BACKGROUND REPORT:

Accelerating the transition in the trucks sector and its value chain

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EDF ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

IIGCC
The Institutional Investors Group on Climate Change

About this report

IIGCC and EDF have worked together to produce a report exploring the corporate, investor and value chain interventions that could accelerate the transition in the trucks sector. The report also provides a preliminary engagement guide with key questions to facilitate dialogue between investors and companies in the trucks value chain. Finally, it provides an assessment of recent market trends, progress in the decarbonisation process, the financing mechanisms to accelerate this process, the barriers to decarbonisation and a preliminary list of solutions that could help overcome those barriers.

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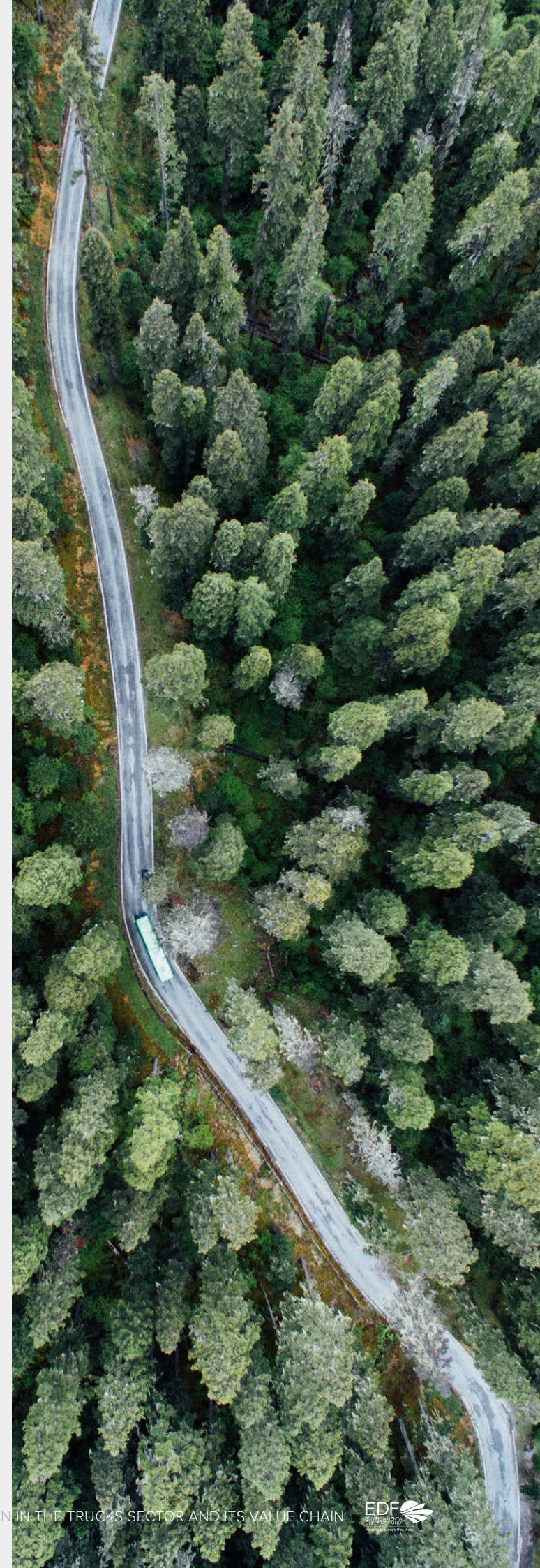
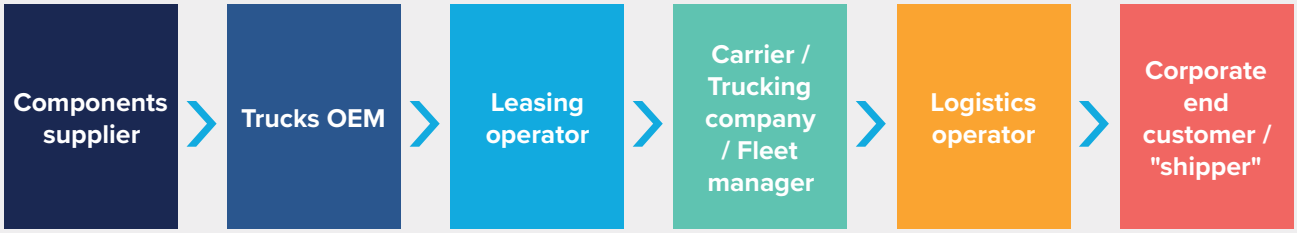


Glossary

BEV:	Battery Electric Vehicle
Capex:	Capital Expenditures
CO_2:	Carbon Dioxide
FCEV:	(Hydrogen) Fuel Cell Electric Vehicle
ICE:	Internal combustion engine
NOx:	Nitrogen Oxides
OEM:	(Original equipment manufacturer): it can refer to the automotive manufacturers and their component suppliers. It the context of this report it relates to truck manufacturers.
Opex:	Operational Expenditures
TKM:	Ton-kilometre
Trucks:	In the context of this report trucks refer to Medium- and Heavy-Duty Vehicles (MHDV) for the transport of freight. This excludes buses and other passenger transport.
VKM:	Vehicle kilometers travelled
ZE Truck:	Trucks with a zero emissions powertrain like battery electric (BEV) or fuel cell electric (FCEV) vehicles.
ZE:	Zero Emissions. In the context of this report this term relates to zero emission vehicles.

Figure 1: Trucks corporate* value chain



Adapted from Strategy&

Components supplier	Company manufacturing the components that truck companies use in their vehicles.
Trucks original equipment manufacturer (OEM)	Company manufacturing the trucks.
Leasing operator	Companies purchasing, procuring, and servicing trucks to customers like carriers or trucking companies.
Carrier or trucking company or fleet manager	Company that provides transportation services, typically owning, leasing and operating transportation equipment. These companies effectively transport goods from corporate end user contracting their services.
Logistics operator	Company that provides integrated operations of warehousing, distribution, storage and transportation services that can be scaled and customized to corporate end users' needs.
Corporate end user or shipper	Company that uses contracted shipping services from carriers, trucking companies and logistic operators to transport their goods to customers.

Note*: excludes final retail customer.

