, coexist with proper safeguards to avoid that carbon neutral vehicles can use fossil fuels. This could be approached in a number of ways, including: fitting vehicles with on-board diagnostics equipment to detect the fuel type and prevent operation with fossil fuels (this is the approach currently used to enforce Euro emissions standard compliance utilising an on-board NO_x sensor), random roadside checks could be used to check the fuel type in vehicles (this is the method used to monitor the use of Red-diesel in transport), or the performance of the '*exclusive carbon-neutral use test*' when national authorities perform the pollutant test.

When considering safeguards against the use of fossil fuel in a renewable fuel vehicle, an approach that does not add cost and complexity to every vehicle would be preferable to avoid additional cost being passed to vehicle operators and consumers. The diesel-gate scandal appears to have created a desire to make regulations less flexible and more prescriptive, the proposed CO₂ regulation for HDVs does not consider renewable fuel vehicles perhaps out of a concern that fossil fuels could be used to circumvent the regulation, however, there is no safeguard proposed to prevent electric vehicles using diesel generators to charge.

As an alternative to expanding the definition of ZEVs to incorporate renewable fuelled vehicles, which would also provide technology neutrality, would be to adopt a well-designed carbon correction factor to account for the carbon reduction potential of renewable fuelled vehicles. Several proposals have been put forward explaining the mechanics of such a system which essentially would account for the carbon emissions abated through the use of renewable fuelled vehicles. This could potentially both accelerate the reduction of carbon and also limit the risks highlighted with the proposed technology limited approach.

One option would be to create a carbon correction factor that reflects the CO₂ reduction of renewable fuels in each MS fuel mix each year and apply this reduction factor to the g/tkm value used in the VECTO calculation. This would prevent manufacturers being fined for CO₂ emission that have been abated through the use of renewable fuels in the market. A separate carbon correction factor for each fuel type would be the most accurate way to reflect the real world contribution, although more complex it would also encourage the most sustainable fuels to be used. A carbon correction factor would not disadvantage any manufacturer and they could pursue the technology solutions they believe are right for their markets.

It is acknowledged that the points discussed here are in the context of examining the technology neutrality of the proposed pathway and to be accommodated would require significant changes to the regulation as proposed. The points do however reflect the views of some stakeholders and could increase the flexibility of the regulations and reduce some of the risks of such a large transition.

3.3. The risks, gaps and challenges of the proposed pathway

The principle of technological neutrality performs a twofold function: while it limits regulation by emphasising that the market rather than the state should decide about the success or failure of

technologies; it also prohibits practices that directly or indirectly distinguish between technologies (i.e., discriminatory practices) without proper justification. While climate change can be considered an emergency on many levels, potentially justifying *in casu* technology neutrality to be side-lined, it may present risks. At this stage, it seems preferable to favour flexibility and openness to all the solutions available.

Aside from the technical merits or decarbonisation potential of any particular technology, the imposition of a technical solution can often be met with resistance for political or ideological reasons. The scale of this resistance will be proportionate to the perceived scale of the change in question, both from a financial and practical perspective. This resistance can be seen already in the passenger car sector where the polarisation of views is growing in a sector with far fewer compromises or limitations than the HDV sector.

Opposition to the non-technology neutral regulation is also likely from both member states and HDV operators who have already invested in renewable fuel solutions and are already ahead of the curve on decarbonisation. Producers of and investors in renewable fuels are also likely to oppose the narrow technology pathway. Some operators planning to switch to renewable fuels in the future could be forced to remain with diesel if the regulatory framework does not accommodate this approach.

One of the largest risks to the zero tailpipe emissions (of any kind) approach is the divestment or lack of investment in renewable fuel production. Renewable fuels will be required for other sectors like aviation and shipping and by not allowing these fuels in road transport the investment required for these other sectors is also at risk. Like traditional fossil fuels, some renewable feedstocks are processed in a similar way through fractional distillation, this process separates the lighter hydrocarbons from the heavier hydrocarbons in the feedstock. As with fossil fuel distillation each fraction (or fuel type) needs a market or destination, in practice this means it is difficult to create renewable aviation and shipping fuels without creating renewable road transport fuels.

