How Europe can lead the global race to zero-emission trucks

The economic wins of a faster transition

September 2023

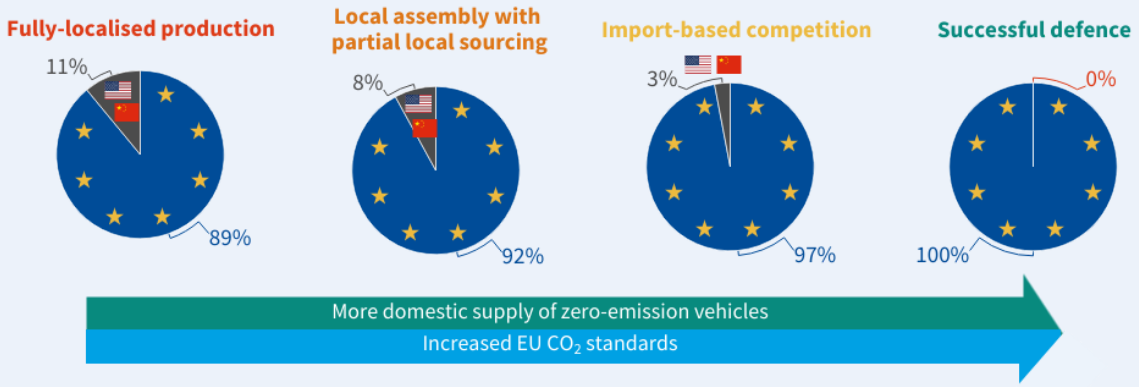
Summary

The European Union is currently reviewing its CO_2 standards for heavy-duty vehicles (HDVs), the EU's key policy to decarbonise road freight transport. To assess the industrial policy contribution of the regulation, Transport & Environment commissioned Boston Consulting Group (BCG) to study the impacts of the transition to zero-emission trucks (ZETs) on the European economy and European truckmakers' global competitiveness.

The analysis shows that a slow transition — as would occur under current HDV CO_2 standards — puts the European truck industry at risk of losing up to 11% of the EU market to competitors from the United States (US) and China by 2035. For comparison, this corresponds to the EU truck market share of Scania or IVECO today. The exact impact of international competition on the European market depends on the market entry scenario.

Tesla and BYD could grab 11% of European truck market by 2035

Share of the European truck market lost to new entrants in 2035



As the total cost of ownership (TCO) of battery-electric and fuel cell electric trucks drops below diesel trucks by the late 2020s, European demand for ZETs will surge. But the current HDV CO_2 standards would not adequately stimulate supply. Meanwhile, strong policies and subsidies in the US and China would lead them to develop economies of scale faster than Europe. This would open

the door to foreign competitors gaining a foothold on the European market through imports, either thanks to lower costs or better technology. Alternatively, strengthening the HDV CO_2 targets would help Europe successfully defend its industry by making sure domestic truckmakers keep pace with both international competition and domestic demand and hold on to their market shares.

Stronger HDV CO_2 standards are also projected to bring more economic benefits to Europe's society as a whole, in particular related to employment and gross domestic product (GDP). Compared to current policies, 7,000 net new jobs (+1%) and 10 billion euros in value added (+12%) would be created in the truck manufacturing, infrastructure, and energy sectors under the Commission proposal. Under T&E recommendations, these gains would reach a net increase of 23,000 jobs (+4%) and 27 B€ of value added (+31%).

A strong push for localising battery production in Europe further enhances the benefits of a faster ZET uptake. The number of European jobs per battery-electric truck produced can be increased by ensuring all battery cells are produced in Europe, and onshoring production of cathodes and active materials. With higher battery sovereignty, an additional 9,000 jobs would be gained under the Commission proposal, and 19,000 under T&E recommendations.

Energy sovereignty is the main driver of employment and economic growth. Moving away from diesel trucks will cut our dependence on oil, almost all of which is imported. Truck diesel demand is replaced with domestically-produced electricity — with renewables being the main power source — and hydrogen. The energy transition will greatly benefit the European economy and reduce its vulnerability to volatile global fossil fuel markets.

While the transition will have a net positive impact overall, losses and gains will occur in different sectors. Credible strategies must be in place to ensure workers in internal combustion engine (ICE) manufacturers and suppliers, and diesel refineries are supported with new skills and opportunities. Using the HDV CO_2 standards to set the pace of the transition, Europe can predictably determine when efforts to transition ICE employees have to be deployed and ramped up.

However, we shouldn't be tempted to slow the transition in order to preserve ICE jobs. As discussed above, lagging behind would lead to domestic truckmakers losing market share to foreign competition, resulting in lower truck production volumes overall. The global leadership position in commercial vehicle technology has been traditionally held by Europe. As the world is shifting away from diesel drivetrains, the race to be leaders in ZET technology and produce ZETs cost-competitively is now unfolding.

T&E therefore finds that the HDV CO_2 standards are not just crucial for climate. The regulation is also the core industrial policy to defend the competitiveness of the European truck industry. T&E recommends that policymakers raise the ambition of the Commission proposal for the review of the HDV CO_2 standards. Namely:

- Strengthen the **2030 CO_2 reduction target to -65%**, up from -45% in the Commission proposal.
- Set a **-100% CO_2 reduction target in 2035** for freight trucks, and 2040 for vocational vehicles.
- **Expand the scope of the regulation to cover all new HDVs**, by introducing CO_2 reduction targets for vocational trucks and a zero-emission sales target for non-certified vehicles.

1. HDV CO_2 standards are as much industrial as climate policy

Trucks are the lifeblood of European trade. They move more than three-quarters of EU inland freight measured in tonne-kilometres (77.4% in 2020[1]). Yet, heavy-duty vehicles (HDVs) are also responsible for 6% of the EU's greenhouse gas (GHG) emissions[2]. Since 2019, European truckmakers have to reduce CO_2 emissions from new sales (-15% by 2025 and -30% by 2030 compared to 2019/20). Current policies however still lead to an increase in HDV emissions by 18% by 2050 due to expected activity growth[3].

The European Union is therefore revising the CO_2 standards for HDVs to align the regulation with the EU's commitment to fully decarbonise by 2050. In February 2023, the European Commission proposed to strengthen the targets to -45% CO_2 in 2030 and -90% CO_2 in 2040. T&E has previously analysed that the Commission proposal falls short of climate neutrality by 2050, as HDVs would emit only 56% less by 2050 than they did in 1990[3]. A more rapid and ambitious transition (-65% by 2030 and -100% by 2035 for all freight trucks) as recommended by T&E on the other hand would nearly fully eliminate CO_2 emissions from HDVs by 2050.

While the CO_2 standards are primarily a climate policy tool, they are also crucial for industrial policy. To understand how beneficial a faster transition would be to European employment, economic growth and global industrial leadership, T&E has commissioned *Boston Consulting Group* (BCG) to study the impact of different ambition levels of the HDV CO_2 standards on Europe's economic competitiveness. BCG delivered both a report which can be found on T&E's website[4] and the model underpinning their analysis. This briefing is based on both the report and the model.

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[1] Eurostat. (2022). *Key figures on European transport.* Retrieved from https://ec.europa.eu/eurostat/documents/15216629/15589759/KS-07-22-523-EN-N.pdf

[2] T&E. (2023). *Ready or not: Who are the frontrunners in the race to clean up trucks?* Retrieved from https://www.transportenvironment.org/discover/ready-or-not-who-are-the-frontrunners-in-the-global-race-to-clean-up-trucks/

[3] T&E. (2023). *Addendum: Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.* Retrieved from https://www.transportenvironment.org/discover/why-all-new-freight-trucks-and-buses-need-to-be-zero-emission-by-2035/

[4] BCG. (2023). *Impact Assessment of the Transition to Zero-Emission Trucks in Europe*. Retrieved from https://www.transportenvironment.org/discover/impact-assessment-of-the-transition-to-zero-emission-trucks-in-europe/

The uptake of zero-emission truck (ZET) sales in Europe based on the HDV CO_2 standards was modelled by T&E as described in previous work[5]. Independent analysis by the International Council on Clean Transportation (ICCT) came to similar results[6]. All other data were supplied by BCG (including projected ZET sales in China and the United States (US)).

The scope of this study is limited to the production and operation of trucks above 6 tonnes (i.e. excluding buses and coaches as well as small lorries) in Europe[7] up to 2035. The scope covers 99% of European truck activity and 92% of new truck sales[8].

2. Europe risks losing technological leadership to China and the US

The global leadership position in commercial vehicle technology has been traditionally held by Europe. Today, more than half of heavy trucks built in the US come from European-owned factories, based on European technology[9], as many major US truckmakers (e.g. Freightliner, Volvo Trucks North America, Mack, Navistar) belong to European parent companies (Daimler Truck, Volvo Group, VW Group's TRATON)[10]. However, as the world is shifting from diesel drivetrains to zero-emission trucks, a race on who produces these new zero-emission trucks in the superior and more cost-competitive way is currently unfolding.

2.1. Current HDV CO_2 standards have Europe fall behind US and China

In November 2022, the US pledged to aim for 100% zero-emission truck (ZET) sales by 2040 by signing the Global Memorandum of Understanding (MoU). While this has not yet been translated into federal law, California — whose environmental regulations are often adopted by other US states — has already adopted a target of 100% ZET sales by 2036 at state level. At the federal level, the US has put in place a combination of demand-side and supply-side policies to decarbonise its trucking sector. Phase 3 of the Environment Protection Agency's (EPA) greenhouse gas standards are already more ambitious than the

[5] T&E. (2023). *Addendum: Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.* Retrieved from https://www.transportenvironment.org/discover/why-all-new-freight-trucks-and-buses-need-to-be-zero-emission-by-2035/

[6] Mulholland, E., & Rodríguez, F. (2023). *An analysis on the revision of Europe's heavy-duty CO_2 standards*. Retrieved from https://theicct.org/wp-content/uploads/2023/05/europe-heavy-duty-vehicle-co2-standards-may23.pdf

[7] Here, Europe refers to the European Union, the United Kingdom, Norway, and Switzerland.

[8] T&E. (2023). *Addendum: Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.* Retrieved from https://www.transportenvironment.org/discover/why-all-new-freight-trucks-and-buses-need-to-be-zero-emission-by-2035/

[9] ACEA. (2022). *Fact sheet: trucks.* Retrieved from https://www.acea.auto/files/trucks_fact_sheet_ACEA.pdf

[10] T&E. (2023). *Ready or not: Who are the frontrunners in the race to clean up trucks?* Retrieved from https://www.transportenvironment.org/discover/ready-or-not-who-are-the-frontrunners-in-the-global-race-to-clean-up-trucks/

EU's current policies[11]. And the US Inflation Reduction Act (IRA) will supercharge ZET sales through 2032 through financial incentives in the form of tax credits, as well as support the development of a comprehensive US battery value chain.

