Report

Accelerating ZET Deployment: Complementary Demand-Side Measures to Strong CO_2 Standards

December 2025

Authored by SFC with contributions from ACEA and AllChiefs

acea DRIVING MOBILITY FOR EUROPE

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Smart Freight Centre

Suggested citation: [Smart Freight Centre, ACEA and AllChiefs] Accelerating ZET Deployment Complementary Demand-side measures to strong CO_2 standards, 2025.

Acknowledgements

This report was written by Francesco Scognamiglio, Priyansh Doshi and Christoph Wolff of Smart Freight Centre, with contributions from Andre Annema of AllChiefs and Thomas Fabian of ACEA.

About SFC

Smart Freight Centre (SFC) is a globally active non-profit organization for climate action in the freight sector. Our goal is to mobilize the global logistics ecosystem, in particular our members and partners, in tracking and reducing its greenhouse gas emissions. We accelerate the reduction of logistics emissions to achieve a zero-emission global logistics sector by 2050 or earlier, consistent with 1.5° pathways.
www.smartfreightcentre.org

About FEC

Smart Freight Centre's Fleet Electrification Coalition (FEC) is a partnership of shippers, logistics service providers, fleet owners and other logistics industry stakeholders to accelerate large-scale electric truck (e-truck) deployment through demand aggregation. Our ultimate outcome is to enable 30% zero-emission road freight by 2030 and 100% by 2040 globally.

About AllChiefs

AllChiefs is a Rotterdam-based consultancy firm that enables organisations to thrive and contribute to a greener, more interconnected future. Through two core practices - Sustainable Logistics & Sustainable Workforce - our mission is to accelerate the journey towards net-zero logistics and build a future-proof workforce. We support organisations in redesigning supply chains and develop the skills and leadership needed for smarter, more resilient growth.
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About ACEA

The European Automobile Manufacturers' Association (ACEA) is the Brussels-based trade association of the 16 major car, van, truck and bus producers in Europe. The ACEA commercial vehicle members are DAF Trucks, Daimler Truck, Ford Trucks, Iveco Group, MAN Truck & Bus, Scania and Volvo Group.
www.acea.auto

Contact
Smart Freight Centre
Keizersgracht 562, 1017 EM, Amsterdam, Netherlands
P.O. Box 11772, 1001 GT, Amsterdam, Netherlands
www.smartfreightcentre.org
info@smartfreightcentre.org

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Executive Summary

Road freight decarbonization in Europe and the world has reached a pivotal moment. Zero-emission trucks (ZETs) are essential for meeting Europe's ambitious 2030 and 2050 climate targets, as commercial vehicles are responsible for about 10% of total emissions.
The European Union has created ambitious obligations for truck OEMs cutting fleet average emissions by 45% until 2030. This is equivalent to a 2030 share of ZET truck sales of 35%. In order to enable this transition, the European Union is mandating member states to provide high power charging infrastructure on the TEN-T corridor network under the AFIR (Alternative Fuel Infrastructure Regulation).

The adoption of ZETs has recently picked up significantly, with sales share of ZETs doubling albeit from a very low base, but still far below the shares observed in leading markets such as China. Several member states such as Netherlands (7.8%) and Sweden (7.1%) in 2025 already reach higher shares of sales, demonstrating the potential of the heavy-duty sector transition in Europe. Overall, the pace is lagging expectations, despite strong supply side regulations, which has led to a series of consultations across the entire ecosystem and a suite of announcements and support measures. In order to accelerate the scale up, the European Commission on September 25th 2025 launched the Clean Transport Corridor Initiative (CTCI) and awarded more funding for HDV infrastructure under the second round of the Alternative Fuels Infrastructure Facility (AFIF) funding. This complements member state incentive programs for both infrastructure and vehicles; only in November, Member States retain the opportunity to exempt ZETs from road tolls until 2031, building on the ETS2, Eurovignette and RED III policies.

Market adoption of ZETs happens in a complex ecosystem of shippers and many largely small-and medium sized carriers as demand side actors, OEMs (and asset financiers) on the supply side and charge point operators (and grid operators) as enablers. Ultimately, deployment of ZET foremost hinges on fleet economics for carriers as the operators of ZETs. Their choice of ZETs over diesel trucks is influenced by their customers, the shippers or cargo owners, that can offer strong procurement incentives but usually aren't willing to pay green premium or offer longer term contracts, with some early adopter exceptions. Large shippers are at the forefront of the ZET transition, and all have the responsibility to kickstart the uptake by investing people and resources into ZETs over bridging technologies.

Total cost of ownership (TCO) of ZETs in comparison with diesel trucks for market actors, in particular carriers and fleets, are not yet achieved on a consistent basis. Upfront capital requirements remain high before truck prices come down further, which is a burden for SME fleets with limited balance sheet. At the same time, enabling conditions such as ramp up of charging infrastructure have so far been coming online with delay, as supportive measures including incentives or policies for market actors remain fragmented and not consistently implemented across member states.

This paper attempts to assess the situation in a comprehensive way and provides solution pathways how to bridge the gap between currently projected ramp up of ZETs until 2030 and the EU Commission targets. So far, the EU-MHDV policy framework addresses the OEMs with "supply-side regulation" on one side and Members States to support infrastructure build out and implement policy levers that support a favourable TCO for carriers and shippers on the other side.

In this context, a whole portfolio of market stimulation levers is considered to rebalance the equation including support for ZET purchases, such as, subsidies, leasing schemes, and tax incentives. Many of these mechanisms are proven in reducing risk and mobilizing private capital, especially for small and medium-sized enterprises (SMEs), that dominate the European road freight sector.

Several current policy instruments, including the "EU Clean Vehicles Directive" do not address this potential: they classify a wide range of fuels as “clean,” do not mandate ZETs and are misaligned with CO_2 regulatory targets for OEMs. Stronger alignment between directives and regulations, alongside faster implementation, is urgently needed.

When it comes to ZET market adoption, lessons learnt from advanced market suggest that deployment of ZETs will not happen in a homogeneous way across the economy but focus on specific use cases representing ca. 20-30% of the market, that are at or close to TCO cost parity. Examples are ports, industrial clusters around mines, chemical or automotive plants and high-density corridors. Market and sector initiatives around TCO parity use cases can support the scale required, especially when coordinated through industry coalitions like the Fleet Electrification Coalition program at Smart Freight Centre.

A particular role in early-stage market acceleration is suggested for public procurement of zero-emission trucking assets and services. ZET deployment in municipalities such as refuse collection and construction, or maintenance services could support ZET take-up but has been underutilized so far. The scale-up of electric bus deployment could serve as a powerful example.

The consideration of broader based demand side measures needs to be evaluated carefully, even if applied to large shippers as opposed to carriers. Even large shippers in Europe use small carriers, who are the ultimate decision makers for ZET deployment, are contracted by many cargo owners. They require contractual commitments, access to low-cost finance and would require enabling robust TMS technology by 2030 latest to shoulder granular reporting requirements, if a ZET deployment mandate for large shippers gets implemented.

This report evaluates the opportunity for complementing the supply-side regulations already in place with targeted action on the market side to accelerate ZET uptake in line with the targets of the EU. It outlines current context and barriers, reviews the existing policy landscape, and assesses options for accelerating demand through procurement, national accelerators, ZET purchase support and potential additional demand-side measures.

Above all, this report calls for faster and harmonized implementation across the EU on enabling policy and infrastructure measures and a balanced distribution of responsibilities across all supply and demand side actors in the value chain. Smart Freight Centre (SFC) unites supply and demand side actors in its membership, while taking a distinct market actor perspective. SFC could contribute to securing accelerated ramp up by creating an observatory – with quarterly updates - of total cost of ownership conditions across member states across key use cases including union wide implementation status of enabling conditions and supportive policies.

Reaching the EU targets by 2030 requires collaboration by many actors in order to bring the required share of 35% or more towards TCO parity. As shipper and carrier demand picks up, this enables the supply side OEMs to capture economies of scale and reduce prices that will eventually start a flywheel. Now all hands-on deck to initiate the flywheel.

1. ZET adoption: current state of implementation

The global transition to zero-emission trucks (ZETs) is accelerating, with sales approaching 90,000 units in the first half of 2025 alone—nearly matching the total for all of 2024. While China covers 90% of global sales, Europe is a key driver of this growth, with the market expanding robustly; ZET sales surged more than 50% year-on-year in H1 2025, with leading markets like the Netherlands, Sweden, and Switzerland achieving adoption rates of over 10%. This momentum is critically underpinned by the EU's stable regulatory framework, including its CO_2 emission reduction targets for truck manufacturers (15% by 2025, 45% by 2030, 65% by 2035 and 90% by 2040 against 2019 levels). The EU's 15% CO_2 reduction target for heavy-duty vehicles (HDVs) took effect in July 2025, and it has already spurred noticeable growth in ZETs. The sales share of ZE HDVs covered by the CO_2 standards rose to 3.6% in H1 2025, up from 2.1 % in the same period of 2024.

In order to accelerate ramp up further and strengthen stakeholder confidence on supply, demand and infrastructure side, the European Commission recently launched the Clean Transport Corridor Initiative to speed up the rollout of HDV charging infrastructure and accelerate grid connections along the Scandinavian–Mediterranean and North Sea–Baltic corridors. In addition, it has awarded about €220 million for HDV charging under the second round of AFIF funding to expand infrastructure across the TEN-T corridors further supporting the uptake of ZETs. These efforts complement earlier measures such as RED III, EU ETS 2 and the Eurovignette Directive, which incentivise ZET transition at the national level. Several member states also offer purchase subsidies, tax benefits.