The Renewable Energy Directive (RED) sets out the standards for fuels to be considered renewable and evaluates the WtW emissions of each fuel or energy vector recognising the CO₂ benefits of renewable fuels especially in unblended forms. The inconsistency between the RED WtW approach and the CO₂ regulation TtW approach for HDVs mandates an ever-increasing share of ZEVs (the definition of which currently does not include renewable fuels) this creates an ever-decreasing market opportunity for renewable fuels or energy vectors that are not renewable electricity or hydrogen. This decreasing market does not create an environment attractive for investment and there is a risk for producers not making the investments necessary to provide the aviation and shipping sectors with the volumes of renewable fuels needed to decarbonise effectively. Due to the above, a pathway without renewable fuels for HDVs will reduce the decarbonisation possibilities in these other sectors.

With parallel pathways for renewable combustion fuels and electrification (BEV or FCEV) the decarbonisation target is much more likely to be achieved. Hydrogen combustion technology has too many financial, operational and production limitations today to be a significant contributor to CO₂ targets for the early target in 2025 and 2030 – this pathway may develop into a viable solution for the later target dates of 2035 and 2040. The problem of decarbonisation is best addressed as quickly as possible to minimise the worst impacts of climate change, the current pathway imposes many limitations on the speed of transition, the inclusion of a renewable fuels pathway offers the best safety net in the event of failure or slower than expected progress towards the targets. This alternative or transitional pathway could be closed off in the future once all enabling conditions are met and other obstacles such as the TCO are favourable towards ZEVs.

In any transition, incentives can be useful to kickstart new technology adoption, however it is market forces that must do the bulk of the work as incentives are limited. The HDV market is extremely cost sensitive and operators are obliged to continually monitor and manage costs. The proposed pathway for ZEV was predicated on an assumption of ever decreasing costs for ZEVs, stable energy costs, availability of raw materials, decarbonisation of grids and the provision of recharging infrastructure. If any of these pre-requisites are not met, then the cost to the market is unlikely to become competitive compared to fossil fuels-based transport which will hinder the decarbonisation of road transport.

Whilst the decarbonisation of HDV through renewable fuels also represents an increase in cost for the sector, the cost increases are predominantly energy cost increases which are easier for the sector to accommodate as they are spread across a vehicle life. The significant increases in capital cost for ZEVs does not appear to be reducing in line with predictions made in the impact assessment created before recent events reshaped the market. Without the predicted cost parity against fossil fuels the transition to ZEV is unable to be driven by market forces, and with regulation as the only driver severe risks of market failure or uncontrolled inflation of transport costs are high.

As we've seen in the last few years with Covid, the war in Ukraine and the subsequent energy crisis, unforeseen or black swan events bring severe disruption to markets and supply chains. The more prescriptive legislation is around decarbonisation the more volatile any individual pathway becomes to these types of events. Conversely the more options or pathways available to the market to meet the targets the more robust and secure the targets will be. The climate crisis requires a fail-safe route to reduce atmospheric CO₂ and renewable fuels provide the backstop position required to ensure CO₂ reduction are delivered regardless of unpredictable or unforeseen global events.

When considering the proposed CO₂ regulation for HDV in the context of the wider regulatory environment affecting the transport sector there are clear inconsistencies in its approach.

For instance, RED creates a supply-based incentive for renewable fuels but the CO₂ proposal reduces demand side incentives, this contradictory position creates confusion for vehicle producers, fuel producers and operators. The ETS specifies caps which reduce over time and a trading mechanism that provides market-based incentives which reward innovation, fast action and adopting currently available technologies, again the CO₂ regulation appears unnecessarily prescriptive in comparison. The proposed CO₂ HDV regulation is also not aligned to the Euro 7 proposal which in its modelling uses a far slower ZEV adoption rate than the CO₂ regulation prescribes. While these regulations can also show, to some degree, a technological bias – as technology neutrality is not a general principle of the EU that always prevails – the inconsistencies in the approach of the proposed CO₂ HDV regulation suggests an overreach of the proposal by favouring particular technological solutions without a preponderant and proportional reason.