Executive Summary

Achieving net zero emissions by 2050 and supporting equitable global health requires immediate climate action from the transportation sector, particularly from medium- and heavy-duty trucks. Reaching the global temperature target of 1.5°C will require a cut of approximately 90% in the emissions produced by medium- and heavy-duty trucks.[1, 2] Emissions from trucks, trailers, buses and commercial vans (categorised as Class 2 to Class 8 vehicles) account for roughly 30% of global transport emissions,[3] which themselves represent about 20% of global CO_2 emissions.[4]

Every year, hundreds of thousands of people around the world die prematurely from transportation-related air pollution, and four million children suffer from new cases of asthma. With demand for road transport expected to rise faster than demand for other carbon-intensive sectors,[5] investors, companies, and policymakers need to take urgent action to accelerate zero emissions (ZE) trucking.

Although truck original equipment manufacturers (OEMs), carriers and corporate end users have begun to establish zero emissions targets, and emerging technologies and public policies have made clean transport more viable, barriers to ZE trucking remain. How truck OEMs, investors and companies in the value chain respond to these barriers will have decades-long consequences, as today's trucks can be expected to be on the road for many years, especially in developing countries.[6]

A few recent insights are especially helpful to guide investor engagements with different stakeholders:

- **ZE truck sales targets and ZE truck usage targets** can help track company progress and distinguish leaders from laggards in the industry. Science-based ZE truck goals over different time periods, targeted at manufacture, purchase, and use of trucks by corporate end users can enable comparisons by year of ambition and duty cycles (i.e. how much a vehicle is used – hours, miles, shifts per day).[7]
- As national and subnational governments ramp up public policies to incentivise clean transport, investors and portfolio companies have an urgent opportunity to **influence the design of public policy incentives** for ZE truck adoption. A Total Cost of Electrification (TCE) approach can incentivise the best use of public funds.[8] TCE is a framework for using public funds creatively to address the mix of costs, risks and frictions facing particular fleets. By being strategic with limited funds, the public sector can increase the flow of private investment into this sector. In addition, investors' support for performance standards globally, is also critical to ensuring both demand and supply of ZE trucks.
- **Corporate end customers** or companies with contracted shipping have a powerful role to play in **driving ZE truck adoption.** E-commerce and retail companies have more significant emissions from shipping than previously understood.[9] They also have new financial tools to drive ZE truck adoption in their supply chain, inspired by power purchase agreements for renewable energy projects.[10] Corporate shippers can and should be expected to take responsibility for the impact of supply chain shipping.

Recommended actions for companies in the trucking value chain

Based on our research, we propose a list of actions for different stakeholders that will help to accelerate the net zero transition in the trucks sector, helping investors and other stakeholders to understand companies' strategy and progress towards targets. This provides investors with a preliminary guide for engaging with the trucking value chain.

Actions for truck OEMs

1. **Commit to transition to 100% ZE truck sales, set time-bound incremental sales targets, and disclose progress annually.** Incremental sales targets are crucial to promoting accountability and ensuring that investors can track progress towards 100% ZE truck sales goals.
2. **Ensure reporting frameworks attribute 'in-use' or Scope 3 emissions back to your company.** Air pollution from diesel trucking concentrates heavily in low-income communities. Attributing in-use emissions back to truck OEMs can foster more robust transparency on the public health impacts of trucking along the value chain and allow for appropriate interventions by policymakers and truck OEMs.
3. **Disclose share of capital expenditures (capex) allocated to ZE trucks and the incremental R&D spending on a path to 100% ZE sales.** ZE truck sales goals are meaningless without subsequent action and aligned capex. Truck manufacturers should increase R&D spending on ZE trucks to guarantee that they seize opportunities presented by the transition to a low-carbon economy.
4. **Support supply-side policies as well as demand-side policies.** Performance standards and government mandates on EV sales will build investor support for manufacturing of ZE trucks, helping manufacturers meet their net zero goals through supportive engagements and transition finance.

Actions for carriers and fleet owners

1. **Commit to 100% ZE truck usage and 100% ZE truck purchase and leasing, set incremental targets, and disclose progress.** Incremental usage targets are crucial to promoting accountability and ensuring that investors can track progress towards 100% ZE truck adoption.
2. **Commit to deploying ZE trucks first in low-income communities. Ask for help from local authorities to understand demographics, concentration of emissions and health burdens in local communities.** Prioritising low-income communities can help alleviate inequalities presented by diesel trucking as part of companies' CSR (corporate social responsibility) and just transition planning.
3. **Disclose share of capex allocated to ZE truck purchase and share of operational expenditure (opex) to ZE truck vehicle kilometres (VKM) travelled.** Capex and opex data can help investors discern the legitimacy of fleet owners' ZE truck purchase and usage commitments.
4. **Release annual report disclosing direct and indirect lobbying, and demonstrating that activities are aligned with Paris goals.** Transparent lobbying disclosure will help investors to track corporate progress to net zero. Policy advocacy is the strongest tool companies have to drive emissions reduction. As such, unequivocal public support from corporates on performance standards and EV mandates is paramount.

Actions for end corporate customers or "shippers"

1. **Commit to 100% ZE shipping operations.** Companies with integrated shipping operations (i.e. companies shipping goods that own the trucks) committing to 100% ZE transport send a critical demand signal to truck OEMs to raise ambition on ZE truck manufacturing. Companies with integrated shipping operations should engage with truck OEMs directly to seek alignment with their emissions reduction goals.
2. **Commit to shipping with carriers and logistics operators that have committed to 100% ZE truck fleet.** If companies outsource shipping to carriers and logistics operators, this type of ZE truck usage commitment can constitute a major demand signal to the wider trucking value chain encouraging these actors to purchase ZE trucks.
3. **Disclose Scope 3 emissions at facility-related level and set a Scope 3 emissions reduction plan that includes all contracted transport services (e.g. carriers, logistic operators).** Measuring facility-related emissions will help shippers understand the health impacts of their trucking on low-income communities as part of companies' CSR (corporate social responsibility) and just transition planning. A Scope 3 emissions reduction plan covering all contracted transport services will help shippers prioritise action on the most material transport emissions.
4. **Participate in debt financing instruments to accelerate ZE truck deployment by carriers and logistic operators.** Corporate end users could build on EDF's 'Zero emissions delivery zone' model,[11] inspired by 'Virtual Power Purchase Agreements'[i] in the renewable energy space. This model is a financial and contractual framework to accelerate the use of ZE vehicles by carriers through corporate end user sponsored payment plans and utilisation guarantees.
5. **Release annual report disclosing direct and indirect lobbying, and demonstrating that activities are aligned with Paris goals.** Transparent lobbying disclosure will help investors to track corporate progress to net zero. Policy advocacy is the strongest tool companies have to drive emissions reduction. As such, unequivocal public support from corporates on performance standards and EV mandates is paramount.

i Virtual Power Purchase Agreement: is a contract structure in which a power buyer agrees to purchase a project's renewable energy for a pre-agreed price enabling the construction of the project through stable demand.