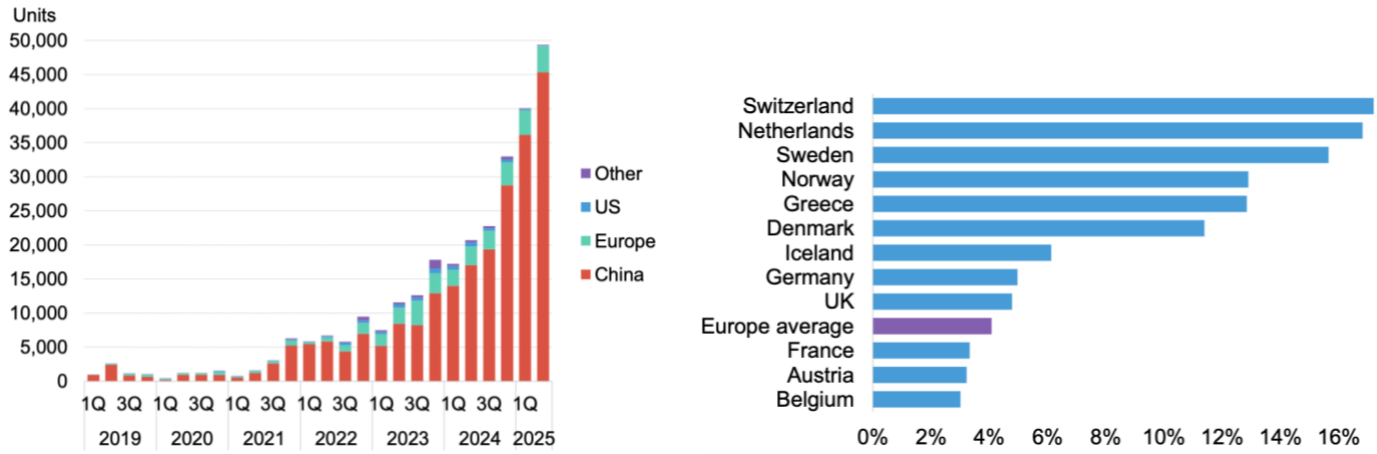


Figure 1: ZET sales ramp up globally (left) and H1 2025 ZET sales share in Europe (Source: BNEF)

Recent developments in the United States serve as a powerful caution, when it comes to provide a stable policy framework to enable investment decisions. Several of the most impactful drivers for ZET adoption are now at risk or being dismantled, in particular California's Advanced Clean Trucks (ACT) rule, which has been adopted by 11 U.S. states, and EPA's Phase 3 truck GHG standards. The U.S. Environmental Protection Agency's broad deregulatory actions have effectively weakened federal CO_2 emissions standards for medium- and heavy-duty vehicles. The reversal of federal incentives and regulatory support under the new administration, caused the U.S. ZET market to plummet, with sales falling about 80% in H1 2025 to a mere 200 units.
Revisiting the supply-side mandates for zero-emission trucks (ZETs) could **create uncertainty around the investment signals** that the current regulatory framework is intended to provide.

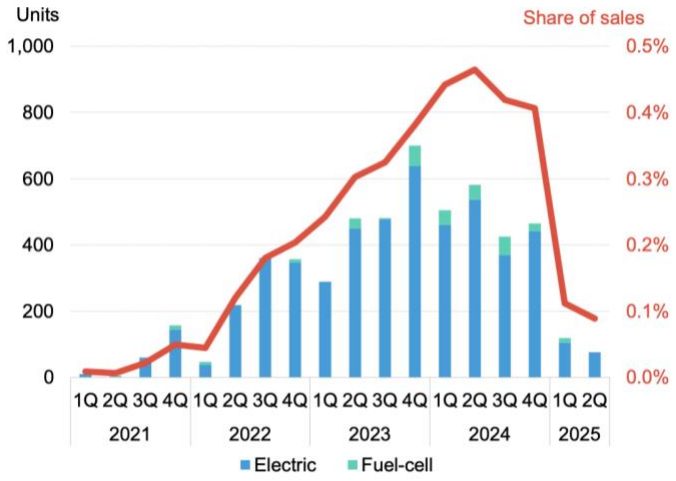


Figure 2: Impact of deregulation on U.S, ZET sales (Source: BNEF)

On the other hand, while in the EU the 2025 target is within reach thanks to OEMs efforts in diesel efficiency improvements, achieving the 2030 goal—which requires a nearly **tenfold increase in ZET annual sales**— estimated at cumulative 400,000 ZET units sold until 2030 (i.e., 35% of sales share) represents **an industry challenge.**

Adoption of ZETs is still hampered by several structural factors. The main economic indicator of this transition, Total Cost of Ownership (TCO), has not been reaching parity between diesel and ZETs due to high recharging costs alongside higher upfront vehicle costs, lack of visibility for optimal operations, financing barriers, and uncertainty about residual values. Small and medium-sized enterprises (SMEs), which dominate Europe's road freight sector, remain hesitant, when considering investing in new technologies with uncertain operational efficiency. Financing institutions also perceive risks, given the limited return on investment and uncertainty around residual asset values and infrastructure development.

Recharging infrastructure challenges amplify these concerns. Public charging points so far have remained limited, grid capacity is constrained in several geographies today and ramp up may be delayed. Permitting for new connections or depot-based solutions face significant lead times, unless prioritized by the Distribution Grid Operators at national level (which are very fragmented). These bottlenecks make e-trucks deployment at scale slower, even for front-running companies. The combination of heterogeneous policy support across the union and long lead times between legislative adoption and real-world effect is slowing down the ramp-up trajectory.

There is currently an asymmetry between regulatory obligations for OEMs and the absence of implemented demand-side measures. Manufacturers face penalties if fleet targets are not achieved, but shippers and carriers lack consistent incentives to adopt ZETs.
The "Clean Vehicles Directive" illustrates this misalignment. It defines multiple alternative fuels — including natural gas and biofuels — as "clean," while the Supply Side regulation only recognizes zero-emission vehicles as compliant. The result is a policy landscape where technologies promoted on the demand side may not contribute to the supply-side targets. More coordinated demand-side measures and incentives may be needed to provide carriers with certainty on fleet investments. That applies to the market too: decarbonization strategies of shippers prioritize cost-neutral bridging solutions, like HVO (or even alternative fossil-based solutions), driven by cost pressure. While supporting short-term decarbonization, ambitious ZET adoption targets from large shippers would instead give confidence to the carriers and the entire ecosystems towards ZET investments.

2. Complex ecosystem with shippers as driving force for ZET adoption

The transition to zero-emission vehicles involves a complex group of stakeholders across the freight value chain. Between OEMs, carriers, shippers, logistics service providers, financiers, and charging point operators, each faces distinct but interconnected challenges, that hinder large-scale adoption.

Shippers (or cargo owners) are the pivotal demand-side actors. They increasingly want to reduce their supply chain scope 3 carbon footprint and seek low-carbon transport solutions in their procurement process in view of ESG, CSRD targets and of related cost increases for non-compliance. However, they are constrained by cost parity requirements for ZET compared to traditional services and remain highly sensitive to TCO gaps, which limits their willingness to support higher-priced ZET services over low carbon alternatives that are cheaper to implement (e.g. HVO). Shipper procurement cycles and decisions are often short-term, i.e. under two years, which reflects today's reality of spot market procurement to the lowest cost bidders. This practice leaves the longer-term utilization risks with carriers, raises capital costs for financing and consequently discourage long-term ZET investments by carriers.

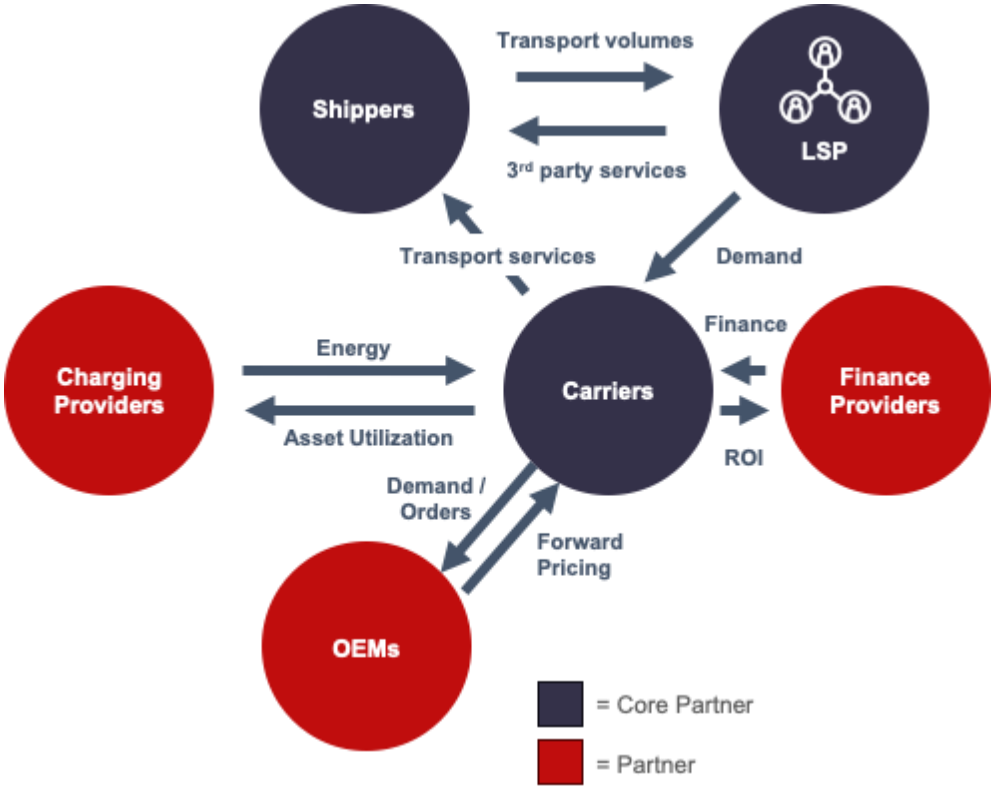


Figure 3: ZET adoption complex ecosystem of stakeholders (Source: Smart Freight Centre)

LSPs (or logistics service providers) play an intermediary role, consolidating volumes across multiple shippers and coordinating subcontracted carriers. While they are well positioned to influence decarbonization, their impact is limited by fragmented carrier capabilities, challenges in optimizing round trips across clients, and embedding ZET requirements consistently across geographies. When invited to road freight tenders by their customers (shippers), they include low-emission options in the form of alternative bids at high-level.

ZET solutions require deep-dive discussions around feasibility and cost competitiveness – as they often are not like-for-like solutions with shippers. LSPs may move forward with pilots if

commercially viable for shippers and aligned with shipper goals (willingness to pay premium often a key prerequisite to start pilot). Internal ESG or innovation teams at LSPs may sponsor projects when considering green premium cost sharing with shippers when strategic customers.