4. Electrification of the heavy-duty transport sector

This section investigates the gaps within enabling conditions that underpin the successful transition to ZEVs. An assessment of the challenges of the grid, charging infrastructure and of the battery supply chain. These challenges need to be overcome and we believe that they will be overcome. The challenges need to be looked upon in terms of timing and as boundary conditions, rather than as an impediment to the final goal of decarbonising the transportation sector.

4.1. Charging infrastructure deployment for zero-emission vehicles

EV charging is a relatively new industry sector and when considering the complex operational characteristics of HDVs, creating the infrastructure necessary will be a complex and time-consuming

process. There is a full expectation that to be sustainable this will need to be a profitable business in itself.

One issue that needs to be addressed is the fact that many HDV journeys go across and beyond the borders of EU countries, and the lack of adequate charging infrastructure would also be addressed in these countries too.

4.1.1. HDV-related charging needs in 2030, 2035, 2040 and onward

The deployment of a strong charging ecosystem must occur early enough not only to prevent impeding the uptake of electric vehicles, but also as a signal of commitment to this solution. By 2025, approximately 40,000 battery electric medium- and heavy-duty vehicles could be in operation in Europe (EU27 + UK)¹¹. According to projections by ChargeUp Europe, an estimated 270,000 to 520,000 electric HDVs are anticipated in 2030¹².

Assessments of infrastructure have been published by ACEA which estimates between 10,000 - 15,000 public and destination charging points will be required by 2025 and 40,000 - 50,000 by 2030 in EU27+UK. The vast majority of these must be high-power >500kW chargers. ACEA's report also projects that at least one high-power charging station with a minimum of four charging points every 100km by 2025 and at least one every 50km by 2030 on the TEN-T core network will be required. Overnight charging will additionally require 40,000 lower power public chargers by 2030. Finally, an estimated 40,000 lower power depot charging points would also be required by 2025 and 270,000 by 2030.

At the same time T&E assessed the charging infrastructure needs for electric trucks by estimating demand based on the ZEV sales targets mandated in the CO₂ regulations¹³. With the commission proposal of -45% target in 2030, they estimate a public energy demand of 8.13TWh, way below the charging available under AFIR¹⁴. In general, this estimate is for significant less infrastructure deployment needs, arguing that if ACEA recommendation were to materialise, it would lead to low utilization of the charging equipment, resulting in considerable risk of financial loss for businesses who invest in charging infrastructures.

4.1.2. Charging infrastructure deployment (AFIR and TEN-T)

The Alternative Fuels Infrastructure Regulation (AFIR) introduces compulsory minimums for the installation of charging infrastructure across Europe. The HDV charging infrastructure will be strategically positioned alongside the Trans-European Transport Network (TEN-T).

Member States must establish minimum charging infrastructure as below:

¹¹ ACEA, European EV Charging Infrastructure Masterplan; March 2022.

¹² Chargeup Europe, LIFE IS A HIGHWAY: DRIVING THE ELECTRIFICATION OF HEAVY DUTY VEHICLES.

¹³ T&E, Fully charged for 2030 Enough infrastructure for more electric trucks 2030; April 2023.

¹⁴ Ibid.

	2025	2027	2030	Number of charging hubs
TEN-T core	At least every 120 km: 15% of the network with 1,400 kW/hub	At least every 120 km: 50% of the network with 2,800 kW/hub	At least every 60 km: whole network with 3,600 kW/hub	1565
TEN-T non-core	At least every 120 km: 15% of the network with 1,400 kW/hub	At least every 120 km: 50% of the network with 1,400 kW/hub	At least every 100 km: whole network with 1,500 kW/hub	1239

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Targets for hydrogen refuelling stations (HRS) are also set out in the AFIR. It mandates that by 2030, the TEN-T core network shall have at least one HRS installed every 200 km. In addition, one HRS is required for each urban node. This will probably produce 659 publicly available HRS in total.