Actions for investors

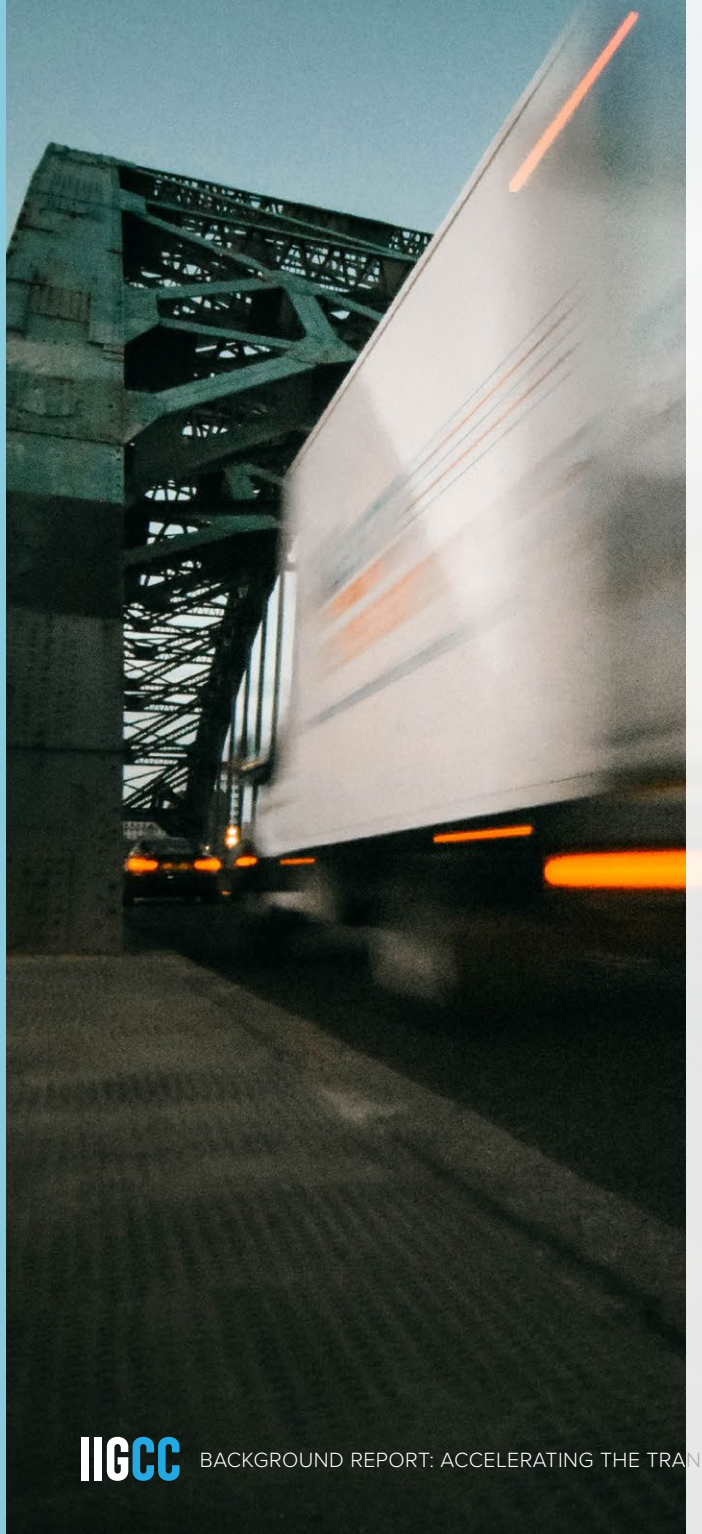
To help encourage the actions expected from truck OEMs and the wider value chain, investors should be actively working on integrating zero emission expectations into both their investment management and stewardship programmes. The following recommendations cover some of the most pertinent actions investors should take to underpin the NZ transition:

1. **Advocate for science-based ZE sales targets from truck OEMs.** Investors should ask manufacturers to commit to goals of 100% ZE truck sales by 2050 globally – and by 2040 in advanced economies – with interim sales milestones as established by the IEA NZE scenario (30% electric[ii] truck sales by 2030 and 50% by 2035).
2. **Seek public commitments to use 100% ZE trucking shipments from portfolio companies that depend on transportation and logistics services.** This will provide a demand signal for truck OEMs to confidently undertake transformational changes in their capex and supply chains.
3. **Engage with carriers, trucking companies and logistics operators to encourage adoption of clear science-based emissions reduction targets and comprehensive transition plans.**
4. **Create investment vehicles for debt financing that can accelerate ZE trucking.** Investors could build on EDF's 'Zero emissions delivery zone' model[12] to fund ZE vehicle purchases by carriers and corporate end customers.
5. **Collaborate with disclosure standards bodies and ESG data providers to improve Scope 1 and 3 transport emissions disclosure from truck users (e.g. carriers, logistics operators, corporate end customers).** These efforts would help address the major gaps in transport-related emissions disclosure from corporate end users and truck-dependent companies. Investors could begin by encouraging the Sustainability Accounting Standards Board (SASB), which is being integrated into a new International Sustainability Standards Board (ISSB), and other sustainability accounting frameworks to update their reporting requirements for sectors with major fleets, such as e-commerce.
6. **Support policy opportunities to catalyse ZE truck deployment, including performance standards and ZE sales mandates.** These efforts would help investors ensure that portfolio companies meet their net zero targets, helping investors achieve net zero financed emissions.

ii Electric trucks in the IEA NZE scenario refers to a combination of hybrid, plug-in hybrid and fully electric trucks.