Carriers (or transporters) are the direct customers of OEMs, struggle with financing constraints, short-term contracts by shippers, and lack of knowledge in operating ZET fleets. These challenges often limit their ability to commit to large ZET purchases.
At the same time, they are impacted by ZET policies such as toll increases or other cost penalties to traditional diesel services, which are passed onto the final customers. They benefit from national ZET subsidies (e.g., Germany's KSNI), toll exemptions, and low-emission zones when moving to ZET. Overall, they find it difficult to navigate a complex, fast changing and locally diverging policy landscape.

Commercial Vehicle OEMs at the same time are under pressure to scale production and invest in new technologies, yet face high R&D costs, uncertain profitability, and dependence on parallel infrastructure deployment. Efforts are being made to support enabling conditions such as public charging and leasing models to carriers for ZET procurement, but slow rollout of such conditions creates demand uncertainty. In order to ramp up ZET production, a significant order book will be required – rather than anecdotal volumes – to avoid underutilization of production lines.

Charging Point Operators (CPOs) develop and operate charging infrastructure for private depots, public charging hubs, and logistics corridors. CPOs partner with carriers and LSPs to design depot charging solutions, collaborate with OEMs on charging compatibility and standards and rely on grid operators and municipalities for site development. Emerging green infrastructure funds see opportunity but demand low-risk projects (driven by committed anchor clients and scalable demand). Overall, charging providers struggle with upfront capital needs, grid capacity bottlenecks, and related lengthy permitting processes.

The ***Commercial vehicle finance sector*** perceives elevated risk, when it comes to ZET financing, given uncertain uptake speeds and residual asset values ZET second-hand markets are only emerging and therefore guarantees to cover residual value risks are nascent.

These barriers for the various market actors reinforce one another, resulting in a fragmented market, which need to be addressed. Large shippers' role remains essential to signal ZETs as prominent technologies and to drive adoption through investments. The approach towards decarbonization is highly influenced by the current business practices and prioritizes solutions lower short-term premiums. On the other hand, focusing on long-term partnerships (3+ years) not only supports the transition to ZETs, but also mitigates against limited biofuels' feedstocks and protects long term logistics costs. In addition to it, as demonstrated by SFC's Fleet Electrification Coalition, motivated shippers' demand for ZETs can provide clarity to CPOs, Carriers and Logistics Service providers and help address ZET total cost of ownership gaps with traditional ICEV.

Aggregating demand enables a virtual reinforcing cycle with 1) The amount of ZET proposals to Shippers 2) Shipper's commitments to LSPs and Carriers 3) LSPs and Carriers' commitments to Charging Providers 4) orders to OEMs 5) ZET trucks entering the market and consequent charging infrastructures' utilization 6) trucks costs reduction that in turn reinforce 1).

3. Policy framework addressing TCO gap undermined by fragmented implementation

To stimulate demand by improving economic differential between diesel trucking and ZET trucking, the European Commission has introduced a suite of measures under the Sustainable and Smart Mobility Strategy. These include several directives and regulations as described below that directly impact operating costs and therefore influence TCO. Additional to EU wide regulations, measures at member state level such as incentives & tax benefits further incentivise the transition to ZETs by improving the TCO.

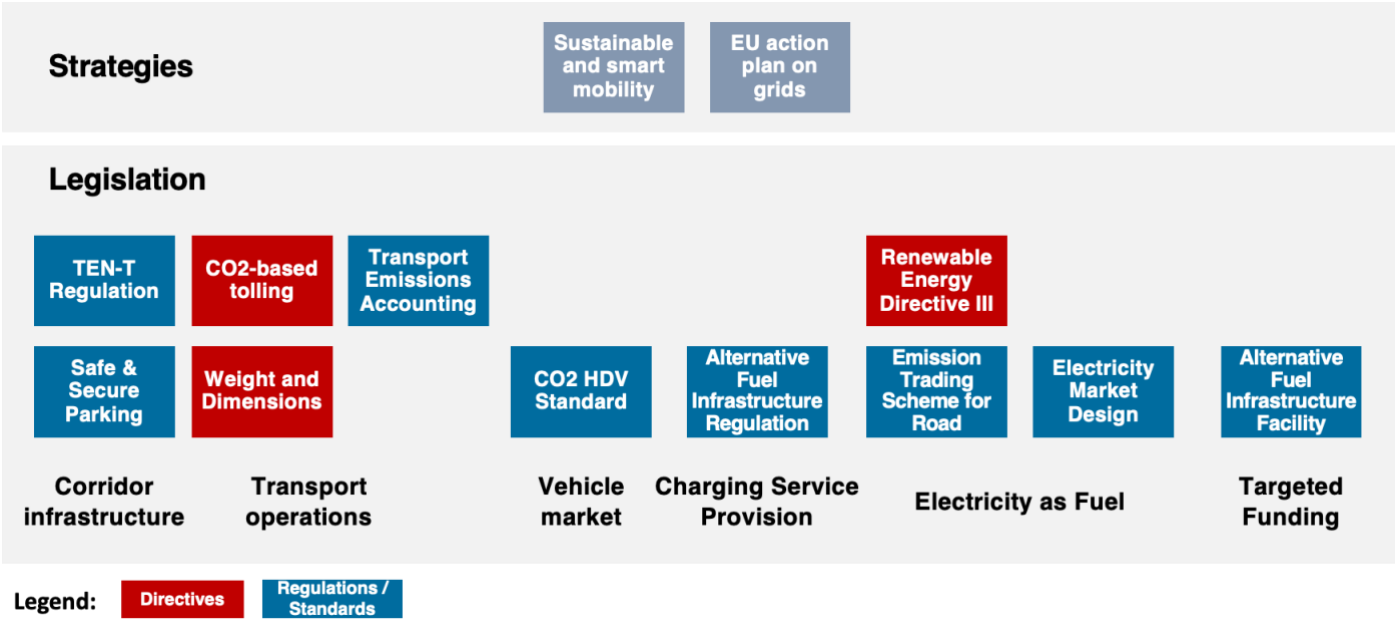


Figure 4: Overview of current road freight electrification policy landscape in EU (Source: Smart Freight Centre)

Renewable Energy Directive III **(RED III)** creates a system of tradable credits for renewable electricity used in public and depot charging stations providing an opportunity for CPOs and fleet operators to trade credits to offset the costs of charger installation (to some extent) and thereby reduce charging costs. However, implementation is uneven across Member States and impact can vary. Projections for major markets would be valuable as the benefits are currently difficult to quantify.

Emissions Trading System 2 **(EU ETS 2)** extends carbon pricing to road fuels, with costs expected to be passed directly to consumers. This will raise diesel prices progressively starting 2028, improving the competitiveness of e-trucks especially in long haul trucking. However, the exact price impact varies by Member State and depends on allowance market dynamics. Additionally, majority of member states are requesting changes to the framework that might have a negative impact on its contribution to closing the TCO gap.

Eurovignette Directive**,** a road pricing mechanism that mandates member states to shift from time-based charges to distance-based tolling, with rates adjusted based on CO_2 emission class (starting 25 March 2024) and air pollution levels (starting 25 March 2026). This can create a structural incentive for carriers to adopt ZETs because of higher toll rates levied on diesel trucks and reductions or exemption of tolls for ZETs until 2031 according to the directive. However, the implementation is uneven across members states with its full potential currently being underutilized.

The Smart Freight Centre analysis highlights that the existing EU policy landscape, specifically the combined impact of the RED III, the ETS 2, the Eurovignette Directive along with financial incentives provided by member states, has the potential to create significant incentive for carriers to transition to e-trucking. In major road freight markets like Poland, Germany, France and Netherlands these policies are projected to shift the TCO in favour of e-Trucks by 2028 as seen in Figure 5, making them a financially prudent choice for Shippers looking for ways to reduce their costs.