Meanwhile, China benefits from an important first-mover advantage. It currently leads both the ZET market (accounting for 90% of global sales in 2022[12]) and battery technology (accounting for 82% of cell production in 2022[13]). China first developed its electric vehicle market through multiple demand-side policies[14], which have since been phased down[15]. To develop national champions, China now leverages both regulation, its large domestic market, and its thriving battery value chain.

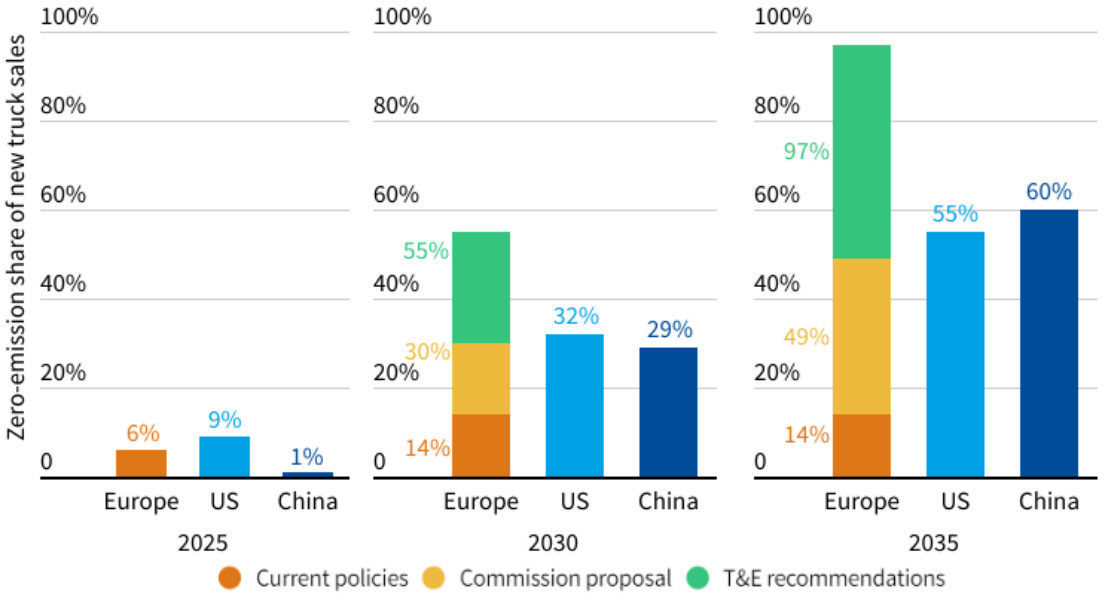


Figure 1. Projected ZET sales uptake in Europe, the United States, and China

Based on the projected ZET uptake in the US and China, there is a clear risk that Europe will fall behind unless the HDV CO_2 standards are strengthened (*Fig.1*). Indeed, under current policies only 14% of new trucks above 6 tonnes sold in Europe would be zero-emission by 2030. Meanwhile, ZETs would already account for 29%–32% of new sales in China and the US by the end of the decade. As proposed, the European Commission's review of the HDV CO_2 standards would deliver a 30% ZET sales share in 2030, allowing Europe to more or less keep pace with its international counterparts. However, by 2035 Europe

[11] US EPA. (2023). *Proposed Rule: Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3.* https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-greenhouse-gas-emissions-standards-heavy

[12] EV-Volumes. (2023). BEV & PHEV Buses & CV Registrations.

[13] BloombergNEF. (2022). 2022 Lithium-Ion Battery Price Survey.

[14] How did China come to dominate the world of electric cars? (2023, February 21). *technologyreview.com.* Retrieved September 11, 2023, from https://www.technologyreview.com/2023/02/21/1068880/how-did-china-dominate-electric-cars-policy/

[15] Mao, S., Zhang, Y., Bieker, G., & Rodríguez, F. (2023). *Zero-emission bus and truck market in China: A 2021 update*. Retrieved from https://theicct.org/wp-content/uploads/2023/01/china-hvs-ze-bus-truck-market-2021-jan23.pdf

would fall behind with the US and China which would already reach a 55%–60% ZET sales share, while the Commission proposal would only result in a 49% share for ZETs.

Lagging behind the US and China in terms of ZET uptake poses several risks to Europe:

- European truckmakers would achieve **economies of scale** later than their international counterparts. This would in turn make it difficult for them to compete on cost.
- There is a risk that European companies active worldwide could prioritise ZET investments (e.g. research and development, factory retooling) in regions with more ambitious climate regulation and/or where subsidies are the most generous. Parent companies present in multiple markets can shift investments from one region to another depending on where emissions standards are stricter or where subsidies are most generous. **Technological leadership** would be at risk of shifting to outside Europe.
- Domestic **vehicle supply could fall behind demand** in Europe. While European truckmakers could decide to keep ZET supply limited, demand from European hauliers is expected to grow rapidly. Trucking is a highly-competitive industry with razor-thin margins, and both battery-electric trucks (BETs) and fuel cell electric trucks (FCETs) are expected to become cheaper to own than diesel on a total cost of ownership (TCO) basis, by 2025/26 and 2030 respectively[16]. Fleet operators will not only want to buy ZETs to save on overall costs, many also have voluntary climate targets forcing them to decarbonise their fleets to reduce emissions[17]. Already, hauliers are calling for more ambitious HDV CO_2 standards so that ZETs become available[18][19]. If domestic truckmakers only supply low volumes (to maintain high profits on diesel trucks), hauliers will turn towards new market entrants to source their trucks and international competitors could gain a foothold in the European market.

It is important to note that domestic EU truckmakers are unlikely to fully transition to ZETs on their own if the EU HDV CO_2 standards are too low. In the truck market, empirical evidence suggests that no progress

[16] BCG. (2023). *Impact Assessment of the Transition to Zero-Emission Trucks in Europe*. Retrieved from https://www.transportenvironment.org/discover/impact-assessment-of-the-transition-to-zero-emission-trucks-in-europe/

[17] See for instance:
DB Schenker places major e-truck order with Renault in France. (2023, August 31). *electrive.com.* Retrieved August 31, 2023, from https://www.electrive.com/2023/08/31/db-schenker-places-major-e-truck-order-with-renault-in-france/
Getting heavy-duty vehicles in gear for net-zero. (2023, September 4). *aboutamazon.eu.* Retrieved September 12, 2023, from https://www.aboutamazon.eu/news/transportation/getting-heavy-duty-vehicles-in-gear-for-net-zero

[18] Companies call on EU policymakers to urgently increase the supply of zero-emission trucks by setting more ambitious truck CO_2 standards. (2023, June 26). *transportenvironment.org.* Retrieved September 11, 2023, from https://www.transportenvironment.org/discover/companies-call-on-eu-policymakers-to-urgently-increase-the-supply-of-zero-emission-trucks-by-setting-more-ambitious-truck-co2-standards/

[19] Siemens, Unilever, Maersk and DFDS join business coalition calling for 2035 deadline for zero-emissions trucks in EU. (2022, December 8). *transportenvironment.org.* Retrieved September 11, 2023, from https://www.transportenvironment.org/discover/siemens-unilever-maersk-and-dfds-join-business-coalition-calling-for-2035-deadline-for-zero-emissions-trucks-in-eu

has been made on emissions reductions in almost 30 years. The real-world fuel economy of diesel tractor-trailers in 2021 (35.3 l/100km) was virtually the same as in 1995 (35.4 l/100km)[20].

In the car market, incumbent carmakers only supplied electric vehicles in significant volumes when forced to do so by the car CO_2 standards. Due to high consumer demand, new entrants such as Tesla and BYD have been able to gain increasing market shares in European car sales[21].

2.2. Cost and technology advantages in US and China can overcome EU trade barriers

Today, the European homemarket is relatively well protected. Multiple trade barriers — such as tariffs and non-tariff barriers including regional homologation requirements or customer preferences — limit the overall volume of imports of new trucks. However, these barriers are eroding with the shift to ZETs.

While the EU imposes a 22% import tariff on internal combustion engine (ICE) freight trucks[22], ZETs are only subject to a 10% tariff[23] as is the case for cars. Road tractors for semi-trailer combinations meanwhile are subject to a 16% tariff[24]. Depending on cost and technology advantages, it can therefore be profitable to produce ZETs elsewhere and then import them into Europe despite paying for the import tariffs. Regions where battery production costs are lower are best placed for this, as batteries account for most of the costs of a BET manufactured in Europe[25].

In the US, the IRA provides considerable financial support to its battery industry through the Advanced Manufacturing Production Credit (AMPC), which runs until 2032[26]. This could cause battery production costs to be significantly lower in the US than in Europe for the foreseeable future.

China currently has the highest cost advantage in battery production. Bloomberg New Energy Finance (BloombergNEF) found that in 2022 HDV batteries produced in China were 54% cheaper than in the rest of the world[27]. Plugging Chinese price data from BloombergNEF for battery cells and packs into the model

[20] T&E calculations based on LastAuto Omnibus data. The data for 2022 shows a 12% reduction relative to 1995. It is not yet clear whether this is due to real efforts to improve fuel efficiency ahead of the 2025 CO_2 reduction target, or if it is a fluke (for example, average fuel consumption in 2008 and 2010 was respectively 8% and 9% higher than in 1995, but without heralding a long-term increasing trend).
[21] T&E. (2022). *From boom to brake: Is the e-mobility transition stalling?* Retrieved from https://www.transportenvironment.org/discover/from-boom-to-brake-is-the-e-mobility-transition-stalling/
[22] Motor vehicles for the transport of goods. TARIC codes 87042–87045.
[23] Motor vehicles for the transport of goods, with only electric motor for propulsion. TARIC code 87046.
[24] TARIC code 87012.
[25] Battery costs account for 64% of the costs of a BET produced in Europe in 2022, based on BCG's model.
[26] The AMPC subsidises 10% of the production costs of critical minerals, 10% of the cost of battery electrode active materials, 35 $/kWh for battery cell production, and 10 $/kWh for module production.
Sec. 45X. Advanced Manufacturing Production Credit. (2022). *irc.bloombergtax.com.* Retrieved September 11, 2023, from https://irc.bloombergtax.com/public/uscode/doc/irc/section_45x
[27] Cells produced in China are 31% cheaper, and pack structures are 84% cheaper. BloombergNEF. (2022). Lithium-Ion Battery Price Survey. Figure 19.

lowers the price of a truck produced in 2022 by 28%. This suggests that importing a BET from China and paying the 10% import tariff would be cheaper than producing in Europe, even before other cost savings are taken into account (e.g. lower labour costs).