Key engagement questions

To track progress on the above recommended actions, investors can rely on the following questions during their engagements with companies in the trucks value chain:



Key questions for truck OEMs

- **Goal:** Do you have a target date for reaching 100% ZE truck sales? What is it? Do you have interim targets (e.g. 2025, 2030) for the ZE share of your sales? What are they and why?
- **Just transition:** Do you assess in-use emissions of nitrogen oxides (NOx) and particulate matter?
- **Deployment:** What share of your capex is allocated towards ZE truck R&D, production, sales, and service? What percentage of your truck sales mix (value and volume) is currently ZE?
- **Policy:** Do you disclose your direct and indirect lobbying expenditures for and against supply side and demand side policies and performance standards? Is your lobbying and political spending aligned with a 1.5°C scenario?

Key questions for carriers and fleet owners

- **Goal:** Do you have a target date for reaching a 100% ZE truck fleet? What is it? Do you have interim targets (e.g. 2025, 2030) for the ZE share of your fleet? What are they and why?
- **Just transition:** Do you track the share of your facilities and other operations located in low-income communities? Of those facilities, what is the share of ZE fleet or capacity and what are your targets going forward?
- **Deployment:** What percentage of your truck fleet usage and capacity (TKM: ton-kilometre and VKM: Vehicle kilometres travelled) are currently ZE? What percentage of your purchases are ZE? Are you actively engaging with investors and corporate end users on ZE trucking and possible financing mechanisms?
- **Policy:** Do you disclose your direct and indirect lobbying expenditures? Is your lobbying and political spending aligned with a 1.5°C scenario?

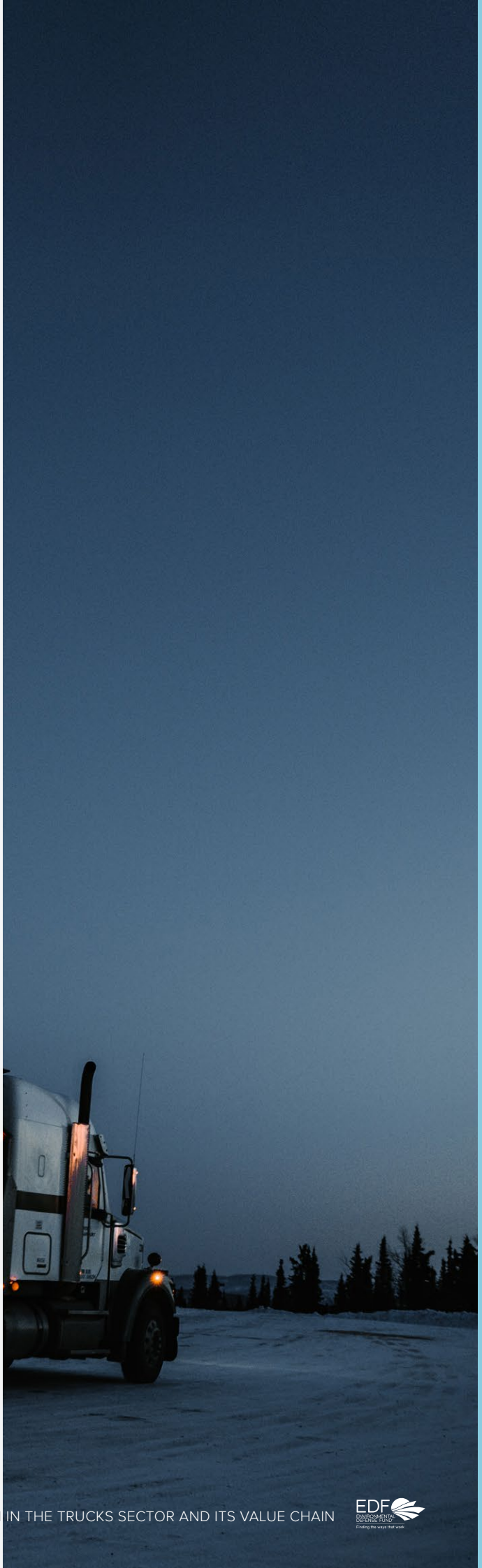
Key questions for corporate end users or shippers

- **Goal:** Do you have a target date for fully decarbonising your truck-related transport? What is it and why? Do you have interim targets (e.g. 2025, 2030) for the ZE share of your contracted shipping? What are they?
- **Just transition:** Do you engage with your carriers on emissions in low-income communities? Have you assessed and made a plan to reduce facility-related emissions you control, such as warehouses and other logistic operations?
- **Deployment:** How do you work with your transport providers (e.g. carriers, logistic operators) to monitor their ZE share and targets? What share of your truck transport volumes (TKM) are currently transported via ZE vehicles? Are you engaging with your carriers in financing mechanisms to accelerate ZE truck deployment?
- **Policy:** Do you disclose your direct and indirect lobbying expenditures? Is your lobbying and political spending aligned with a 1.5°C scenario?

Investors can also ask the following questions internally to determine whether they are appropriately managing the risks and opportunities associated with the ZE transition.

Key questions for investors

- **Goal:** Are you engaging directly with truck OEMs, carriers, fleet owners/operators, and corporate end users on the ZE transition? Which companies have you engaged? Have you committed to an end date for facilitating new fossil fuel truck purchases? What is it?
- **Deployment:** Are you developing creative financing solutions to aid the transportation transition?
- **Enabling conditions:** Are you working to improve truck-related emissions disclosures? How?
- **Policy:** Are you supporting ZE transport policy? Is your lobbying and political spending aligned with a 1.5°C climate scenario?