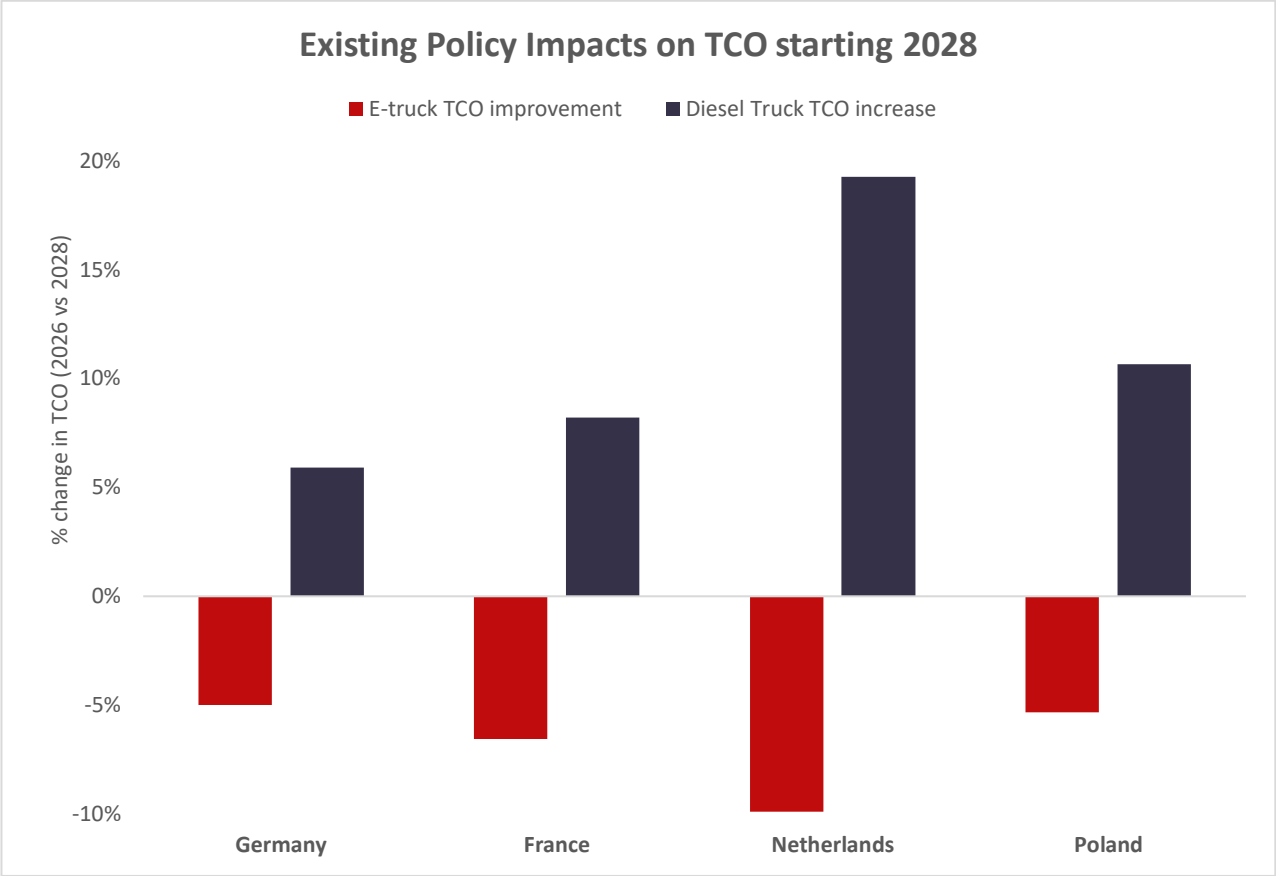


Figure 5: Impact of EU Regulatory Frameworks on the E-Truck Transition Across Member States (Source: Smart Freight Centre).

However, the inconsistent implementation of these directives across Member States is undermining their effectiveness and creating a fragmented market as seen in Figure 6. As of 2025, only Denmark and Czech Republic have implemented RED III, and only Germany fully utilize the potential of the Eurovignette Directive, offering full toll exemptions to ZETs thus creating a lack of operational incentives for fleet operators to transition to ZETs. Sweden, while offering ZET toll exemption, still applies time-based road toll charges which might not capture the full potential of Eurovignette. While the system of voluntary ZET toll exemptions has just been extended until 2031, implementation is left to discretion of Members States. Greece and Poland have failed to take any action yet on the transposition nor implementation of the Eurovignette Directive.
The Weights and Dimensions Directive, which allows higher payloads for ZETs and thereby improves operational efficiency reducing TCO and freight costs per tonne, have also faced resistance to implementation from some Member States.

In addition to the above measures, the EU's decision to postpone the ETS2 to 2028 significantly weakens the policy framework, delaying a crucial price signal that would have improved the economics of ZETs and slowing the transition at a time when stronger incentives are urgently needed to stimulate the ZET demand.

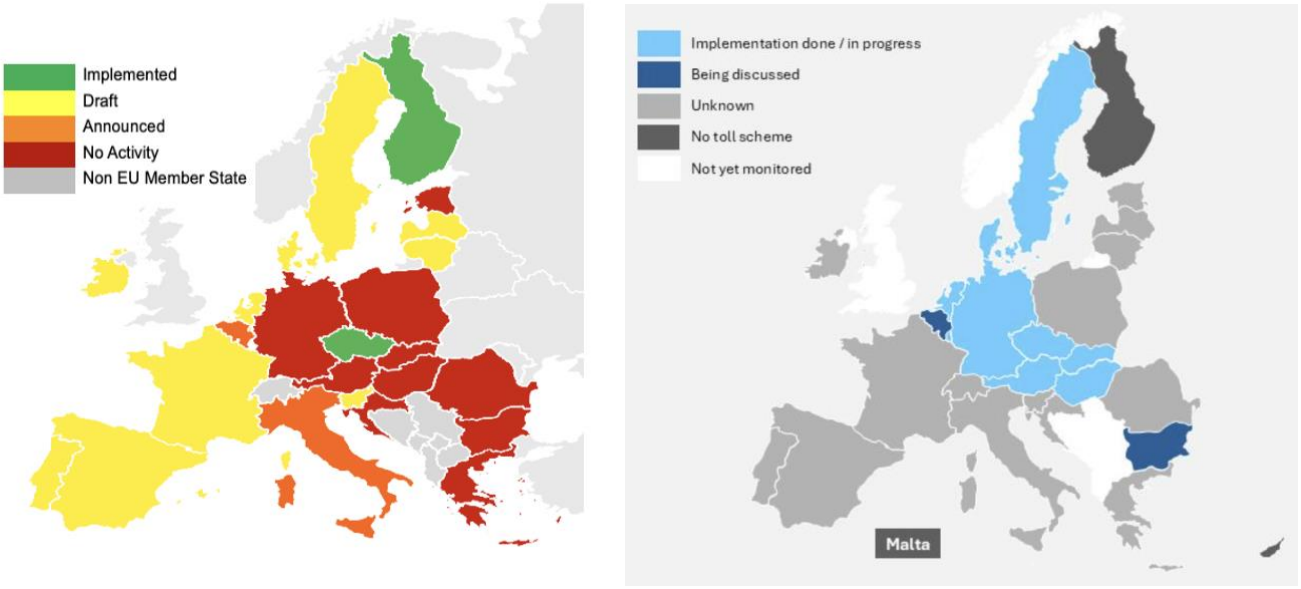


Figure 6: Status of RED III implementation (left) and eurovignette deployment (Right) (Source: eFuels Alliance & IRU)

Overall, the current regulatory landscape provides strong operational incentives but fails to stimulate demand of ZETs at scale that align with EU's truck CO_2 reduction targets. This is due to delayed transposition of directives, uneven enforcement, underutilized potential and the limited ability of carriers to absorb upfront costs before long-term benefits materialize, particularly in member states where financial incentives are lacking. The most urgent priority is the timely, consistent, and complete implementation of existing EU Directives and Regulations across all member states. The European Commission must strengthen enforcement under the infringement procedures and raise penalties for non-compliance.

Smart Freight Centre recommends a heightened focus on monitoring the real-world TCO impact of these policies across Member States. This data is crucial for validating policy effectiveness, guiding shipper and carrier investment decisions, and informing future policy adjustments. SFC and its partners are positioned to play a key role in this framework.

4. Charging infrastructure development regulations promise ZET uptake

In July 2023, the Commission adopted a package of legislative proposals “Fit for 55”, including the Alternative Fuels infrastructure Regulation (AFIR) which sets concrete targets to boost the number of publicly accessible electric recharging pools across core and comprehensive networks of TENT. The AFIR is projected to meet around 50% to 70% of the EU-27’s public charging needs by 2030 (as shown in figure 7), providing a strong foundation for the large-scale roll out of charging infrastructure for ZETs.

Complementing this, the Alternative Fuels Infrastructure Facility (AFIF), implemented under the Connecting Europe Facility (CEF), has allocated €422 million to a wide range of Charge Point Operators (CPOs) across Europe to deploy charging infrastructure, including around 2,400 HDV charging points along the TEN-T network in its first 2024–2025 funding round. In November 2025, second AFIF round added additional about €220 million for HDV charging, including about €50 million dedicated to megawatt charging (MCS), enabling over 2,500 additional HDV-capable chargers, at least 600 of which will be MCS. This reflects a strong private-sector commitment to accelerating infrastructure deployment. Together, AFIR’s binding targets and AFIF-supported CPO investments are driving the timely delivery of the minimum public charging infrastructure required to support the transition to alternative fuel vehicles across the EU.

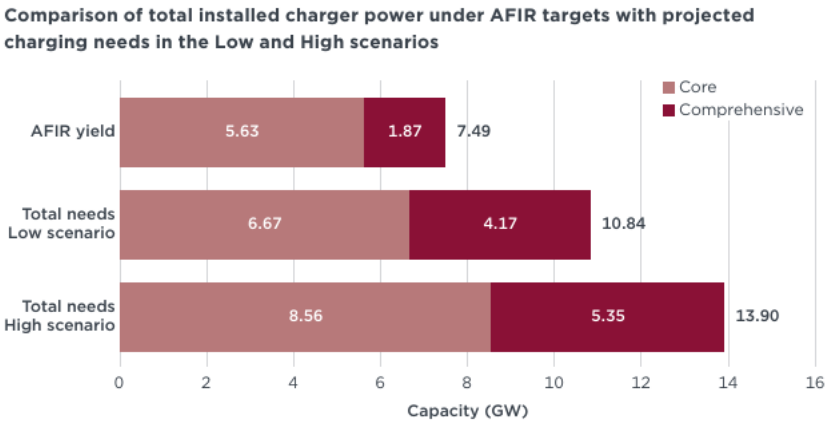


Figure 7: AFIR coverage compared to total public charging needs between the core and comprehensive road networks (Source: ICCT 2025)

However, AFIR distance-based targets do not precisely reflect actual traffic circulation profiles. This results in a significant gap between the AFIR targets and the actual charging needs for countries, that host a high share of trucking activity but a low share of the TEN-T network.

The implication is uneven coverage of charging infrastructure based on AFIR targets at member state level as shown in figure 8. Gaps between approximate targets and projected needs are primarily evident in countries with a high share of road freight traffic but a small share of the TEN-T road network, such as the Netherlands and Belgium. In half of the countries (including the Netherlands and Belgium), AFIR targets only cover 30 % to 50 % of modelled public charging needs. On the other hand, the AFIR target for Romania is twice as high as expected charging needs, due to the country’s large share of the road network and relatively low share of freight activity.

Thus, while AFIR provides an important baseline floor for charging rollout, it is **insufficient by itself to meet full demand in many member states** particularly in members states, that are expected to account for more than 70% of the total charging demand in EU 27 (Germany, Poland,

France, Spain, and Italy). Additional infrastructure (beyond the AFIR minima) will be needed to fill in the shortfall, particularly in freight-intensive countries with constrained TEN-T representation.