Additional national infrastructure plans that go beyond AFIR have been created by a few Member States, most notably Germany and the Netherlands, and more MSs are anticipated to do the same. However, to enable and accelerate investment conditions in EV charging infrastructure, several challenges and hurdles must be addressed.

We identify and examine these challenges not as insurmountable barriers to implementation, but as areas that need solutions, and obstacles that need to be overcome.

Challenges:

- **Locational Challenges:** Identifying suitable sites, permitting delays, civil works are not insignificant hurdles to overcome. MS must develop allocation strategies and incentives to make more public land available (e.g., Germany¹⁶) or prioritise permitting requirements.
- **Financial:** The number of electric HDVs and the deployment of charging infrastructures has to go hand-in-hand. Operators may install charging infrastructure at their depots, however, as they are already confronted with a high purchase price for electric trucks, they will require financial support.
- **Power Distribution:** HDV charging necessitates access to substantial power. This is a requirement for high-voltage connections with considerable power that can accommodate multiple vehicles rapidly charging at the same time during peak times.
- **Interoperability and Standards:** High operational compatibility and frictionless payment facilities are required across the charging networks.

A comprehensive strategy, ranging from high-power charging networks to grid upgrades and innovative charging solutions, can ensure that the infrastructure will not create operational disruption while maximizing the benefits of electrification.

4.1.3. Conditionality between CO₂ Standards and AFIR?

Given that the market uptake of ZEVs relies on a comprehensive framework of enabling conditions, conditionality needs to be examined between non-compliance penalties imposed on OEMs and the timely deployment of these enabling conditions.

¹⁵ T&E.

¹⁶ See ChargeUp Europe life is a highway.

Vehicle producers are delivering a wider choice of zero-emission solutions that cover different use cases, payloads, and ranges. The ability of transport operators to finance and profitably run these new powertrain vehicles, however, will play a significant role in how quickly they are adopted by the market. Therefore, it is crucial to create a strong enabling environment that is completely in line with the ambition levels established for manufacturers. Being in a B2B market, it is important to consider how well each stakeholder can adjust to shifting circumstances. EU manufacturers must be given the chance to advance the market and evolve with it.

Collaborative effort and shared responsibility are paramount in facilitating an effective transition towards electrification. Acknowledging the pivotal role that OEMs play, it is essential to avoid placing the entire financial burden of non-compliance penalties solely on them.

Integrating AFIR as a conditionality within CO2 standards signifies a more inclusive approach, fostering shared responsibility among stakeholders and a more realistic distribution and compatibility between responsibility, accountability and ability to influence outcomes.

The establishment of a Zero Emission HDVs Forum, as proposed within the Draft Report by the ENVI rapporteur, resonates with this collaborative spirit. Depending on its remit and governance, this forum would serve as a dynamic platform wherein representatives from the HDV sector, Transmission System Operators (TSO), transport operators, think tanks, civil society, MSs, and SMEs convene annually. Collectively, these stakeholders chart the course for charging and refuelling infrastructure rollout, aligning it with the dynamic needs of the market.

The proposed forum should also include Trade Unions and other worker representation to monitor the impact on jobs and skills.

An annual review and monitoring processes should also be established to assess the efficiency of the pathway and adjust to the sector's evolving requirements. This annual review process should include the adjustment of penalties imposed on OEMs in the event of delayed deployment of charging infrastructures.

4.2. Updating the electricity grid to meet the energy demand increase from HDV charging

As the deployment of AFIR progresses, it is imperative to assess the readiness of the electricity grid to accommodate the increasing energy demand from HDV charging. This examination involves evaluating the current state of the electricity grid and identifying necessary improvements to ensure a seamless integration with AFIR deployment.