1 The case for action on trucking

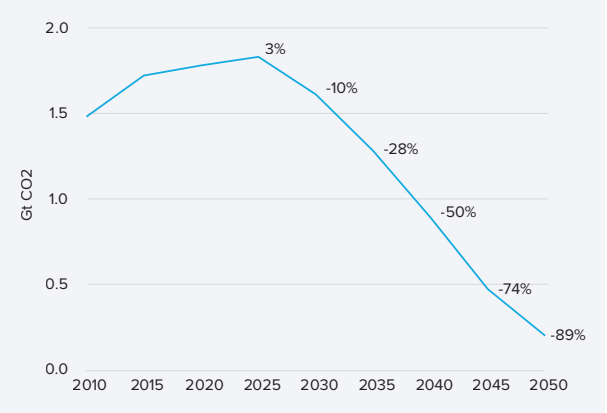
1.1 Trucks emissions: more than aviation, shipping and rail emissions combined

The path to a net zero economy depends on transportation. Transportation accounts for approximately 20% of global CO_2 emissions.[13] Approximately 30% of these global transport emissions come from medium- and heavy-duty vehicles (MHDVs), more than aviation, shipping, and rail combined.[14] Reaching a 1.5°C temperature target will require cutting around 90% of the emissions produced by medium- and heavy-duty trucks by 2050.[15, 16] The emissions pathway or trajectory and interim milestones between now and 2050 is also crucial. This pathway requires 10% emissions reductions by 2030 and 50% by 2040.

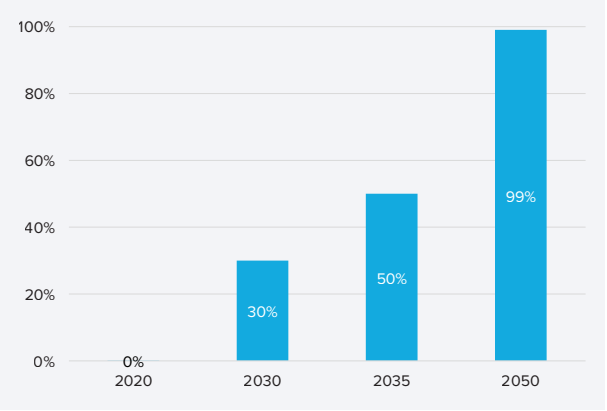
This pathway can only be achieved through increasing sales of ZE trucks while progressively retiring the existing internal combustion fleet. In many markets, including the United States and the EU, a target date of 2040 for 100% zero emissions medium and heavy duty truck sales is both necessary and feasible. According to the IEA NZE report, a global emissions reduction pathway consistent with 1.5°C scenario requires 30% of low emissions truck sales by 2030 (e.g. battery electric, plug-in hybrid and fuel cell trucks), 50% by 2035 and 99% by 2050. With demand for road transport expected to rise faster than demand for other carbon-intensive sectors, policymakers, investors, and companies need to take urgent action to accelerate sales of ZE trucks.[17]

Figure 2: Emissions and sales targets based on IEA NZE scenario

Emissions pathway for heavy trucks (% change vs. 2020)



Heavy trucks low-emissions sales targets (% over total sales)



Source: IEA, NZE 2050 scenario.

1.3 The case for investor action

Failure to embrace ZE trucking could present financial institutions with significant financial and ESG risks. Companies that continue to sell or own diesel trucks increase the financed emissions footprint of investment and lending portfolios, preventing asset managers and banks from reaching their net zero emissions targets. These emissions expose investors to heightened transition risks and limit their ability to meet growing client demand for climate-aligned products. Companies that fail to transition to electrification also face increased demand, regulatory and reputational risks, undermining their future profitability and viability. Financial institutions can combat these risks through corporate engagement and financing mechanisms tailored to ZE trucking.

1.4 The case for corporate action

Truck transportation exists in most value chains, regardless of region or economic sector. As such, reducing emissions from trucking will be key to reducing the Scope 3 emissions of most companies. As national and subnational governments introduce increasingly rigorous emissions standards, companies that embrace ZE trucking and shipping will have an advantage. Laggards, not only truck manufacturers but also truck owners and companies with contracted shipping, may face regulatory pressure, financial risks (e.g. fines, stranded assets) and pushback from climate-conscious clients, consumers and investors. Reducing risks associated with diesel trucking and seizing new business opportunities will require a value chain-wide effort to catalyse ZE transport.

1.5 The case for policymaker action: public health and healthcare costs

Transitioning to ZE trucks will also benefit human health and taxpayers' pockets given the impact of trucking on air pollution. Globally, air pollution is estimated to be responsible for up to 33 million asthma-related emergencies and 4 million new cases of childhood asthma.[18, 19] The impact of heavy road transport on air pollution has an outsized role. Although delivery trucks and heavy-duty trucks comprise only 4% of vehicles on the road in the US,[20] they produce nearly half of all NOx emissions and 60% of fine particulates from vehicles. Proportions are similar in Europe.[21]

This translates into significant healthcare costs. In Europe alone, the cost of the health impact of heavy-duty trucks' air pollution is estimated at €43-46 billion per year, around half of the €100 billion cost of air pollution from all road transport in Europe.[22] Immediate progress on ZE trucking can advance both progress towards countries' NDCs (National Determined Contributions), and public health improvements while lowering the healthcare costs for citizens and taxpayers worldwide.

2 Status of decarbonisation in the trucks sector

2.1 Trucks industry background

According to OICA[iii] data, the trucks industry sells around 20 million vehicles per year, of which 4 million are heavy-duty trucks. Production is concentrated to a few companies which are also involved in light vehicles manufacturing. European, North American and Japanese OEMs have historically dominated the global trucks market. However, exponential trucking demand in China over the last two decades and a fragmented and cost-competitive market has led to several domestic OEMs dominating the Chinese market.

2.2 Demand for ZE trucks

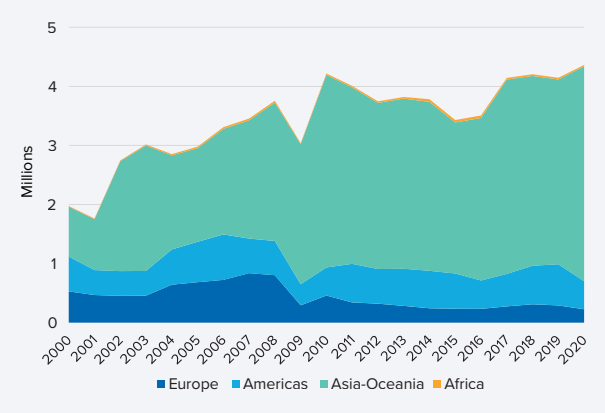
Recent supply and demand trends in the global trucks market highlight the investment potential of the ZE truck transition. Currently, ZE trucks comprise a small percentage of the total trucks market. Less than 0.2% of new medium- and heavy-duty commercial vehicle sales were electric or fuel-cell in 2020.[23] This compares to 5.6% of passenger vehicles sales and an outstanding 37.9% of buses, mostly driven by the Chinese market.