Beyond imports of complete vehicles, European production of high-value e-mobility components is also at risk. As Lithium-ion batteries are only subject to a 2.7% import tariff[28], there is a real economic risk to import cheaper batteries from abroad instead of developing a strong battery value chain at home.

In addition, non-tariff barriers are losing importance. For example, trucks with elongated cabs have been permitted since 2020 (under the Weights and Dimensions Directive, with the first such vehicle entering the market the following year), giving much greater design flexibility to both EU and non-EU truckmakers to base their production on the current cab-over-engine design. This will likely lead to a harmonisation of the cab design across the different markets. As to customer preference, brand loyalty to truckmakers with an excellent reputation for their diesel trucks may become less important to hauliers when they shift to a new drivetrain.

2.3. 11% of the European truck market at risk by 2035

The impact of international competition on the European market depends on the market entry scenario. Based on lessons learned from the car market, the following potential scenarios for Europe's truck industry were developed:

- **Successful defence:** assumes domestic truckmakers provide sufficient supply to meet domestic demand. Non-European truckmakers never gain sufficient cost or technological advantages to get a foothold in the European market. Ambitious HDV CO_2 standards will play a crucial role to make this "successful defence" scenario a reality.
- **Import-based competition:** assumes non-European truckmakers manage to overcome trade barriers and enter the European market thanks to cost and technological advantages. However, the gap between domestic supply and demand is never large enough for them to start localising assembly or production. As a result, domestic truckmakers gradually lose market share to imports (with no benefits to the EU economy or employment), but don't get fully displaced.
- **Local assembly with partial local sourcing:** assumes new market entrants are able to reach sufficient sales volumes to partially switch from imports to localised production in order to avoid trade barriers. New players start by localising assembly and part of the supply chain (at half the level of incumbent truckmakers), meaning the European economy and workforce only partially benefits from their production presence in Europe.
- **Fully-localised production:** assumes entrants transition from imports to a fully-localised production model.

In the import-based competition case, new entrants would take 3% of the European market from 2029 onwards. As a result, employment in the truck manufacturing industry (including suppliers) would be

[28] TARIC code 85076.

1.7% lower in 2035 than in the successful defence scenario, and the sector's contribution to European gross domestic product (GDP) would decrease by 2.7%.

Local assembly with partial local sourcing would be the worst-case scenario for the European economy, even though imports of complete vehicles gradually come down (making up only 1% of the European market from 2033 onwards). This is because new entrants could gain a much higher market share (8% of the European truck market from 2030 onwards), but only half of the supply chain of the trucks assembled in Europe by new players would actually be localised in Europe. When imports peak at 4% of the European truck market in 2029, employment in truck manufacturing (including suppliers) would be 2.7% lower than with successful defence, and the sector's contribution to European GDP would go down by 4.8%. By 2035, losses compared to successful defence would be 1.6% for jobs and 3.3% for sectoral GDP.

In the fully-localised production case, new entrants could make up 9% of the European truck market in 2029, rising to 11% in 2035 (*Fig.2*). This is comparable to the market share of one domestic truckmaker[29]. Imports would peak in 2028 at 4% of the European truck market. This would negatively impact truck manufacturing jobs (including suppliers) and sectoral value added (-2.4% and -4.3% respectively). Much of the losses would be cleared by 2035 (-0.4% for jobs and -1.1% for sectoral GDP).

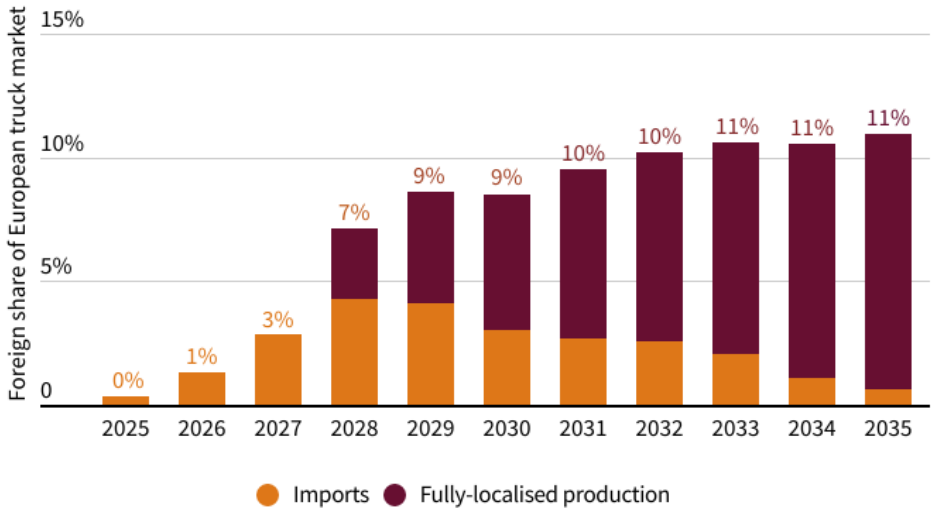


Figure 2. Share of the European truck market captured by new entrants in the full localisation case

3. A faster transition brings more job gains and economic growth

Today, the truck sector as defined in this study employs 575,000 people in Europe across four core value chains: automotive suppliers, truck manufacturers, charging and refuelling industry, and energy

[29] In 2022, European truckmakers had the following market shares: Mercedes-Benz Trucks 22%, Volvo Trucks 16%, DAF 15%, MAN 13%, Scania 11%, IVECO 11%, Renault Trucks 9%.
Mulholland, E., & Rodríguez, F. (2023). *An analysis on the revision of Europe's heavy-duty CO_2 standards*. Retrieved from https://theicct.org/wp-content/uploads/2023/05/europe-heavy-duty-vehicle-co2-standards-may23.pdf

suppliers[30]. BCG analysed how the transition from diesel trucks to ZETs would impact sectoral employment, as well as total sectoral value added. The latter corresponds to the contribution to European GDP of the truck industry as defined in this study.

Based on the CO_2 reduction targets and regulatory scope assumed, three trajectories for the uptake of ZET sales above 6 tonnes are modelled (*Fig.3*). BCG only modelled the impacts of two trajectories (Commission proposal and T&E recommendations). The impact of current policies on jobs and the economy was modelled by T&E using the model provided by BCG. The assumptions and methodology behind the ZET sales uptake are detailed in T&E's analysis of the Commission proposal[31]. For all three scenarios, it is assumed that 90% of ZETs above 16 tonnes are BETs and 10% are FCETs, and that 80% of vocational and special purpose ZETs are BETs and 20% are FCETs[32].

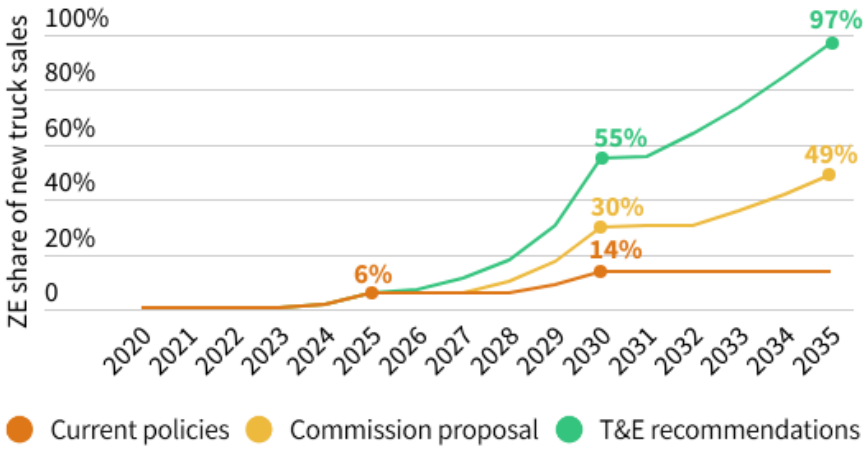


Figure 3. Zero-emission share of sales of new trucks above 6 tonnes under 3 regulatory scenarios

Freight activity, and therefore the number of trucks produced in Europe, is expected to grow significantly through 2035[33]. To isolate the impact of the shift in powertrain on the economy, BCG looked at two scenarios: one where the number of trucks produced in Europe remains constant at its 2019 level, and the other where it follows IHS Markit's production forecast. In both cases, and in all three policy scenarios

[30] Value chain steps without major dependence on powertrain type are assumed constant throughout the analysis (e.g. aftersales), as well as reuse and recycling. Raw materials are excluded from the scope of this analysis, as well as one-time expenses for the build-up of H_2 stations, diesel stations, and energy grid.

[31] T&E. (2023). *Addendum: Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.* Retrieved from https://www.transportenvironment.org/discover/why-all-new-freight-trucks-and-buses-need-to-be-zero-emission-by-2035/

[32] These assumptions are comparable to the recently published sales forecasts by the so-called 'Cleanroom talks' by the German Ministry of Transport which project a ZET sales share of 63% in 2030 in the EU (above 12 tonnes) of which 89% are expected to be BEVs and 11% FCEVs. NOW. (2023). *Market Development of Climate-Friendly Technologies in Heavy-Duty Road Freight Transport in Germany and Europe.* Retrieved from https://www.now-gmbh.de/en/news/pressreleases/now-also-in-english-market-development-of-climate-friendly-technologies-in-heavy-duty-road-freight-transport/

[33] European Commission. (2021). *EU Reference Scenario 2020.* Retrieved from https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en

considered here, the transition to ZETs has an overall positive impact on employment and the European economy. For brevity, only the results for the scenario aligned with expected truck production increase are shown here. The results assuming stable production at 2019 level can be found in annex A.2 and in the report[34].

3.1. New jobs outnumber old ones

The transition to ZETs opens opportunities for job creation in Europe. Employment in the truck sector as defined in this study[35] increases under all policy scenarios considered here. Under current policies, 50,000 (+9%) new jobs will be created based on the model. More ambitious HDV CO_2 standards would create further jobs growth: 57,000 jobs (+10%) in the Commission scenario, and 73,000 jobs (+13%) in the T&E scenario (*Fig.4*). Compared to current policies, the Commission proposal increases employment in 2035 by 7,000 jobs (+1%), while T&E recommendations would add an additional 23,000 new jobs (+4%).