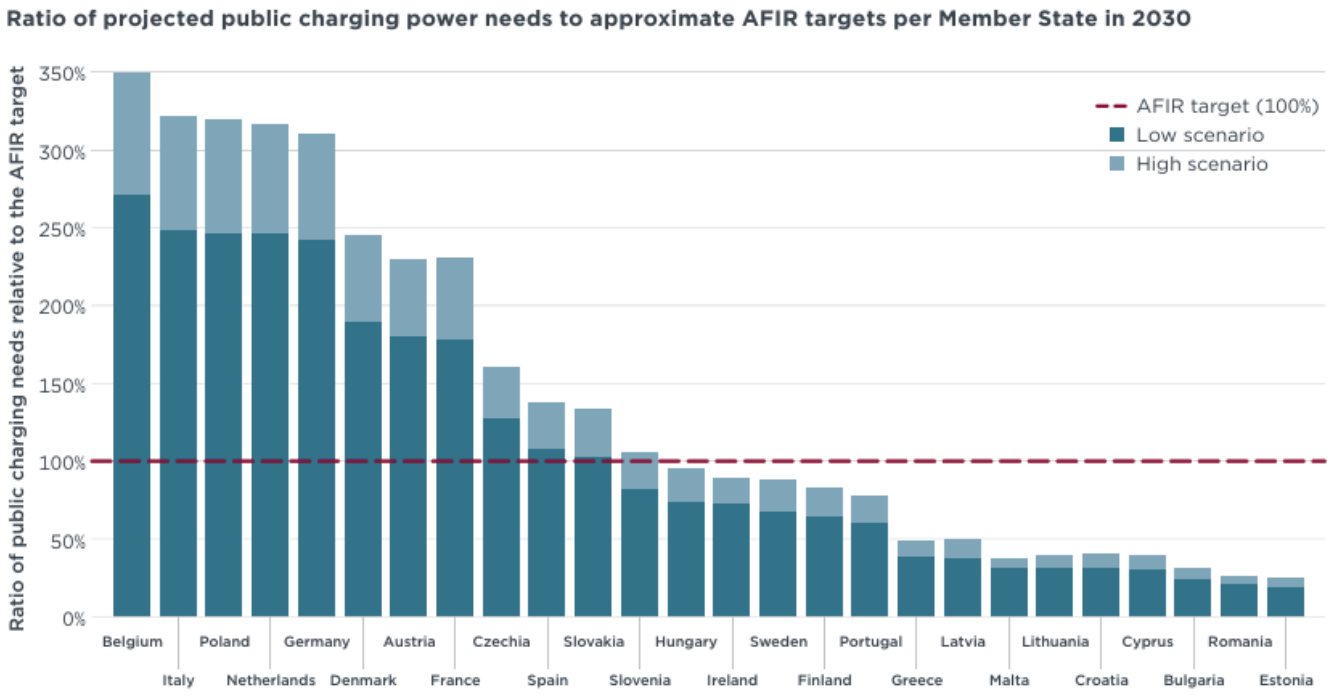


Figure 8: Projected public charging power needs vs. AFIR targets by EU member state in 2030 (Source: ICCT 2025)

Moreover, **the large-scale rollout of charging infrastructure poses significant challenges for local electricity grids**, particularly across high power charging sites on TEN-T corridors. In addition to potential grid congestion, lengthy permitting procedures and investment barriers may further delay timely infrastructure deployment. Many of these issues could be mitigated through the upcoming AFIR review and through complementary policies on grid planning, permitting, and investment coordination.

To further accelerate infrastructure deployment and address these implementation challenges, the European Commission launched the **Clean Transport Corridor Initiative** in September 2025. This initiative focuses on scaling up HDV charging infrastructure along two priority freight corridors, the Scandinavian–Mediterranean and North Sea–Baltic routes.

- The *North Sea–Baltic Corridor* connects Rotterdam through the Netherlands, Belgium, Germany, and Poland, extending toward the Baltic region and Ukraine.
- The *Scandinavian–Mediterranean Corridor* links northern Scandinavia through Germany and Austria to Italy.

The initiatives aim to address key challenges (e.g. slow permitting, grid constraints, fragmented funding) and sets roadmap development (by March 2026), fast-tracking of AFIF-funded projects, transparency of grid hosting capacity, and exploring battery storage / renewables integration in the identified corridors.

5. Demand-side measures

Fleet mandates may have a direct impact on stimulating the demand of ZETs, however, the experience in California has shown mixed signals. A key difference to be considered is that the Californian Advanced Clean Fleet (ACF) rule that was designed to create demand-side symmetry to the supply side Advanced Clean Truck (ACT) rule, applied to carrier fleets, whereas the EU Commission plans so far target large shippers.

The California Advanced Clean Fleets (ACF) rule signalled serious regulatory intent to decarbonize road freight, but its implementation has been plagued by serious legal and economic challenges. Several key aspects of the ACF rule (e.g. requirements for drayage and high-priority fleets) have been undercut by legal challenges, withdrawal of the federal waiver request under the Clean Air Act, and active repeal of parts of the regulation. For example, CARB withdrew its U.S. EPA waiver request in January 2025 and later agreed to settle with a coalition of 17 other states to repeal the requirements for drayage and high-priority fleets. This uncertainty has made fleet operators hesitant to invest and has delayed compliance.

California's experience with the ACF rule demonstrates that even well-intentioned and synchronized supply- and demand-side mandates can struggle with effective implementation without stable legal and regulatory foundations. Without enforceable deadlines, fleets hesitate to purchase heavy-duty ZETs, while manufacturers are reluctant to ramp up production, resulting in scarcity and sustained high prices.

For fleet operators, majority of whom are SMEs operating on narrow margins, mandatory procurement of ZETs without sufficient supporting ecosystem and infrastructure creates financial strain. This could lead to delayed fleet renewals, suboptimal investment decisions, and heightened exposure to operational and financial risks, ultimately increasing logistics costs and reducing competitiveness.

For shippers, applying fleet purchase/service procurement mandates for large freight buyers based on their fleet size require practical reporting considerations. Most shippers rely on third-party logistics providers, where fleet capacity fluctuates seasonally (e.g., during Christmas or other peak demand periods). This makes consistent mandate compliance highly complex. Moreover, the absence of a robust monitoring and reporting framework further limits enforceability, creating uncertainty for both shippers and operators.

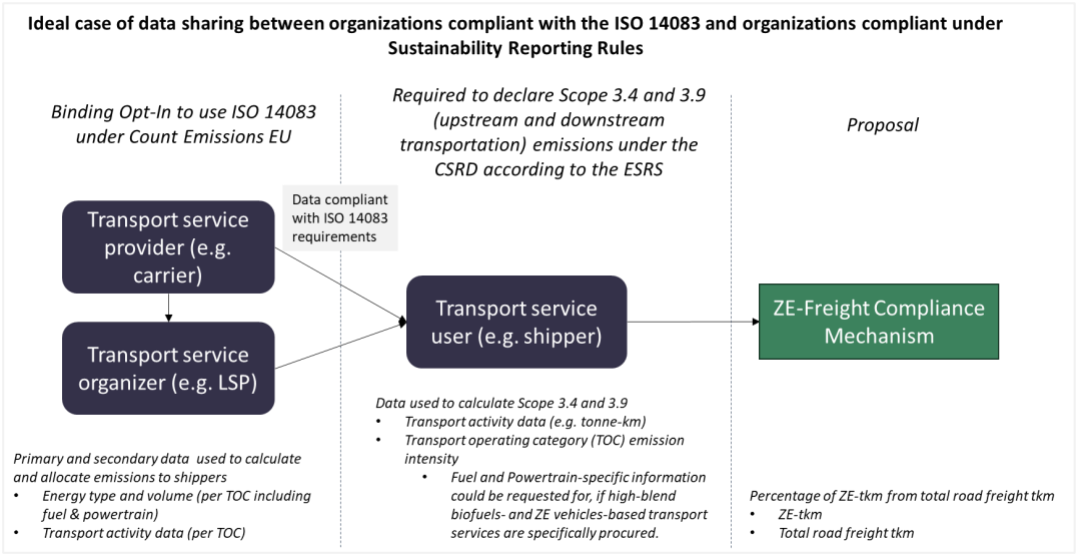


Figure 9: Conceptualized data sharing from fleet operators to shippers towards the proposed compliance mechanism (Source: Smart Freight Centre)

For the plan to use share of electric tkms by shippers executed by their subcontracted carriers, a thorough "Impact Assessment" needs to be conducted. The assessment obviously needs to consider the financial and operational implications on all stakeholders incl. the monitoring requirements. Advances in telematics can be leveraged to build ecosystem primary data platforms to substantiate compliance or non-compliance.

To monitor or enforce potential targets set for freight buyers, the following options could be considered:

- **Evaluation of due diligence or sustainability reports**: The implementation of the Corporate Sustainability Reporting Directive and the Corporate Sustainability Due Diligence Directive could provide a mechanism for monitoring the level of procurement of e-truck transport services by shippers of an adequate size. This level of information is not requested by current frameworks, such as the European Sustainability Reporting Standard (ESRS). Further, shippers are also not yet required to implement the ISO 14083 under the currently evaluated Count Emissions EU legislative proposal. In this case, amendments to the respective requirements could be made.
- **Annual (audited) road freight procurement reports**: Freight buyers are required to submit the percentage of procured services using electric vehicles annually. This must be verified by a third-party certified verification body. Adequate information to provide proof that transport was carried out using the electric vehicle should be provided. The percentage of procured services could be calculated using similar metrics used in the calculation of emissions according to the ISO 14083, such as the tonne-kilometre.
  For such framework to work, it will require shipment data to be qualified with the associated energy carrier, ZET vs non-ZET. This relies on a minimum level of carrier data to be communicated from the shipper to the carrier.

Moreover, any such framework must be aligned with existing policies and contingent upon the readiness of the enabling ecosystem, including infrastructure, grid capacity and vehicle availability.

6. Prioritizing targeted early cost-parity cases

Experience from China, India, and selected European countries, illustrates that targeted interventions, such as city-level zero-emission zones, industry or port cluster programs or national corridor programs, can catalyse rapid uptake. For Europe, this means focusing on specific use cases (e.g., municipal services, urban logistics, port operations) and corridors where electrification is most feasible, creating economies of scale and experience base for scaling across the broader network.