Vehicle category	2020 Penetration rate* of low and zero emissions vehicles over global sales (%)
Passenger	5.6%
Bus	37.9%
Light Commercial Vehicles/Vans	0.6%
Heavy-duty Trucks	0.2%

*Penetration rate refers to the number of zero and low emissions vehicles (BEV, PHEV, FCEV) sold over total sales including ICE (Internal Combustion Engine) vehicles.

Source: OICA, IEA, penetration rate estimates

Figure 3: ICE Heavy-duty truck production by world region



Source: OICA

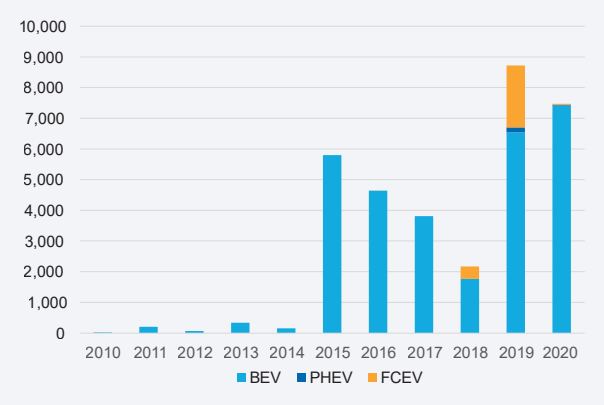
Demand for ZE heavy-duty trucks is increasing. According to the IEA, around 7,400 ZE heavy-duty trucks were sold globally in 2020, of which 6,700 were sold in China. As a result, the global ZE heavy-duty trucks fleet is also increasing. Approximately 33,000 ZE heavy-duty trucks were on the road globally in 2020.[24] Of these, 90% were fully electric (BEV) and 9% hydrogen fuel-cell powered (FCEV), with only 1% plug-in hybrid (PHEV), reflecting the cost advantages of fully decarbonised vehicles.

Experts expect demand to continue to increase due to e-commerce demand, increasingly stringent emissions policies, global trade, and urbanisation.[25] Also, the improving economics of ZE truck usage could accelerate the transition of trucking in certain use cases. For example, in urban driving conditions, battery electric trucks of any size were already the cheapest option for several use cases in 2020.[26] However, a cohesive plan by truck OEMs, corporate end users and policymakers is now needed to accelerate the removal of economic and technical barriers.

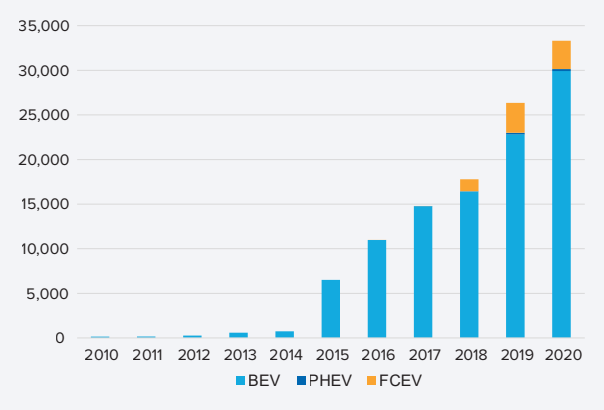
iii OICA: Organisation Internationale des Constructeurs d'Automobiles

Figure 4: Historic sales and stock of ZE trucks

Trucks sales by zero/low emission powertrain type



Trucks stock* by zero/low emission powertrain type



*Stock: cumulative zero/low emissions trucks sales since 2010

Source: IEA, EV Outlook 2021

2.3 Supply of ZE trucks

As of 2021, the model availability of electric heavy-duty vehicles is broadening, with four major truck manufacturers anticipating an all-electric future.[27]

In North America and Europe, a handful of suppliers are best positioned to lead this transition given their outsized market shares. In North America, Daimler leads the Class 7-8 heavy-duty tractor truck market, with a roughly 40% market share, while Paccar holds approximately a 30% market share, and Ford controls over half of the Class 4-6 truck market.[28] In Europe, Volkswagen is the largest heavy-duty truck manufacturer followed by Daimler.[29]

However, the supply of electric and fuel cell truck manufacturing is still dominated by Asia. BYD, headquartered in Shenzhen, is the world's largest electric truck manufacturer. The company is already completing orders for its electric Class 8 cab, which Anheuser-Busch deployed at the end of 2019. Other Chinese truck OEMs like Geely are also stepping into the heavy-duty trucks market. European truck OEMs like VW, Daimler and Volvo have already started piloting and delivering ZE heavy trucks although production volumes will remain low for the foreseeable future. Tesla will deliver the first units of its semi truck in the first quarter of 2022, although future production volumes are unknown.

3 Stakeholder signals for ZE trucks deployment

Although the trucking sector still faces significant barriers to decarbonisation, progressive government regulations and zero emissions commitments from both truck manufacturers and trucking customers have already begun to catalyse early adoption of zero emissions transport. These steps from critical stakeholders demonstrate the viability and urgency of reducing truck-related emissions.