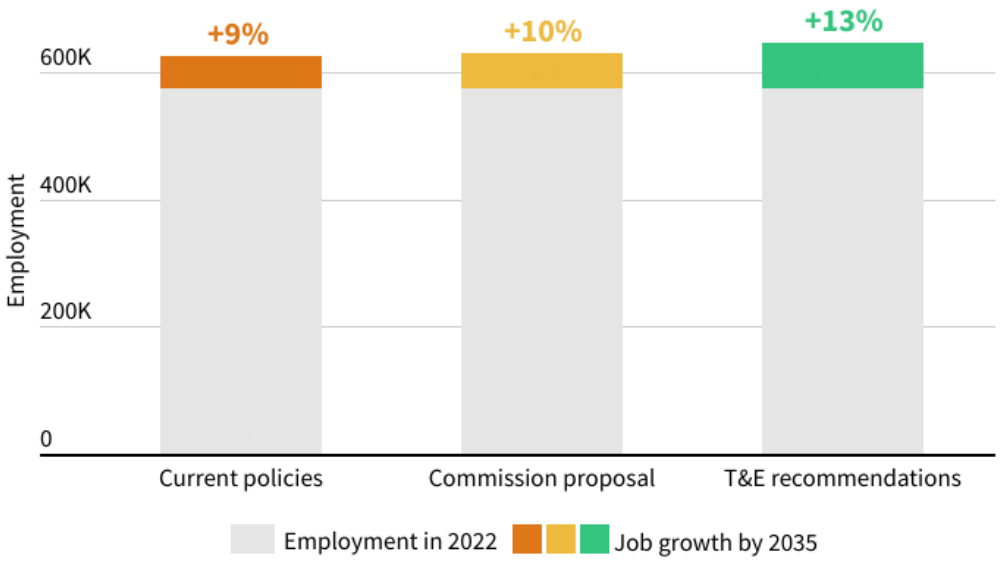


Figure 4. Change in employment in the three policy scenarios, truck production volumes as forecasted by IHS Markit

Key driver of the job growth from the ZET transition is the electric utility industry (*Fig.5*), as the truck fleet steadily shifts from running on imported fossil fuels to charging with domestically-produced electricity. From the model, HDVs currently account for 37% of European diesel demand, representing 87,000 employees in the energy sector in 2022. As trucks decarbonise, jobs associated with diesel production (e.g. extraction and oil refinery) would decline by 11,000 under current policies (-13% of HDV diesel production employees), 19,000 in the Commission scenario (-21%), and 31,000 in the T&E scenario (-35%).

[34] BCG. (2023). *Impact Assessment of the Transition to Zero-Emission Trucks in Europe*. Retrieved from https://www.transportenvironment.org/discover/impact-assessment-of-the-transition-to-zero-emission-trucks-in-europe/

[35] The truck sector comprises automotive suppliers and truckmakers, as well as the downstream industries related to refuelling and recharging trucks (service providers and utilities).

Under current policies, trucks would consume 1% of European electricity production in 2035. This would create 15,000 jobs in the electricity sector (e.g. equipment manufacturing, generation, distribution, trade), while 3,000 jobs would be created in the hydrogen supply chain. If the HDV CO_2 standards were strengthened to the level proposed by the European Commission, electricity demand from trucks would increase to 2% of European electricity demand in 2035. This would create 38,000 electricity jobs and 6,000 hydrogen jobs in 2035. Under T&E recommendations, trucks would account for 4% of European electricity demand in 2035, and 72,000 jobs in the electricity sector and 14,000 jobs in the hydrogen sector would be created.

For suppliers, 19,000 new jobs in core vehicle manufacturing would be created in 2035 relative to 2022. ICE-related employment would stay stable under current policies, and would go down by 10,000 jobs in the Commission scenario, and 22,000 in the T&E scenario. New jobs in battery cells, electric drivetrain components, and hydrogen-related components would go up by 4,000 under current policies, by 15,000 in the Commission scenario and by 30,000 in the T&E scenario.

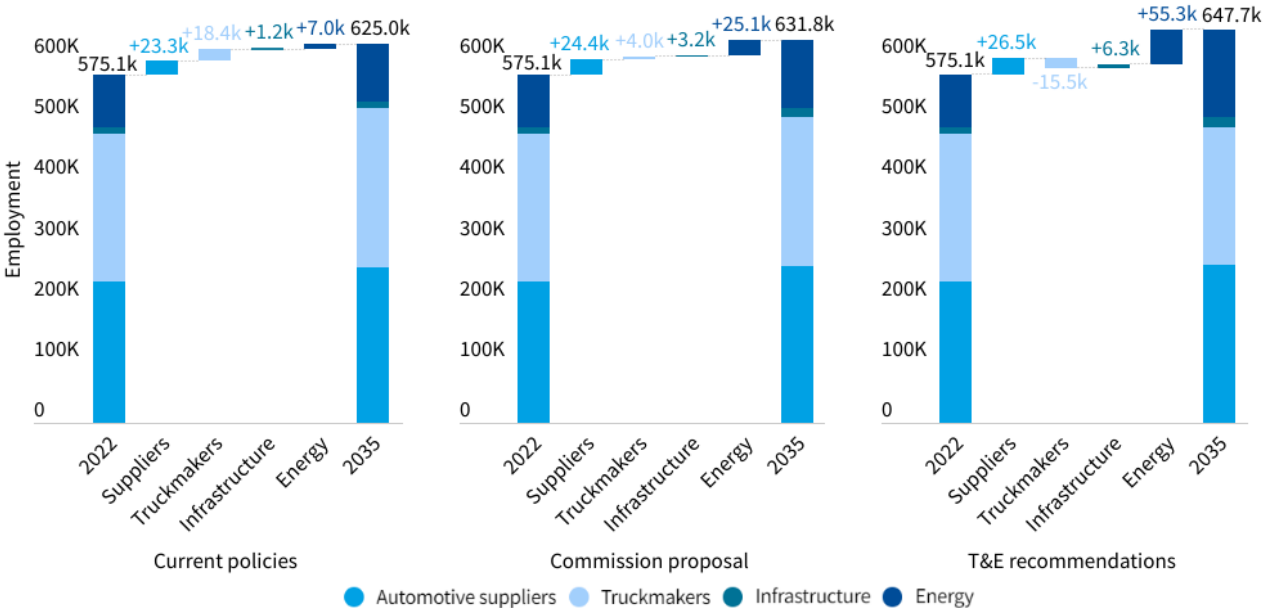


Figure 5. Change in employment between 2022 and 2035 by sub-sector, assuming truck production volumes as forecasted by IHS Markit

For truckmakers, the increase in volumes strongly offsets the losses projected when assuming that vehicle production remains constant over time. Under current policies and in the Commission scenario, employment for truckmakers would go up by 18,000 and 4,000 jobs respectively instead of going down when assuming stable production. In the T&E scenario, 15,000 jobs would be lost.

Looking at the truckmaker breakdown, 17,000 new jobs related to common operations (i.e. assembly, tooling, painting, marketing) would be created in 2035 compared to 2022. Employment in ICE manufacturing would be stable in the current policies scenario. It would decrease by 17,000 in the

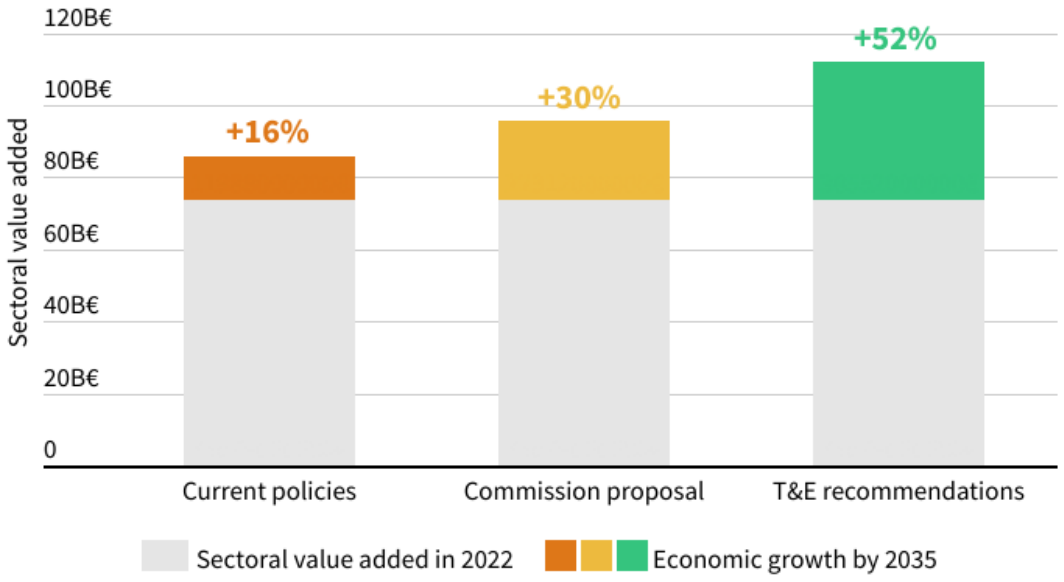
Commission scenario, and by 41,000 in the T&E scenario. For battery packs and battery management systems, 1,000 jobs would be created under current policies, 4,000 jobs under the Commission proposal when assuming stable production and 8,000 jobs under T&E recommendations.

What is more, truckmakers could capture part of the job gains which are expected for suppliers. Major European truckmakers are already adapting their business model towards increased vertical integration, with plans to manufacture their own battery cells, packs, electric drivetrains, or fuel cells[36]. Taking the T&E scenario as an example, if new jobs related to those components were instead equally split between automotive suppliers and truckmakers (i.e. +15,000 jobs each, instead of +30,000 jobs for suppliers only), then almost all truckmaker job losses would be offset. Policies aimed at localising battery value chains in Europe would further add to job gains for truckmakers and suppliers, as quantified in chapter 4.

Lastly, deploying charging infrastructure for BETs[37] would create 1,000 jobs in 2035 under current policies, 3,000 jobs in the Commission scenario, and 6,000 jobs in the T&E scenario.

3.2. Value added increases across sectors

The ZET transition will create opportunities for economic growth, with the greatest gains coming from the fastest transition. The contribution to European GDP of the truck sector as defined in this study is expected to grow by 12 billion euro (B€) in 2035 under current policies (+16%), by 22 B€ under the Commission proposal (+30%), and by 39 B€ under the T&E scenario (+52%, *Fig.6*). Again, a faster transition brings the most benefits.



[36] T&E. (2023). *Ready or not: Who are the frontrunners in the race to clean up trucks?* Retrieved from https://www.transportenvironment.org/discover/ready-or-not-who-are-the-frontrunners-in-the-global-race-to-clean-up-trucks/

[37] Employment in petrol stations or related to the build-up of hydrogen infrastructure was excluded from the scope of this study.