4.2.1 Assessment of the readiness of the electricity grid today and onward

The grid's current capacity must be assessed to determine its ability to handle the additional load from HDV charging. It should account for peak demand periods and strategies for balancing the load to prevent grid instability. The geographical distribution of grid infrastructure also plays a role in enabling equitable access to charging facilities across regions. It is necessary to address disparities between urban and rural areas as well as cross-border connections.

Other issues that need to be addressed are fluctuations in renewable energy generation, the need for new and old distribution infrastructure to function together, while coping with the substantial and fluctuating demand cycles.

4.2.2 Current challenges may jeopardize future needs

Numerous challenges could occur linked to the rise of EVs and the increased pressure on grid capacity and resilience. Among them is the lack of visibility regarding its state, particularly with the proliferation of distributed assets connected at the distribution level. In addition, given grid's aging infrastructure, with more than a third of its components over 40 years old, there is a need for modernization.

Other factors include delays in obtaining permits for grid upgrades, connections to renewable infrastructures and approval for civil works hinder the rapid implementation of necessary improvements.

But many of these are being addressed. The EU's REPowerEU strategy aims to bolster the availability of renewable energy sources is a crucial prerequisite for decarbonising the EU economy and especially the road transport sector. According to the REPowerEU plan and the 'Fit for 55' legislation package, the power system must include 750 GW more in wind and solar power generation capacity, 50 million heat pumps, and 50–70 million electric vehicles by 2030.

However, not all EU countries are tackling the electrification of heating, transport, and renewable energy integration at once. In Germany, Distribution System Operators (DSOs) are undergoing quick electrification of the heating and transport sectors alongside the pressing need to include more Renewable Energy Sources (RES). The Netherlands sees climate goals threatened by a clogged power grid and is facing congestion issues¹⁷.

It is a reality that needs to be addressed that due to the fast electrification of its economy, many of the electricity networks are already operating at full capacity, which highlights the challenges of accommodating new customers, on the demand or supply side.

4.3. BEVs: secure EU's battery production capacity in a sustainable way

The EU's strategic focus on battery development and production plays a fundamental role in its clean energy transition and automotive sector competitiveness. Anticipated growth in demand for batteries spans various sectors, making them fundamental to achieving the EU's Green Deal objectives.

As a result, in 2018, the Commission introduced a comprehensive action plan covering the battery value chain, strategic goals, and implementation tools¹⁸. One of the main concerns is access to raw materials. The European Court of Auditors underscored that the existing strategy could potentially result in a shortfall in battery production capacity¹⁹. Currently, the EC action plan lacks specific, quantifiable, and time-bound targets, making it impossible to meet the EC's target of zero emissions by 2050 without relying on imported batteries or vehicles. This is not an outcome that is desirable if we are to maintain an industrial and prosperous EU and points to a significant amount of additional effort, focus and resources being needed.

To actively compete in ZEVs the EU must establish an industrial policy that is robust, ambitious, and consistent. This policy should encompass the entire battery value chain, from raw materials to recycling and promote innovation and sustainability throughout. Despite the introduction of policy initiatives, the EU's battery value chain continues to be heavily reliant on external supply sources.

¹⁷ Alliander.

¹⁸ [resource.html \(europa.eu\)](#).

¹⁹ European Court of Auditors Special report 15/2023: The EU's industrial policy on batteries.

Metals including copper, nickel and lithium are at the heart of geopolitics, as investments into new mines, as well as concentration concerns, escalate.²⁰

Reserves of strategic materials for BEV production are scarce on the European continent, moreover the EU has also a deficit in the processing capacity which is currently dominated by China (Europe depends on imports for more than 80%).²¹

Beyond 2030, EU manufacturers could experience a scarcity of battery raw materials. This is due to a combination of factors, including a rise in worldwide demand, primarily driven by the electrification of road transport and the restrictive and limited domestic raw material supply inside the EU.

To address these issues the Commission initiated 2023 the European Critical Raw Materials Act (CRM Act)²². The CRM Act is designed to accelerate projects throughout the supply chain under the “Strategic Project” designation. The primary objective is to expedite the permitting process and prompt swift action by local administrations.