3.1 Regulatory drivers

Governments around the world have implemented climate policies and transportation regulations that will help advance the electrification of road transport, including trucks. Some of these policies are:

- In **Europe**, the EU has devised more stringent CO_2 emissions standards to curtail the use of diesel trucks. The EU's Clean Vehicles Directive also outlines electric truck procurement requirements for EU member states from 2021 to 2030. Countries like France, the Netherlands, and Norway have supplemented the EU's requirements with their own deployment goals, further incentivising ZE trucking across the continent.[30]
- In **North America**, 15 states representing a third of the US economy have pledged that 30% of sales of medium- and heavy-duty vehicles will be zero emissions by 2030, in alignment with the IEA NZE scenario.[31] California offers financial incentives for zero emissions trucks through its Hybrid and Zero emission Truck and Bus Voucher Incentive Project (HVIP), as well as other programmes. California also will ramp up sales of zero emissions trucks via the Advanced Clean Truck rule, and is also developing a Clean Fleet rule.[32] Several states are in the process of adopting the California ZE mandate rules. California has noted its aspiration to fully transition to ZE trucks by 2045.[33]

  EPA has also announced a Clean Truck Plan, which will encompass several rulemakings, with the stated goal of improving public health and reducing GHG emissions from commercial highway transportation.
- **China** has thus far led the way in zero emissions passenger vehicles thanks to its New Energy Vehicle Mandate, which has helped the country become the world's largest EV passenger market.[34] However, the electrification of the commercial truck segment is still nascent, and the policy tools for electrifying these vehicles are far less robust than those that apply to cars.[35] Chinese policymakers should take steps to facilitate similar strides in electrification of the country's heavy-duty truck sector.
- **Several other countries in Asia** have followed suit with their own electrification targets, fuel economy standards, and sales goals. Pakistan aims for electric vehicles to comprise 30% of new heavy-duty vehicle sales by 2030 and 90% of new sales by 2040.[36]
- **Local governments** around the world have also enacted policies to spur transport-related emissions reduction, with restrictions on ICE vehicle access to city centres already operating in multiple cities. At least 34 municipalities globally have committed to ensuring that a major area of their cities is zero emissions by 2030.[37]

3.2 Truck manufacturers' commitments to zero emissions

With the above regulatory changes, truck manufacturers have begun to develop new zero emissions products and decarbonisation timelines. Most manufacturers have focused on BEV technology, although hydrogen FCEV technologies continue to attract interest from some automakers, particularly in Asia.

Manufacturers are starting to recognise the potential demand presented by ZE heavy transport and are devoting increasing resources to meeting evolving end consumer needs. The broadening range of ZE heavy duty vehicles and specifications available (e.g. vehicle size, powertrain type, battery capacity) demonstrates the commitment to providing fleet owners and operators with the flexibility to meet operational needs.[38]

By 2023, more than 125 electric truck and bus models from new and established manufacturers will either be available or in production.[39] Truck makers such as Daimler, MAN, Renault, Scania and Volvo have indicated they see a zero-emission future. Daimler has committed to offering a completely carbon neutral fleet of trucks in Europe, North America, and Japan by 2039.[40] Volvo will offer all-electric versions of its heavy-duty trucks in 2021 and 100% fossil fuel free trucks by 2040.[41] Scania plans for 50% of total vehicle sales volumes to be electrified by 2030.[42] GM has also launched an electric delivery vehicle start-up called BrightDrop, which will provide FedEx with 500 electric trucks in 2021,[43] while Ford will launch an electric model of its Transit, the world's best-selling cargo van, in 2022.[44] Two-thirds of Ford's commercial vehicle sales in the EU are expected to be all-electric or plug-in hybrid by 2030.[45]

Trade associations are also signalling clear and cohesive commitments from their members. Under the umbrella of the European Automobile Manufacturers' Association (ACEA), major truck manufacturers Daimler, Volvo, Scania, CNH, MAN, DAF, and Ford have committed to only sell zero emission trucks by 2040.[46]

Some manufacturers have also invested in developing hydrogen truck models, including Hyundai, which last year shipped the first of 50 hydrogen trucks, and Hino Motors, the truck division of Japan's Toyota Motor Corp, which is developing a FCEV truck for the North American market.

Zero emission vehicle alliances have also helped strengthen manufacturers' decarbonisation efforts. Over 35 manufacturers have joined CALSTART's 'Global Commercial Vehicle Drive to Zero' initiative, to share best practices in the low carbon vehicle transition over the next five years.[47] Other initiatives include the UNFCCC Race to Zero, the Transport Decarbonisation Alliance (TDA)'s initiative on zero emission freight, the European Clean Trucking Alliance and WEF's Road Freight Zero.

3.3 Carriers and corporate end users' zero emissions commitments

Net zero pledges from major businesses that either own, manage or depend on large trucking fleets are already sending consistent demand signals for the decarbonisation of trucks. Nestle has committed to net zero emissions by 2050;[48] Walmart aims to achieve zero emissions shipping by 2040;[49] IKEA has committed to being climate positive by 2030;[50] 100% of FedEx's package pickup and delivery fleet will be zero emission by 2040, and 100% of the FedEx pickup and delivery purchases will be zero emissions by 2030.[51] These commitments constitute clear market signals to spur production of ZE trucks by OEMs and rapid replacement of ICE vehicles by fleet operators.