Figure 6. Change in sectoral value added in the three policy scenarios, assuming truck production volumes as forecasted by IHS Markit

Compared to current policies, the Commission proposal increases sectoral value added in 2035 by an additional 10 B€ (+12%), while T&E recommendations increase it by 27 B€ (+31%). Note that the economic and health benefits related to reduced air and noise pollution are not quantified here.

Sectoral value added increases for all sub-sectors (*Fig.7*). Similar to the situation regarding employment, the energy sector is where the impact of the transition is the most positive. In 2035, the contribution to European GDP of the energy sector (as it relates to charging and refuelling trucks) would go up by 5 B€ annually under current policies (+35%), by 12 B€ under the Commission proposal (+75%), and by 23 B€ under T&E recommendations (+144%).

Based on the model, diesel consumption would drop by 13% in 2035 compared to 2022 under current policies, by 21% under the Commission proposal, and by 35% under T&E recommendations. This is accompanied by a rise in electricity (and hydrogen) demand, where Europe captures most of the added value. Today only 8% of diesel value is generated within Europe, as diesel is mostly sourced from overseas and then refined domestically. Meanwhile, the European added value share of electricity production is 81% in 2022, rising to 98% in 2035, as domestic renewable power generation expands further[38]. For hydrogen, the model assumes that 60% of the value will be generated in Europe in 2025, increasing to 80% by 2035.

When assuming truck production volumes follow IHS Markit's forecast, the contribution to European GDP of automotive suppliers goes up by 4 B€ per year between 2022 and 2035 in the Current policies scenario (+12%), by 6 B€ in the Commission scenario (+21%), and by 10 B€ (+34%) in the T&E scenario.

For truckmakers, it goes up by 3 B€ under Current policies (+10%), by 4 B€ under the Commission proposal (+15%), and by 6 B€ under T&E recommendations (+20%).

Lastly, charging infrastructure deployment is where there is the least added value. In all scenarios, the sector's contribution to GDP increases by less than 1 B€ in 2035. In relative terms, it would go up by 6% in 2035 under current policies, 32% in the Commission scenario, and 63% in the T&E scenario.

[38] The European value share depends on the power source. It is only 40% for electricity generated from natural gas, but rises to 85% for coal power, 95% for nuclear power, and 100% for renewables and hydropower. The model projects that 94% of European electricity will be generated from renewables (88%) and hydropower (7%) by 2035.

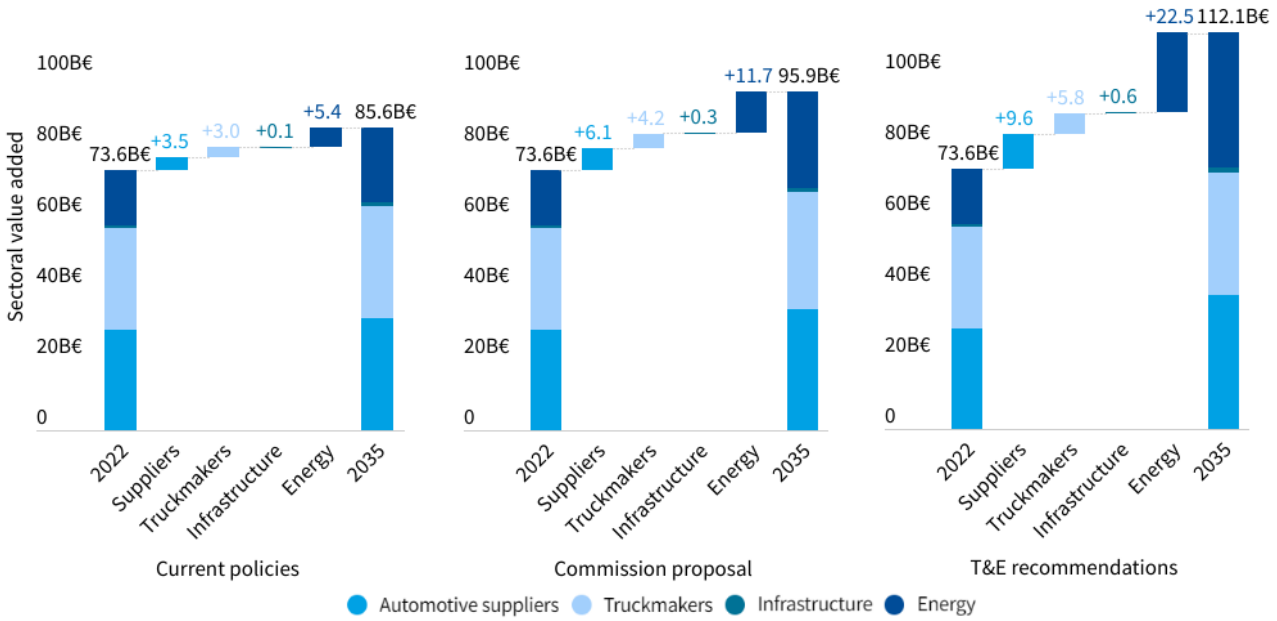


Figure 7. Change in employment between 2022 and 2035 by sub-sector, assuming truck production volumes as forecasted by IHS Markit

4. Stronger industrial policy needed to localise jobs and create added value

Two cases were considered regarding the European share of production of new e-mobility components (e.g. batteries, fuel cells). In the business-as-usual case, Europe secures only a limited share of the new value chains. This corresponds to the bare minimum that Europe would achieve in the absence of ambitious policy to support the development of the industry in Europe.

In the *Trailblazer* scenario, presented here, Europe succeeds in localising a larger portion of the new value chains. This assumes increased policy support, such as a strong *Net Zero Industry Act* (NZIA) and *Critical Raw Materials Act* (CRMA). For batteries, the Trailblazer case assumes that virtually all battery cells, modules, and packs are produced in Europe from 2030 onwards. However, there is room for further improving the European battery value chain after 2030. Both raw materials refining and precursors production can be further localised in Europe. Therefore the Trailblazer scenario is far from representing the maximum potential achievable for building an EU battery supply chain, especially when looking over a long timeframe.

The European share of value added for each component in the two scenarios are detailed in the Annex (see *Fig.A1.2.a* and *Fig.A1.2.b*). Throughout this section, truck production is again assumed to follow IHS Markit's forecast.

4.1. European e-mobility value chains add jobs in the automotive sector

Localising electric (and hydrogen) powertrain production in Europe leads to higher employment in the automotive sector (*Fig.8*). The impact is stronger if more ambitious HDV CO_2 standards are implemented, as more ZETs (and consequently more ZET components) are produced.

Compared to the analysis shown in chapter 3 above, the Trailblazer scenario would bring an additional 3,000 manufacturing jobs in 2035 under current policies, 9,000 under the Commission proposal, and 19,000 under T&E recommendations. Automotive suppliers would experience virtually all the gains (95% for suppliers, 5% for truckmakers).

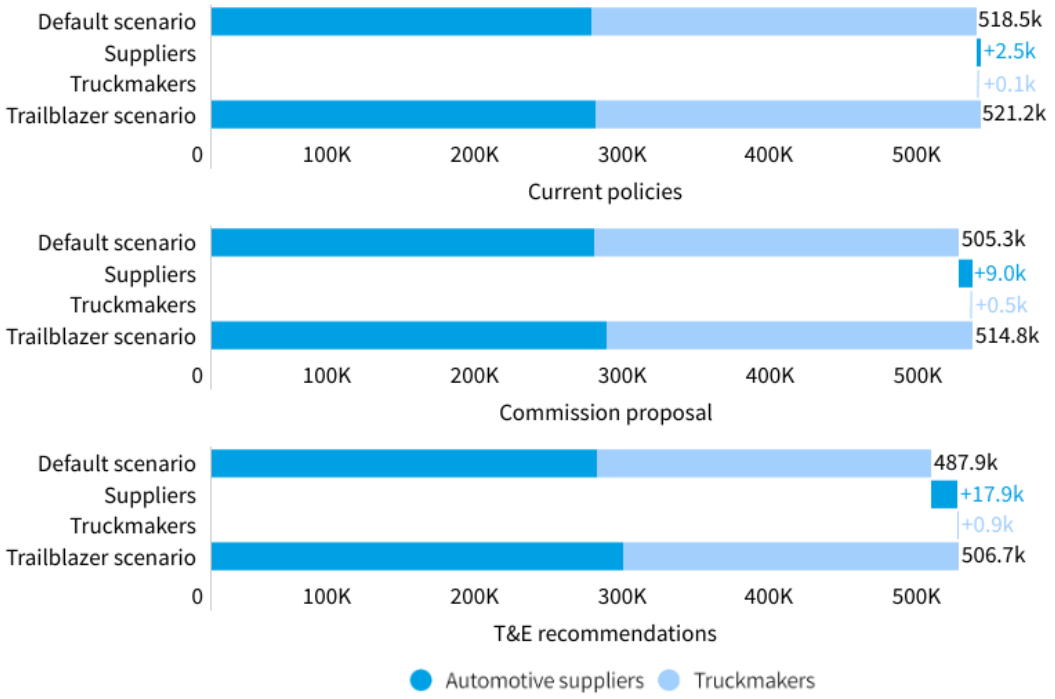


Figure 8. Employment in the automotive sector in 2035 in the default and Trailblazer scenarios, assuming truck production volumes as forecasted by IHS Markit

4.2. European batteries increase the value added of the automotive sector

Increasing the European share of total value added per component has an important impact on the contribution of the automotive sector to European GDP. As before, the impact is larger when the HDV CO_2 standards are stronger (*Fig.9*).

Again compared to the analysis shown in chapter 3 above, the Trailblazer scenario would bring an additional 1 B€ in sectoral value added in 2035 under current policies, 4 B€ under the Commission proposal, and 9 B€ under T&E recommendations. Automotive suppliers would experience most of the gains (81% for suppliers, 19% for truckmakers).