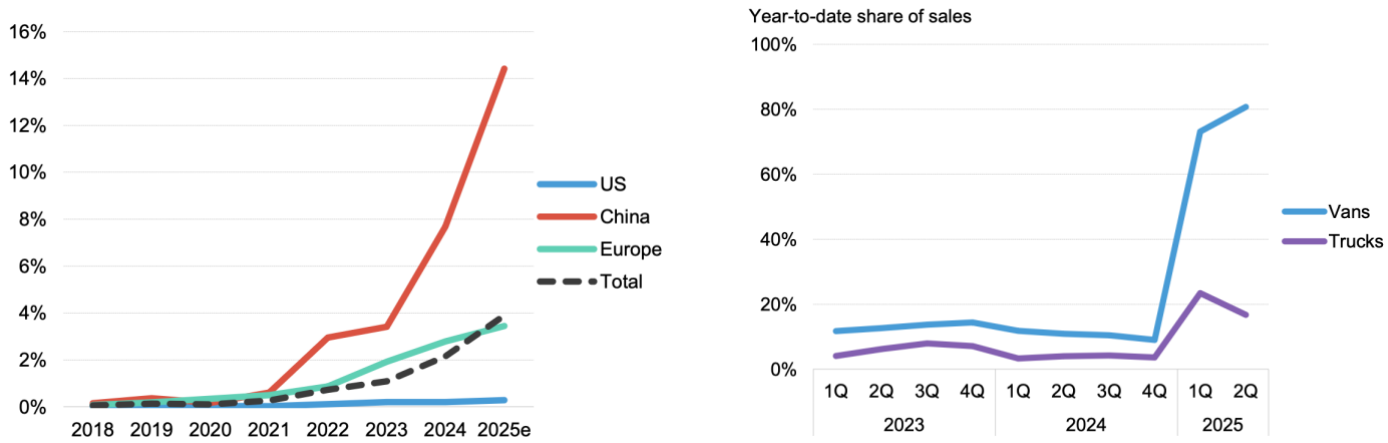


Figure 10: Examples of ZET steep adoption driven by policy support and early cost-parity cases (Source: BNEF)

China's ZET market is accelerating rapidly, with sales approaching 80,000 units in the first half of 2025 alone, surpassing the total for all of 2024 and more than doubling the figure for 2023. China clearly prioritized TCO parity use cases around predictable high density duty cycles such as found in port drayage, industrial clusters for chemical, steel, cement and automotive or high-volume retail networks. Early growth in priority use cases and geographies has been critically underpinned by continuous innovation in battery and vehicle technology, coupled with a significant expansion of truck-dedicated charging infrastructure.

Simultaneously, the Netherlands has emerged as a global leader in the electric van segment, where purchases surged to constitute over 80% of all new light commercial vehicle registrations in H1 2025. This adoption rate stands in sharp contrast to the European average of just 10%. A primary driver of this uptake has been the implementation of city-level zero-emission zones. Since the beginning of 2025, Dutch municipalities have held the authority to designate areas where vans and trucks with tailpipe emissions are prohibited. As of August 2025, 18 cities—including Amsterdam, The Hague, Rotterdam and Eindhoven—have already established these zones, with a further 11 in the planning phase.

Although a transitional period exempts certain Euro 5 and 6 vehicles until 2030, the operational lifetime of new vehicles typically exceeds this deadline, creating a powerful incentive for fleet owners to transition to zero-emission alternatives. It is important to mention that expiration of preferential taxation by the end of 2024 resulted in the total van market to almost triple in the 2024 (45.920 in H1 2024), while reducing by almost 80% in 2025 for the same period (9.636 units). While the solid growth year on year is promising, it is important to continue monitoring the impact of city-level zero-emission zones across major European cities.

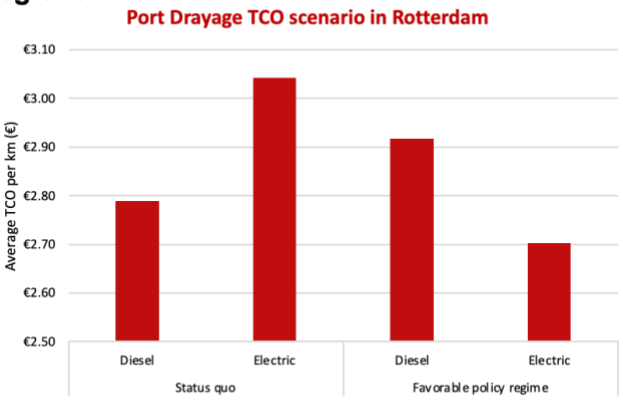
7 Use cases already favorable in India

Use Case	Truck Types	TCO Favorability	Minimum Monthly Running
E-commerce	14 Ton, 18.5 Ton	Positive	8000 km
Snacks	14 Ton, 18.5 Ton	Negative	5000 km
Food & Beverage	14 Ton, 18.5 Ton	Positive	8000 km
Cement	55 Ton	Positive	7500 km
LSP	18.5 Ton	Negative	3000 km
LSP	18.5 Ton	Positive	10000 km
LSP	55 Ton, Port to DC	Positive	7000 km
LSP	14 Ton	Positive	6500 km
Chemical & Pulp	55 Ton	Positive	10000 km

Other Parameters that impact TCO significantly

Terrain leading to Energy consumption	Loan Term and Interest Rate	Charging infrastructure availability	Battery Resale Value

Highly sensitive to policy regime in other Regions



15% TCO variation between with or without REDIII and Euro vignette implementation

Figure 11: Examples of ZET cost-parity use cases (Source: Smart Freight Centre)

Our analysis confirms that ZET uptake will not happen in a linear fashion but rather in S-curves once tipping points in TCO parity and infrastructure availability come close. Focusing resources on early cost-parity cases builds scale, expands visibility, and drives the market to a tipping point where market forces take over.

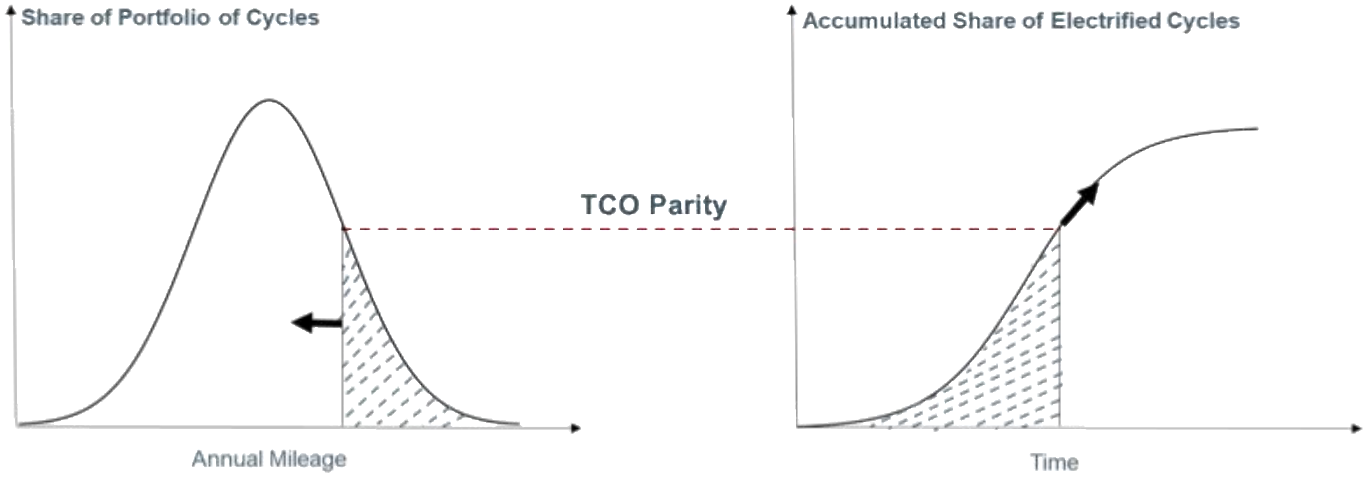


Figure 12: Examples of ZET cost-parity use cases (Source: Smart Freight Centre).

This experience suggests in line with many other sector transformations, that ramp up will not follow a linear trajectory but accelerate, once economic conditions are in place.

7. Options to stimulate ZET demand in Europe

SFC identified practical use cases that have the potential to close the gaps in the uptake of ZET that will help Europe achieve its 2030 climate goals under the truck CO_2 standards. Such framework is composed of key areas that require urgent policy action. Sudden increase in ZET demand can cause significant supply bottlenecks and, for this reason, solutions are required, that can bring results from 2026 onwards.

This section quantifies potential of each area and policy recommendations by SFC.