The Comprehensive Resource Management Act (CRMA) mandates compliance with EU environmental regulations regarding water, waste treatment, and biodiversity preservation, which cannot be disregarded as well as meaningful engagement with local communities.

European social and environmental regulations, as well as permitting provisions, do not apply to overseas sources. To address this inconsistency and level the playing field an effective global standards must be established. The responsibility for regulating such matters falls under a separate framework, namely the EU Corporate Sustainability Due Diligence Directive (CS3D), which is currently in the finalization stage.

The CRM Act should exclusively recognize global standards that feature multi-stakeholder governance, site-specific controls, and transparent and independent auditing processes.

Finally, regarding circularity and recycling, data from CES (Circular Energy Storage) reveals that although there is sufficient pre-processing capacity to convert end-of-life batteries into feedstock, the ability to recover materials like lithium and nickel from is lacking. To address this, there is a need to expand material recovery capabilities in Europe, and this can be facilitated through financial support and the implementation of the Strategic Projects framework.

5. Conclusion

While the CO₂ regulation for HDVs is not prescriptive, the parameters de facto enshrine pathways which give a direction and lead to the promotion of electrification and H₂. In this case, the achievement of the CO₂ emissions targets requires a series of cumulative conditions, which include: (i) the provision of a wide variety of ZEVs through OEMs capable of performing the same duties as current ICE vehicles; (ii) the provision of renewable energy generation to accommodate the power demands of the sector; (iii) the provision of an expanded distribution network of renewable electricity; and (iv) the provision of a dense network of charging points across the EU. These elements not only

²⁰ [The Critical Raw Materials Act: EU's attempt to have quality and speed \(transportenvironment.org\)](https://transportenvironment.org/).

²¹ Data Source Provider: Study on the EU's list of Critical Raw Materials (2023): Final Report, European Commission 2023.

²² See Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/102.

need to come together to enable the transition to ZEVs, but they also need to be affordable to all market participants, otherwise economic stability and employment are also put at risk.

The scale of the endeavour potentially risks achieving the CO₂ targets, considering the lack of a safety-net.

Against this backdrop, ERCST concludes that technological openness and complementary pathways to decarbonisation are necessary to maximise the benefits of all technologies in delivering CO₂ emission reduction. Multiple pathways also offer more security against market disruption, consumer cost increases, employment risks and skills shortages as well as the ability to move with speed in this period of transition, while aiming to a clear outcome.

A multi-solution pathway encompassing renewable fuels should be considered as they can both help secure the achievement of the targets and provide a more cost effective and faster reduction in emissions due to reduced barriers to deployment and more affordable costs of ownership. Thus, it is not the responsibility of regulators to decide on which particular fuels can be used as long as they contribute to the reduction of CO₂ emissions.

Overall, the HDVs CO₂ regulation end up treating renewable fuels as a fossil fuel. That represents a missed opportunity to promote the development and the deployment of renewable fuels and to recognise and acknowledge the contribution these fuels can bring to road freight.

It is undisputable that electrification and later H₂ will have a major role, but renewable fuels can also play a role, even if time-limited, and should not be excluded. Renewable fuels offer the best side-bet to compliment the zero-tailpipe emissions pathway and could take up any slack in the CO₂ targets created by delays in the ramp up of ZEVs.

None of the technical solutions to decarbonisation are perfect and each has its benefits and limitations with the diverse nature of HDVs, there are too many variables and unknowns at this early stage to discourage innovation or close off technical pathways.

In addition to alternative regulatory pathways for renewable fuels, the enabling conditions for the roll-out of ZEVs discussed should be linked to the manufacturers targets and more closely monitored to ensure progress is in line with objectives and that other risks are mitigated such as employment, skills, affordability and dependencies on areas outside the EU.

By widening the scope of technological pathways and by better monitoring of the enabling conditions, the reduction of CO₂ from the HDV sector will be more affordable, it will be faster and less susceptible to shocks and impacts from unforeseen events in the future.

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