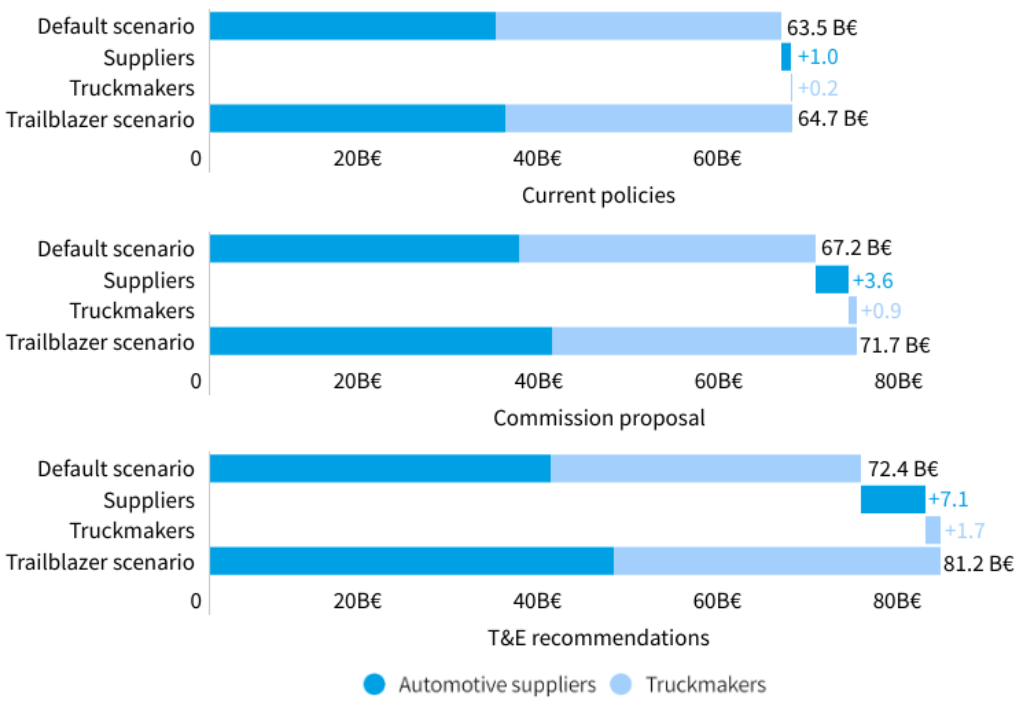


Figure 9. Sectoral value added in the automotive sector in 2035 in the default and Trailblazer scenarios, assuming truck production volumes as forecasted by IHS Markit

4.3. Localising ZET production in Europe is crucial to gain jobs

Looking at the number of manufacturing jobs required to produce one truck underlines the need to localise production of ZETs and ZET components in Europe. At the global level, producing one BET requires 0.75 jobs on average and across the total value chain, equal to what producing a diesel truck requires (*Fig.10*). Producing a FCET requires even more labour: 0.88 jobs.

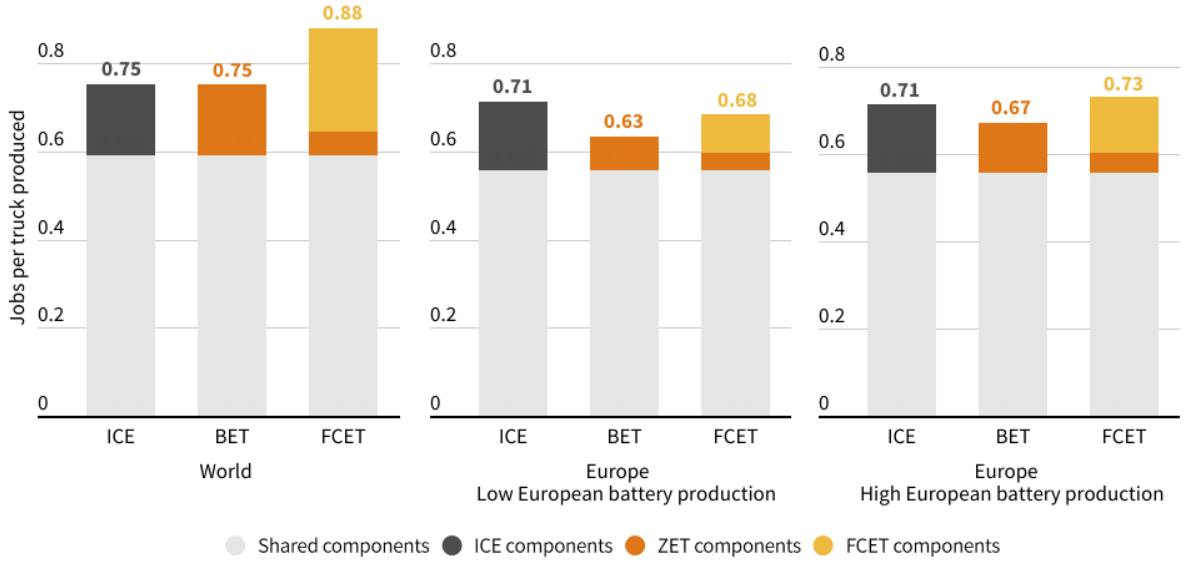


Figure 10. Number of global and European truck manufacturing jobs in 2035 by truck produced

However, the proportion of manufacturing jobs located in Europe is slightly higher for diesel trucks than for ZETs. The exact difference highly depends on policy, and can therefore be addressed with a comprehensive industrial policy focused on localising production in Europe.

Producing a diesel truck[39] in Europe requires 0.71 European jobs out of a global 0.75. So 95% of employment occurs in Europe and 5% abroad. For ZETs, many components are currently manufactured abroad. While producing a BET[40] requires a total of 0.75 jobs, only 0.61 (81%) of those are currently in Europe. Meanwhile, producing a FCET[41] today requires 0.88 jobs, but only 0.60 (68%) of those are in Europe.

The proportion of ZET components produced in Europe is however expected to grow in the coming years. Under current conditions, 0.63 European jobs will be created for each BET produced in Europe from 2030 onwards, or 84% of jobs per vehicle. In the Trailblazer scenario, this could rise to 0.67 European jobs per new BET produced. In this case, 90% of jobs associated with producing a European BET would be located in Europe.

For fuel cell trucks, by 2035 each FCET produced in Europe will require 0.68 jobs, meaning 78% of the jobs associated with producing a FCET would be located in Europe. In the Trailblazer scenario where a higher share of European demand for batteries and fuel cells is met through domestic production, this would rise to 0.73 jobs, or 83% of new jobs per vehicle.

5. Conclusions

Analysis shows that under current policies, ZET supply in Europe would meet only half the share of new sales reached by ZETs in the US and China by 2030. This means European truckmakers would achieve economies of scale later than their international counterparts, making it difficult for them to compete on cost. While strengthening the HDV CO_2 standards as proposed by the European Commission would allow Europe to somewhat catch up with its international competitors by 2030, they are insufficient to avoid Europe falling behind again in the 2030s. Meanwhile, as battery-electric electric trucks become cheaper to own than diesel on a total cost of ownership (TCO) basis by the mid 2020s (and fuel cell electric trucks by the late 2020s), demand for ZETs will surge. This gap between domestic supply and demand is likely to be filled by foreign competitors. Up to 11% of the European truck market in 2035 could be lost to such new foreign entrants.

[39] Producing a diesel truck creates jobs to manufacture the core vehicle, ICE engine, transmission, and periphery. Employment is also associated with the production value add of the truckmaker.
[40] Producing a BET requires manufacturing new components such as battery cells and pack (including battery management system), the e-motor, inverter, transmission, and power electronics. The core vehicle and production value add are assumed the same as for a diesel truck.
[41] Producing a FCET requires the same components as a BET (though the battery is smaller). FCET-specific components are the fuel cell propulsion system and the hydrogen storage system.

T&E therefore concludes that ambitious HDV CO_2 standards are not just crucial for climate, they are also the key industrial policy to defend the European truck industry against foreign competitors, and create local jobs and economic growth. Additional EU industrial policies such as a strong Net Zero Industry Act and Critical Raw Materials Act would further strengthen this.

As shown above, jobs and value added in the sector are expected to increase due to growing freight activity and the shift to zero-emission powertrains already underway (+50,000 net new jobs and +12 B€ annual sectoral value added in 2035). Analysis however shows that the faster the transition, the greater the economic benefits. Raising the ambition to the level proposed by the Commission or recommended by T&E would increase net employment by 57,000–73,000 jobs, and sectoral value added by 22–39 B€ in 2035. However, jobs in ICE manufacturing and fossil fuel extraction will be phased down as Europe shifts to ZETs. Ambitious CO_2 standards can ensure that these jobs are replaced by new jobs in the value chains of the future such as batteries, electric drivetrains, and hydrogen components.

The economic benefits of strong CO_2 standards are even higher when coupled with a comprehensive industrial strategy on batteries. The Trailblazer scenario shows that an additional 3,000 jobs would be gained under current policies, 9,000 under the Commission proposal, and 19,000 under T&E recommendations. Localising battery cell production in Europe (as well as raw materials refining and battery precursors manufacturing) is crucial to bridge the employment gap between producing a diesel truck or a BET in Europe. A robust industrial policy on batteries is deeply needed, as China already leads the growing market, and the US is boosting its domestic industry with subsidies.

Energy sovereignty is integral to making the transition a European success. Moving away from diesel trucks cuts our dependence on a fuel source which is almost entirely imported (oil). The switch to domestically-produced energy (either electricity or hydrogen) will greatly contribute to the European economy and make it less vulnerable to volatile global fossil fuel markets.

While the transition will have a net positive impact overall, losses and gains will occur in different sectors. Jobs related to diesel refining and ICE manufacturing will gradually disappear. The Just Transition Mechanism — which addresses the social and economic effects of the transition through financing dedicated to the most affected regions and industries — as well as national programmes can support efforts to reskill workers. The faster the transition, the quicker efforts need to be in place to make sure no one is left behind.

However, slowing down the transition in order to avoid diesel or ICE job losses is not the solution. As shown above, a slow transition creates room for international competitors to enter the European market. In this case, Europe would not only lose jobs related to ICE manufacturing, but also related to core vehicle manufacturing. Instead, setting a clear and ambitious trajectory is needed to secure the development of new value chains in Europe.

Already, leading European truckmakers have started to adapt their business models to move into new growth areas (e.g. battery packs and cells, infrastructure, or fuel cells)[42]. Strong HDV CO_2 standards are needed to make sure laggards catch up and leaders implement their announced plans.

The imminent transition offers an opportunity to strengthen Europe's industrial base. Focusing on zero-emission technology can safeguard Europe's technological leadership at a time when the global race is accelerating.

6. Policy recommendations

The HDV CO_2 standards are the core industrial policy to defend the global competitiveness of the European truck industry.

The Commission proposal goes a long way to raise the ambition of the standards, thus both protecting the climate and defending European leadership in commercial vehicle technology. It is the minimum required to make sure truckmakers stick to their voluntary announcements and do not lose an important share of the European market to new entrants.