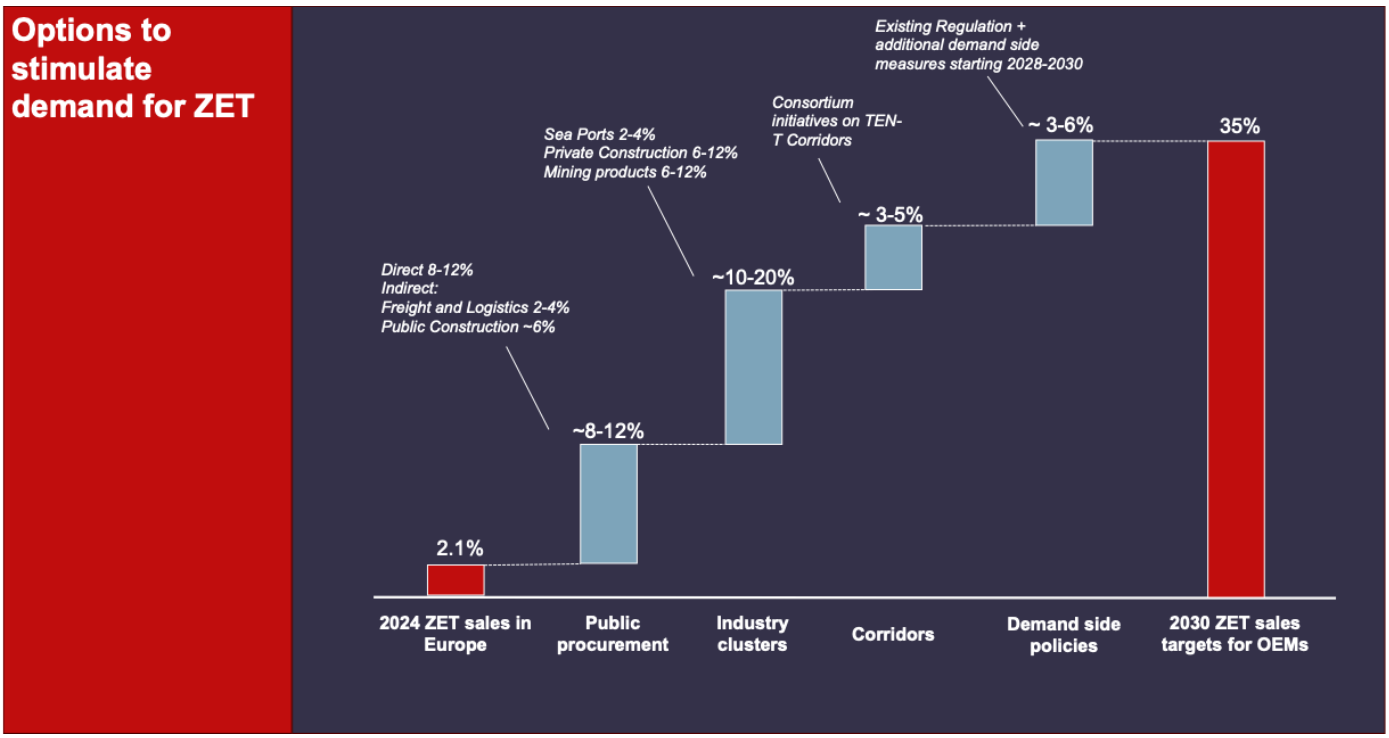


Figure 13: Estimated contribution to ZET sales share of each proposed solution (Source: Smart Freight Centre).

7.1 Direct public procurement

Total EU public procurement amounts to EUR 2.5 trillion, or about 14% of the EU27 GDP, making it a meaningful, albeit underutilized, lever to stimulate initial demand for zero-emission trucks (ZETs) and shape the early market. This section frames its overall potential. This chapter distinguishes between direct and indirect channels and identifies key enabling factors.

Direct public procurement is an influential segment of the HDV market, estimated at up to 10% of annual N2/N3 registrations in key countries like Germany. While this segment of direct public procurement may seem limited at first sight, it will help shape the market: public buyers can validate use cases, drive standardization, create visibility and demonstrate operational viability to the private sector as well as serve volumes, that can help reduce fixed and variable costs in the industry.

Direct purchase of vehicles is governed by the EU “Clean Vehicles Directive”. However, its impact is limited by low minimum targets for trucks and a definition of "clean" that includes non-ZE technologies like CNG and biofuels, creating misalignment with the CO_2 regulation. Demand is driven predominantly by local authorities (municipalities, city councils) for specific, well-suited use cases including garbage and refuse collection, fire engines, road maintenance, and street

sweeping. These applications are ideal for electrification due to predictable routes, depot-based charging, and the benefits of low-noise, zero-local-emission operations, and represent a relevant volume of up to **150 thousand vehicles across Europe over the next five years** (30 thousand per year on average) that are yet to be adequately addressed by public policy.

The Clean Vehicle Directive is central to ZET demand creation in public procurement but suffers from fundamental design effectiveness. Trucks qualify as “clean”, when powered by a range of alternative fuels — including natural gas and certain biofuels — even though these do not count towards compliance with the EU CO_2 standards. Moreover, the directive sets no explicit ZET target, unlike for buses or light-duty vehicles. Finally, targets for Member States range between 8% and 15%.

This misalignment weakens its effectiveness. Member States can meet procurement obligations without deploying ZETs, undermining both market certainty and the credibility of Member states’ decarbonization strategies. As a matter of fact, even though some Member States may overfulfill these targets, this does still not align with the EU CO_2 standards. This discrepancy undermines Europe’s ability to meet its climate targets and should be corrected as a matter of priority.

The "Clean Vehicle Directive" requires urgent revision to be more ambitious and technologically aligned with climate goals. This includes significantly increasing minimum procurement targets for trucks (i.e. 35% by 2030 in line with the EU truck CO_2 standards) and narrowing the definition of "clean" to exclusively zero-emission technologies (battery-electric and hydrogen fuel cell). Furthermore, implementation must be improved; the highly fragmented nature of public buyers (mostly local authorities) complicates engagement and requires clear guidance and support from national governments to ensure cohesive action and amplify demand signals across the market.

7.2 Indirect public procurement

Another large, untapped opportunity lies in indirect procurement—public tenders for products or services that require transport and logistics. While the "Clean Vehicle Directive" does not govern this scope, it involves a material segment of the current 6 million medium and heavy trucks within the EU. It leverages the public sector’s purchasing power beyond vehicle acquisition itself. By embedding ZET requirements or incentives into the award criteria for these service contracts, public authorities could stimulate a substantial portion of HDV demand and fleet transition that currently falls outside clean vehicle policies. In this section, we highlight the potential impact of public procurement in construction and general logistics associated with all other procurement.

The construction sector represents a material share of the HDV stock (estimated at 20-30%). About half of construction activity has a high share of demand driven by public spending - respectively 80-90% for civil engineering and 20-30% for non-residential building activity. This is also highlighted by analysis of European public procurement data, which shows that construction and engineering alone constitute close to 40% of public tender procedures across EU Member States. The 20-30% share of European HDV stock deployed in construction, combined with public sector contributing 25% of demand for construction activity overall, suggests that roughly 5-7% of total HDV stock could be impacted by indirect public procurement. Assuming an average remaining economic life of four years across the fleet, implies potential replacement of 60-90 thousand vehicles per year, or **300-450 thousand vehicles over a five-year period**.

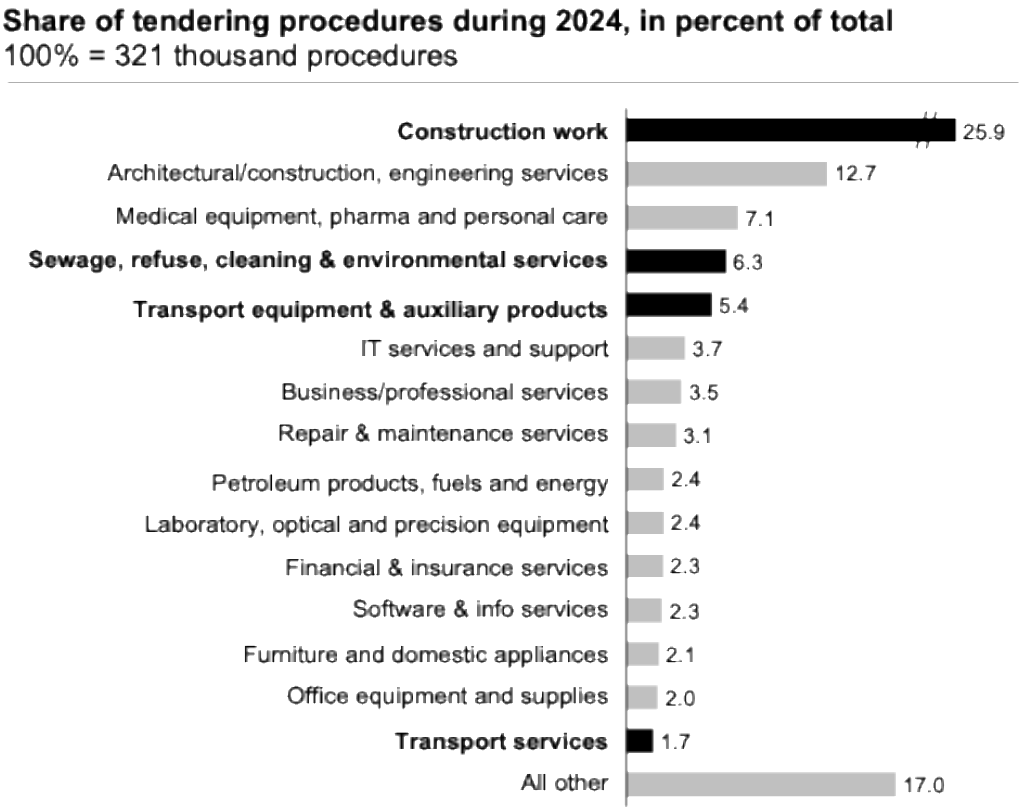


Figure 14: Share of transport equipment and services in public tender procedures (Source: Allchiefs analysis of EU Public Procurement Data Space)

The majority of HDV stock is deployed in general freight and logistics (50-70%). Public procurement spending beyond direct vehicle procurement and construction is close to 10% of total EU GDP, with a 55%-45% split between product procurement vs services procurement respectively. Even if general logistics related to public procurement could impact just 1-2% of HDV stock in logistics, this still represents a total of 30-60 thousand vehicles. Assuming an average remaining economic life of four years across the fleet, implies potential replacement of 7-15 thousand vehicles per year, or **35-60 thousand vehicles over a five-year period**.

Overall, the impact of the indirect procurement cases could amount of a volume of about 75-125 thousand vehicles per year, or **345-615 thousand over a five-year period**. This is potentially a factor four times higher than direct procurement, with public procurement in construction representing 70-80% of this potential.

To realize impact from indirect procurement, an (additional) enabling framework should set requirements for the use of clean vehicles for the suppliers of the products and services procured by public authorities. For example, these could be fleet (transition) requirements to be considered as supplier and/or as part of the contract awarding criteria. In indirect procurement cases, the public buyers do not influence full deployment of vehicles and suppliers will therefore be sensitive to demand from other buyers.

7.3 Industry clusters

Governments can also influence the use of HDV outside their own public procurement when they are shareholders of a business, as in the case of container ports, construction in the private sector or other industry clusters, such as, mining and steel sectors.

Top European container ports are typically publicly owned landlord ports, with container terminals usually privately run on concessions. The top 15 container ports in Europe have an estimated 50 thousand daily truck entries. A substantial share of those (60-70%) are assumed to be trips within electrification range. These ports could introduce measures to stimulate the use of ZET. This activity is estimated to represent 30-35 thousand vehicles. Assuming an average remaining economic life of four years across the fleet, implies potential replacement of 7-9 thousand vehicles per year, or **35-45 thousand vehicles over a 5-year period**.