To guarantee successful defence and capture all the economic benefits associated with a fast transition, T&E recommends raising the ambition of the 2030 CO_2 reduction target from -45% in the Commission proposal to -65% (up from -30% in the current regulation). This is both achievable[43] and necessary for the climate[44]. A clear deadline for 100% ZETs must also be set in 2035 for freight trucks and 2040 for vocational trucks. The fleet cannot be 100% zero-emission by 2050 otherwise. This is also necessary to keep up with regulation abroad (e.g. California's 2036 diesel end date) and to avoid investments being sunk into the technology of yesterday. Lastly, both the current regulation and the Commission proposal fail to cover the entire truck market as some vehicle types such as construction and small urban delivery trucks are not covered by the targets. Expanding the scope of the regulation to all new trucks is necessary to make sure all trucks decarbonise in time.

Regarding industrial strategy beyond the HDV CO_2 standards, the analysis shows European sovereignty in battery manufacturing is key to making the transition to ZETs a success. The battery value chain (including battery and component manufacturing, raw materials refining and processing) should be prioritised, for example by simplifying permitting and approval processes of battery value chain projects

[42] T&E. (2023). *Ready or not: Who are the frontrunners in the race to clean up trucks?* Retrieved from https://www.transportenvironment.org/discover/ready-or-not-who-are-the-frontrunners-in-the-global-race-to-clean-up-trucks/

[43] T&E. (2023). *Ready or not: Who are the frontrunners in the race to clean up trucks?* Retrieved from https://www.transportenvironment.org/discover/ready-or-not-who-are-the-frontrunners-in-the-global-race-to-clean-up-trucks/

[44] T&E. (2023). *Addendum: Addressing the heavy-duty climate problem. Why all new freight trucks and buses need to be zero-emission by 2035.* Retrieved from https://www.transportenvironment.org/discover/why-all-new-freight-trucks-and-buses-need-to-be-zero-emission-by-2035/

as proposed in the Net Zero Industrial and Critical Raw Materials Act. On top of policies to onshore the supply chain, funding support for best-in-class projects - e.g. via an expanded European Innovation Fund - and smart trade defence policy is needed to scale local green manufacturing in view of the fierce global competition. Finally, ZET subsidies should be subject to environmental, social, or industrial local value conditions, for example by ensuring that no subsidies are given to vehicles whose production has already been subsidised elsewhere (e.g in the US through the US IRA or in China).

From responsible sourcing to carbon footprint requirements, truck manufacturers in the coming years will have to meet the provisions laid out in the EU Battery Regulation. Similarly to what car manufacturers are already doing, truck manufacturers can invest today in responsibly-sourced materials ensuring both oversight on human rights and sustainable environmental practices but also security of supply. And unlike oil, batteries can be recycled and critical raw materials almost fully recovered. Recycling and circular value chains can already be prepared today to limit dependence on new raw materials in the future.

Further information

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Annexes

A.1. Scenarios

A.1.1. Truck production volumes

In order to isolate the impact of the shift from ICE trucks to ZETs on the European economy and employment, BCG assumed that truck production volumes stayed constant at their 2019 level throughout the analysis.

The BCG model also includes the possibility of changing truck production volumes according to IHS Markit's forecast published in February 2023. IHS Markit projects that truck production volumes will grow through 2035. This is in line with the expectation that freight activity will increase.

In addition, IHS Markit expects the number of trucks produced in Europe to remain under its 2018 level until 2033. This supports the idea that the projected increase is reasonable.

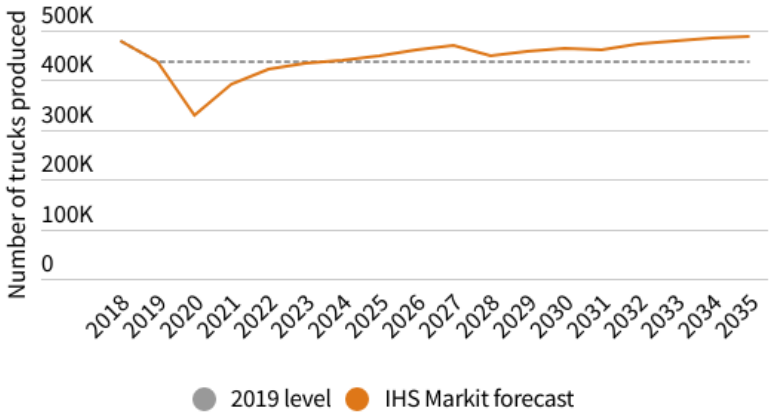

Figure A1.1 Number of trucks above 6 tonnes produced in Europe

A.1.2. Production and value added in Europe

The model includes two cases for the share of European production of important ZET components: battery cells; battery packs, modules, and management systems; fuel cells; and hydrogen tanks (*Fig.A1.2.a*).

Under the Trailblazer case, virtually all battery cells are produced in Europe from 2030 onwards. This is in line with European potential based on T&E's assessment of industry announcements[45]. Even with 95% of battery cells produced in Europe, the European share of value added is capped at 65% in the Trailblazer case. This is due to the European value share of battery raw materials, which is limited to 18% in the Trailblazer case (up from 4% in the default case) (*Fig.A1.2.b*). In practice, the European share of value

[45] T&E. (2023). *A European Response to US IRA*. Retrieved from https://www.transportenvironment.org/wp-content/uploads/2023/01/2023_01_TE_Raw_materials_IRA_report-1.pdf

added for raw materials could be further improved beyond 2030. So the Trailblazer case should not be mistaken for the maximum potential achievable under a long timeframe.

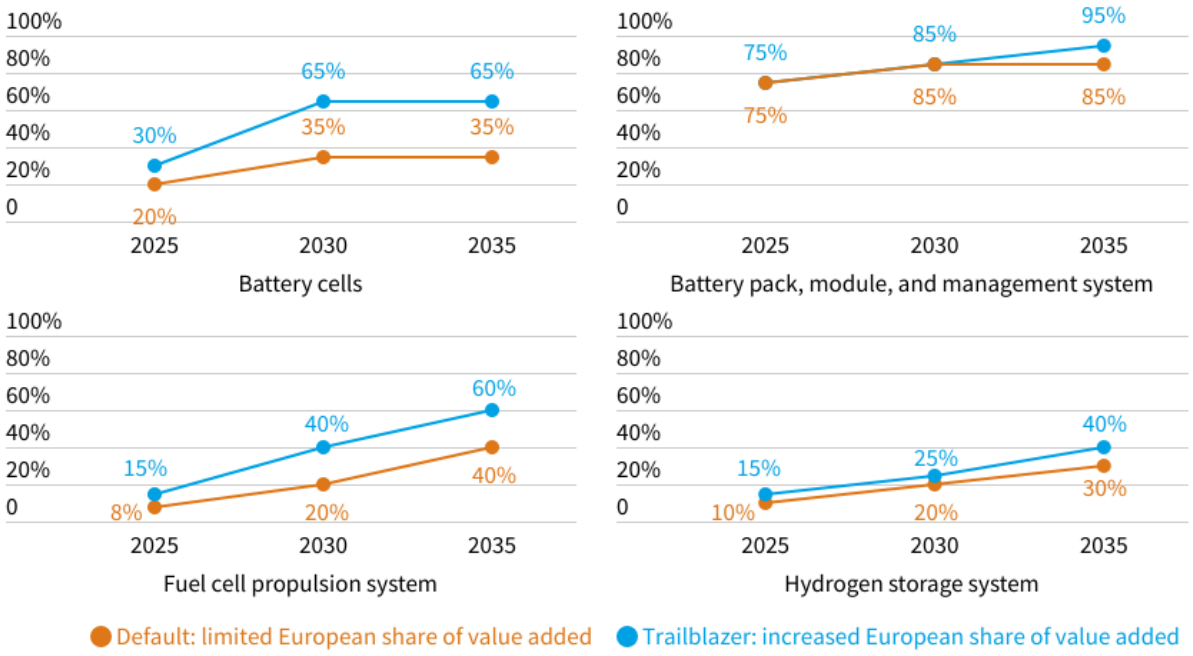

Figure A1.2.a European share of value added in the default case and Trailblazer scenario

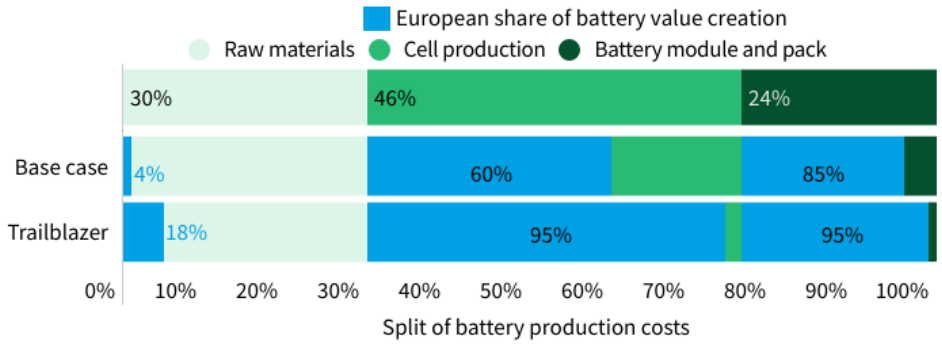

Figure A1.2.b Split of battery costs and European share in the default and Trailblazer cases in 2035

A.2. Results assuming truck production remains at 2019 level

A.2.1. Employment

Assuming truck production stays constant at 2019 levels, employment in 2035 would rise by 1% to 581,000 under current policies, by 2% to 589,000 people under the Commission scenario, and by 5% to 607,000 people under the T&E scenario.

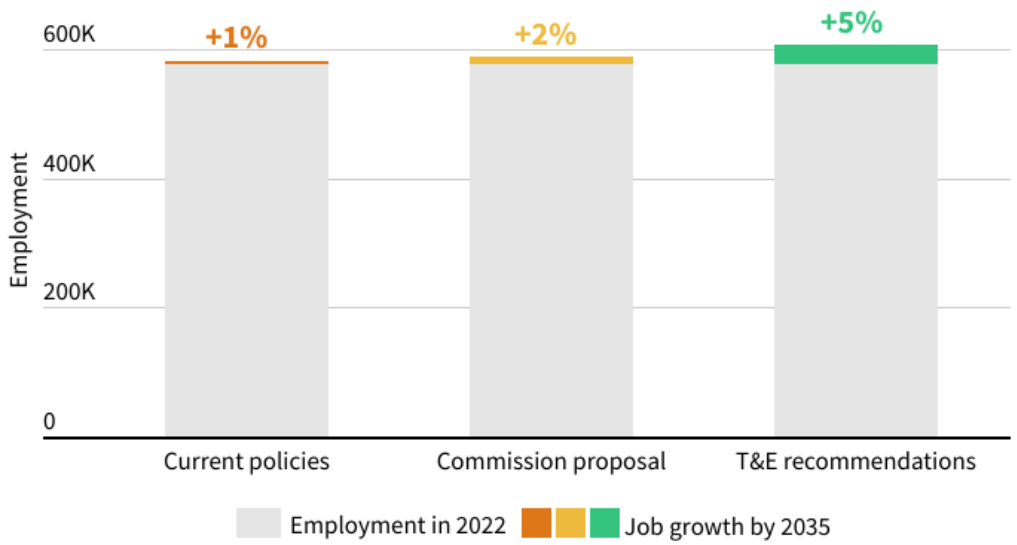

Figure A2.1.1 Change in employment in the three policy scenarios, assuming truck production remains constant at 2019 level

Overall employment is expected to increase among automotive suppliers in all scenarios. ICE-related manufacturing jobs would decline by 3,000 jobs in 2035 under current policies, by 12,000 in the Commission scenario, and by 23,000 in the T&E scenario.

However, the job losses for suppliers would be offset by the increase in battery cell manufacturing (current policies: +2,000 jobs; Commission: +8,000; T&E: +16,000), electric drivetrain components[46] (current policies: +1,000; Commission: +4,000; T&E: +7,000), and FCET components[47] (current policies: +1,000; Commission: +2,000; T&E: +4,000).

All in all, employment among automotive suppliers would increase by less than 1% under current policies, by 1% in the Commission proposal, and by more than 2% in the T&E scenario.

For truckmakers, the shift to ZET production would entail job losses if truck production volumes remained constant at 2019 level and truckmakers did not adapt their business models. Employment in ICE manufacturing would drop by 6,000 jobs in 2035 under current policies, by 21,000 in the Commission scenario, and by 42,000 in the T&E scenario. Employment in battery packs and management systems would only represent a gain of 1,000 new jobs in 2035 under current policies, 4,000 in the Commission scenario, and 7,000 in the T&E scenario.

Overall, truckmaker employment would decrease by 3%, 11%, or 23% by 2035 in the current policies, Commission, and T&E scenarios respectively. However, this is only when assuming that truck production volumes stay at their 2019 level.

[46] E-motor, inverter, transmission, and power electronics
[47] Fuel cell propulsion system and hydrogen storage system

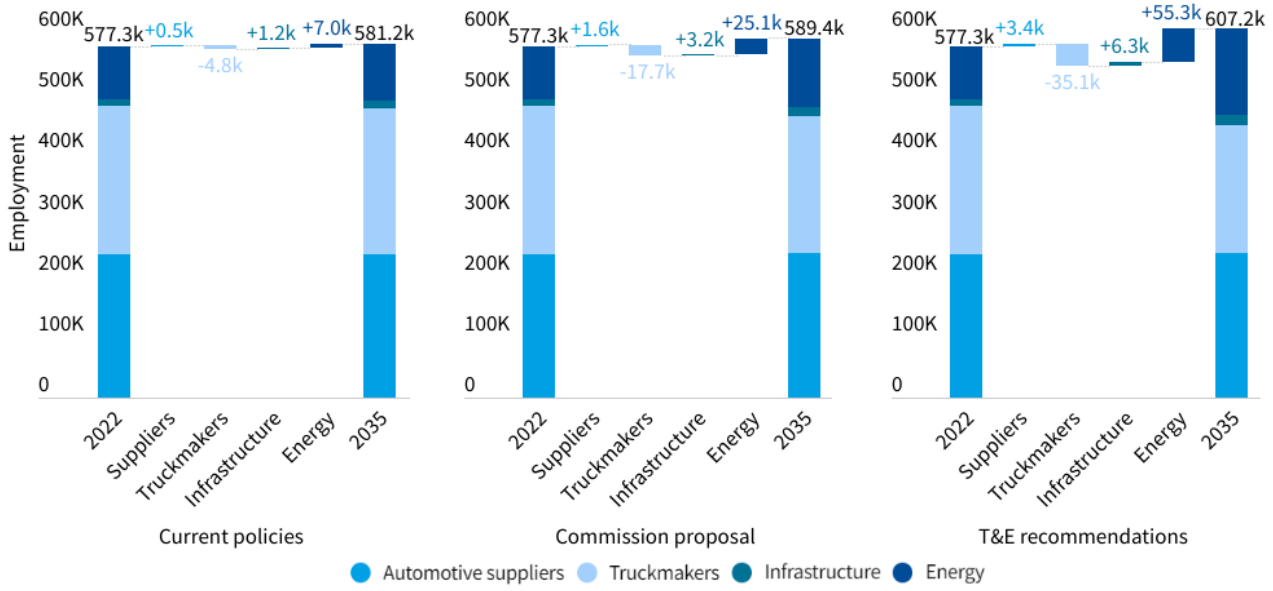

Figure A2.1.2 Change in employment between 2022 and 2035 by sub-sector, assuming truck production remains constant at 2019 level[48]

A.2.2. Value added

When assuming that truck production remains constant at its 2019 level, the contribution to the European economy of the truck sector as defined in this study would grow to 81 B€ under Current policies (+9%), to 91 B€ in the Commission proposal (+22%), and to 107 B€ in the T&E scenario (+43%).

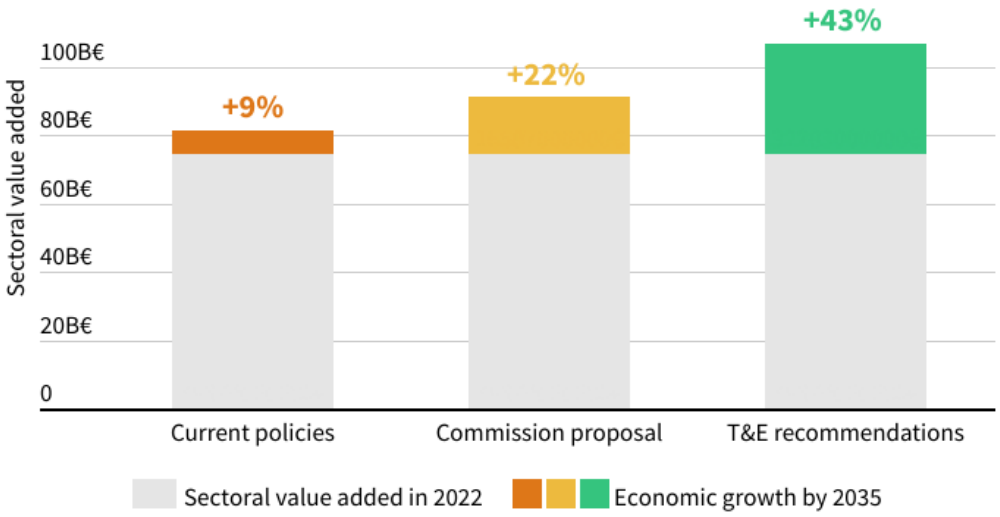

Figure A2.2.1 Change in sectoral value added in the three policy scenarios, assuming truck production remains constant at 2019 level

[48] The data for 2022 shown in *Fig.A2.1* differs from *Fig.5*. This is because the charts in *Fig.A2.1* assume constant truck production at 2019 level, while the charts in *Fig.5* are based on IHS Markit's production forecast. Truck production was higher in 2019 than in 2022, which increases the number of jobs estimated.

After the energy sector, value is primarily created among automotive suppliers, thanks to battery cell production. Sectoral value added would go up by 1 B€ in 2035 under current policies (+3%), 3 B€ under the Commission proposal (+11%), and 6 B€ under T&E recommendations (+22%).

The contribution to European GDP of truckmakers would also increase as the HDV CO_2 standards are strengthened. It would be stable under Current policies (+1%), and would go up by 1 B€ under the Commission proposal (+5%), and by 3 B€ under T&E recommendations (+10%).

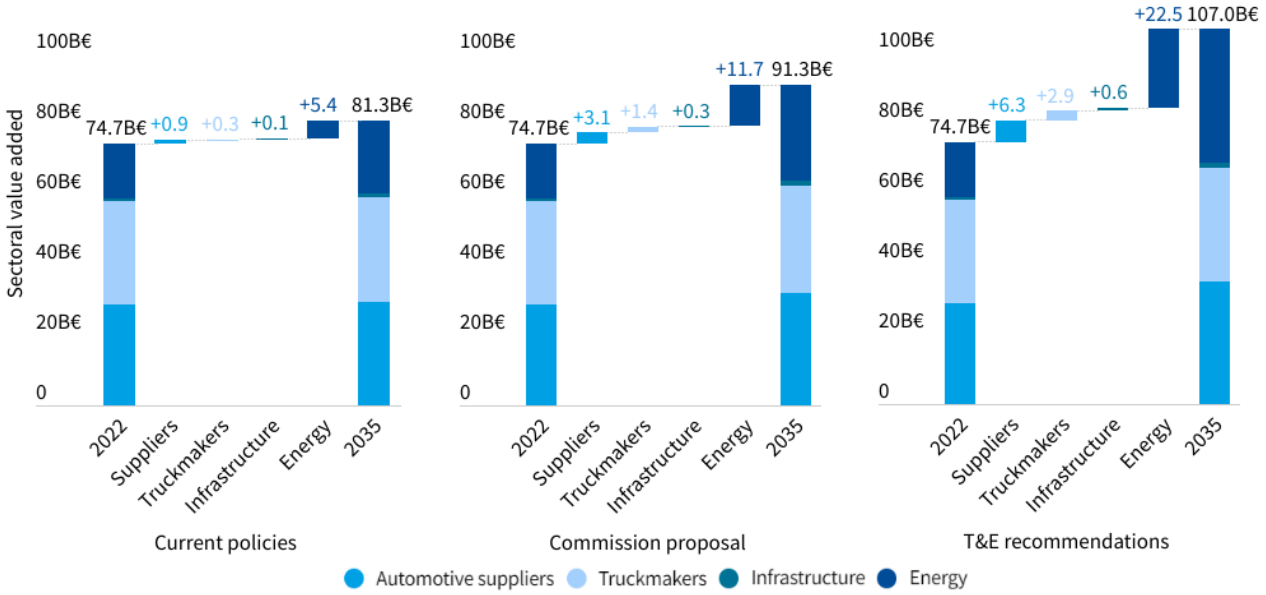

Figure A2.2.2 Change in sectoral value added between 2022 and 2035 by sub-sector, assuming truck production remains constant at 2019 level