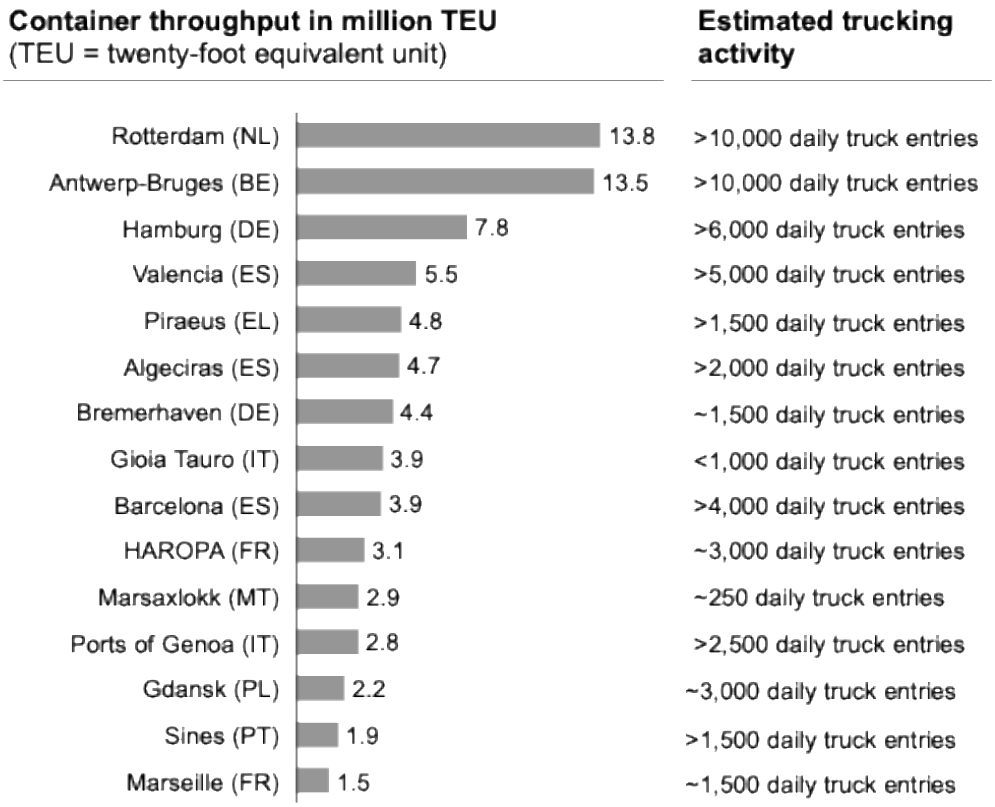


Figure 15: Top 15 European container seaports (Source: Allchiefs)

Similarly, to construction, heavy industry sectors such as mining and steel production, represent another significant lever for indirect demand creation. These industries are characterized by intensive logistics operations, from the movement of raw materials like ore and coal to the distribution of finished products such as chemicals and steel coils.

A substantial portion of the activity within these sectors is linked to public demand, either through public infrastructure projects requiring steel and concrete, or through government-backed industrial policy and ownership in strategic assets. By applying ZET criteria to the procurement of these materials or to the services supporting these industrial clusters, public authorities can drive the transition of a dedicated segment of the HDV fleet that operates within predictable, often shuttle-based, routes well-suited for early electrification.

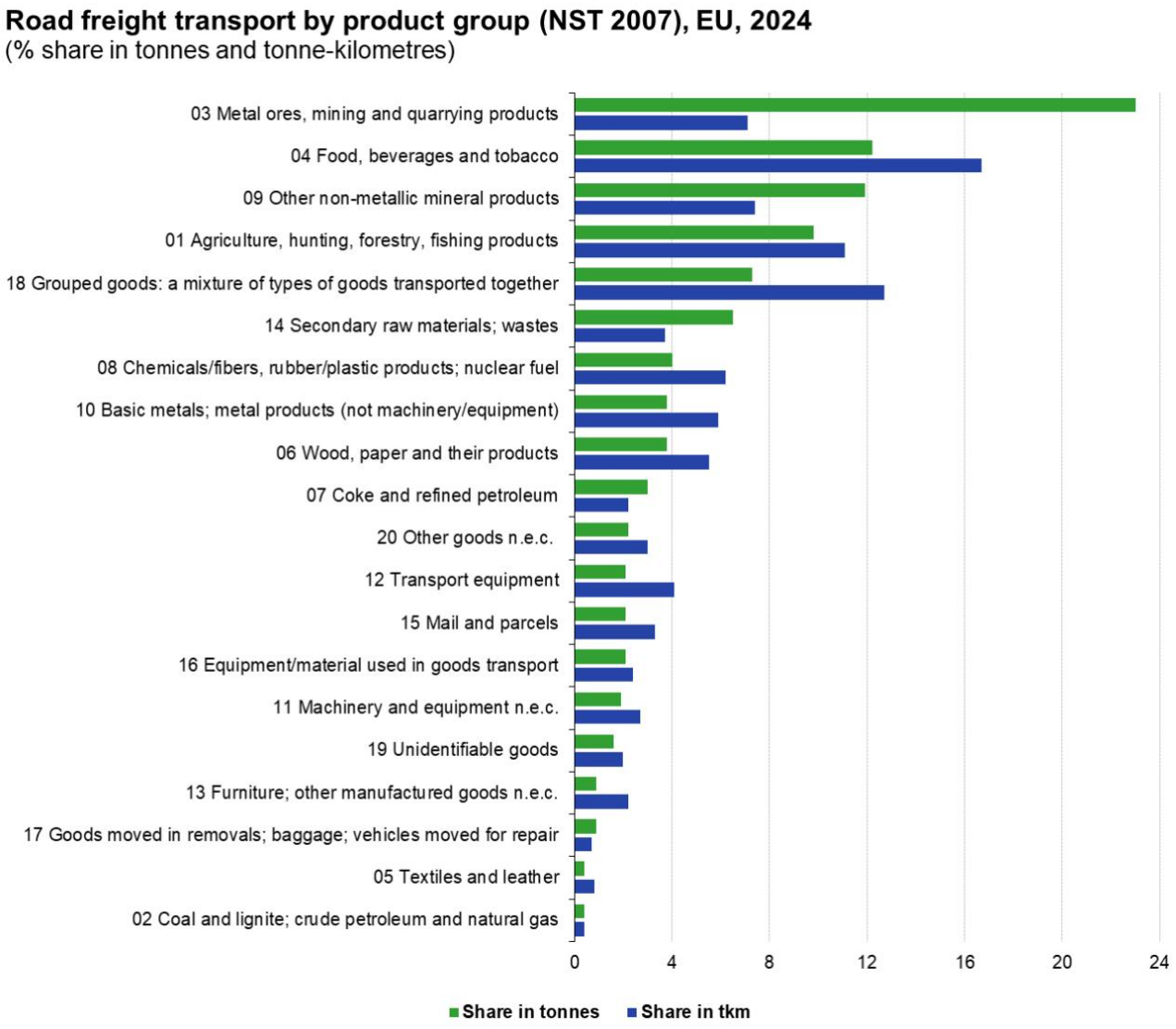


Figure 16: European road freight volumes by product group (Source: Eurostat)

As shown in figure 16, Metal ores, mining and quarrying products (i.e., NST code 3) represent a clear priority area with 23% of total tonnes transported in Europe. Additionally, the ratio tonnes to tonne-km, indicate that such products are transported over shorter distances which makes it a priority sector due to early-cost parity indicators. It is estimated to represent 5-10% of the HDV stock. Assuming an average remaining economic life of four years across the fleet, implies potential replacement of 60-120 thousand vehicles per year, or **300-600 thousand vehicles over a five-year period.**

SFC suggested focus on such sectors, including steel or other non-metallic mineral products, seaports and construction, would follow the Chinese market's approach to accelerate ZET adoption.

8. Conclusion and recommendation

The transition to zero-emission road freight is both urgent and achievable, but only if supply- and demand-side measures are aligned. It is essential to take urgent action to better align the rollout of the enabling conditions with the existing supply-side mandates for ZET. Strong supply-side regulations, such as the CO2 standards, provide an essential, stable framework that has enabled the European ZET market to achieve robust, over 50% year-on-year growth.

The immediate priority must be to strengthen the complementary ecosystem through monitoring and accelerated implementation. The current policy landscape is undermined by fragmented and delayed transposition and implementation of key directives and regulations like EU ETS 2, RED III and the Eurovignette Directive across Member States, creating an uneven playing field and failing to fully close the TCO gap. An **"observatory tower" approach** is recommended to rigorously track the real-world impact of these policies on TCO and to enforce timely, consistent implementation, ensuring that the projected operational incentives for carriers materialize effectively by 2028.

To catalyse the early market uplift necessary to meet 2030 targets, Europe should emulate the targeted, sector-driven success seen in markets like China. This involves strategically complementing the regulatory framework with powerful demand-side levers. Public procurement represents a massive, underutilized opportunity. **Revising the "Clean Vehicles Directive**" to mandate zero-emission technologies and leveraging both direct vehicle purchases and, more significantly, indirect procurement for services like construction and port logistics could address hundreds of thousands of vehicles over five years. This should be coupled with a **focused push for sectorial implementation**, starting with high-impact zones such as ports and urban construction, which offer predictable routes and depot-based charging. These targeted efforts can build scale, demonstrate viability, and create the reinforcing loops of demand needed to drive the market toward the tipping point where infrastructure utilization increases and costs fall, ultimately enabling a broader rollout along priority freight corridors.

Fleet mandates should be approached with caution, given their potential to create market distortions and significant new reporting requirements for SME carriers. **New mechanisms for monitoring and enforcement** are needed for both fleet operators and freight buyers, such as, annual fleet report or annual road freight procurement reports.

Smart Freight Centre may continue to contribute to ambitious HDV ramp up, jointly with industry and NGO partners: monitoring TCO, facilitating consultation, and supporting alignment across stakeholders. By doing so, Smart Freight Centre helps to ensure that demand-side measures are effective, equitable, and timely — ultimately enabling Europe to achieve its climate goals while strengthening the competitiveness and resilience of its road freight sector.