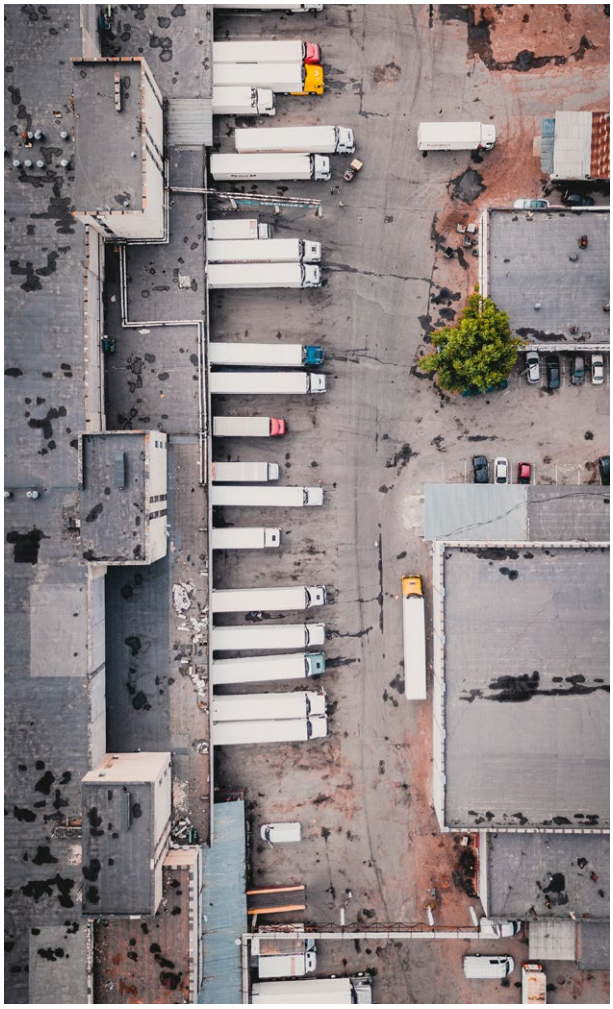


Table 1: Corporate end user declarations related to ZE commercial vehicles

Company	Operating area	Announced	Target/Actions
Amazon	Global	2020	Orders 100,000 BEV light-commercial vehicles from start-up company Rivian. Amazon aims to be net-zero emissions by 2040.
Anheuser-Busch	USA	2019	Orders up to 800 hydrogen fuel cell Nikola heavy-duty trucks. Bavaria, Ambev and other brands owned by Anheuser-Busch target transformation of fleets to EVs.
DHL Group	Global	2019	60% of global inner-city logistics fleet electric by 2030 (i.e. ~80,000 electric vehicles) and Net-zero emissions logistics by 2050. In 2020, EVs made up 18% of DHL fleet.
FedEx	Global	2018	Transition to an all zero emission vehicle fleet and carbon neutral operations by 2040.
H2 Mobility Association	Switzerland	2019	19 of Switzerland's largest retailers invest in Hyundai hydrogen trucking services that will deploy up to 1,600 heavy-duty zero emission trucks.
IKEA	Global	2018	Zero emission deliveries in leading cities by 2020 and in all cities by 2025.
Japan Post	Japan	2019	Electrify 1,200 mail and parcel delivery vans by 2021 and net-zero emissions logistics by 2050.
JD	China	2017	Replace entire vehicle fleet (> 10,000) with New Energy Vehicles by 2022.
SF Express	China	2018	Launch nearly 10,000 BEV logistics vehicles.
Sunning	China	2018	Independent retailer's Qingcheng Plan will deploy 5,000 new energy logistics vehicles.
UPS	North America	2019	Order 10,000 BEV light-commercial vehicles with potential for a second order.
Various companies	Multinational	Since 2018	Walmart, Pepsi, Anheuser-Busch, FedEx, Sysco and other large multinational corporations pre-order 2,000 Tesla Semi models within six months of truck's debut.
Walmart	USA	2020	Achieve zero-carbon operations by 2040.

Source: Adapted from IEA EV Outlook 2021

4 Financing the transition to ZE trucking

Consistent demand signals for ZE trucking along with national and subnational government policies suggest a strong business case to finance the transition to ZE trucking. This, however, requires investment vehicles to scale up the opportunity to the 'ticket size'[iv] of institutional investors and the integration of new areas of expertise to overcome the challenges for the financing of ZE trucking. The balance between initial capex and opex differs from what transport-dependent companies are used to. Financial innovation through securitisation and tailored investment vehicles involving several value chain participants can help address these barriers.

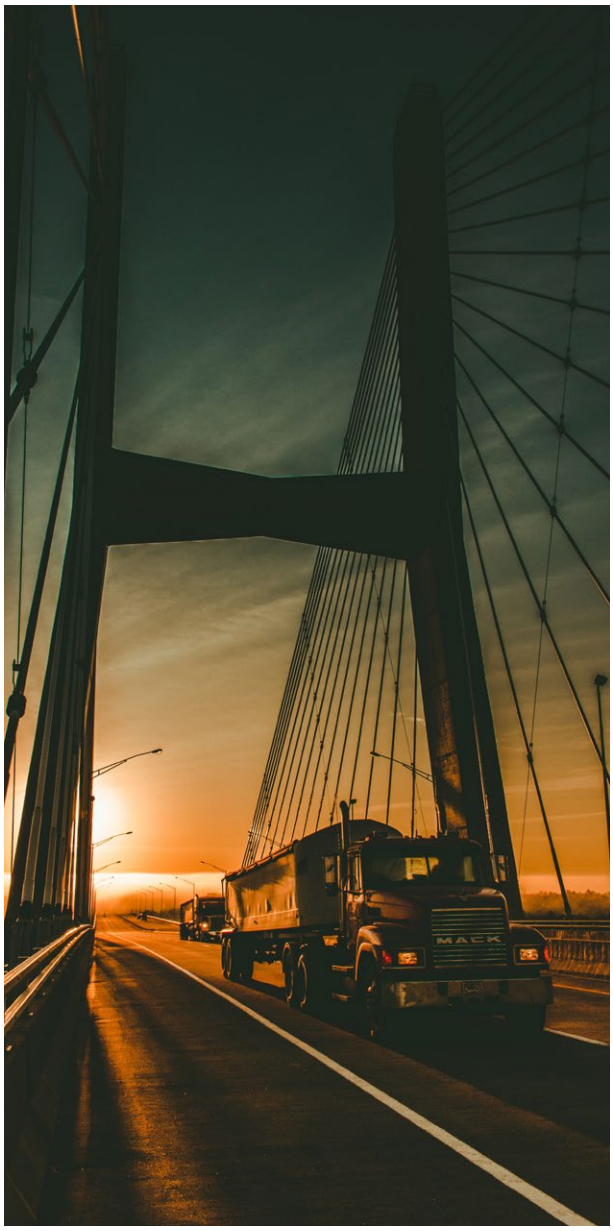
Financial institutions that act now to innovate and capture this opportunity can help to establish a new asset class that generates financial, environmental, and social returns for long-term investors. As demand for sustainable investment products skyrockets, investors can capitalise not only on the direct benefits of ZE trucks; they can position themselves as ESG leaders, attracting heightened attention from climate-conscious clients.

One new potential asset class is Zero Emission Delivery (ZED) Zone financing,[52] inspired by Virtual Power Purchase Agreements. In this model, corporate end users or 'shippers' (i.e. companies shipping products), sponsor commercial ZE trucks through payment plans and utilisation guarantees during a fixed period of time. Private and public financiers then provide the capital needed to purchase the ZE trucks.

Carriers or fleet managers add ZE trucks to their fleets based on the fixed demand from shippers, enabling them to procure cleaner shipping options. In this model, 'shippers' are not necessarily paying more, but are changing the timing of their payments and taking on some additional counterparty risk due to guaranteed demand through long-term contracts. This model could take three forms:

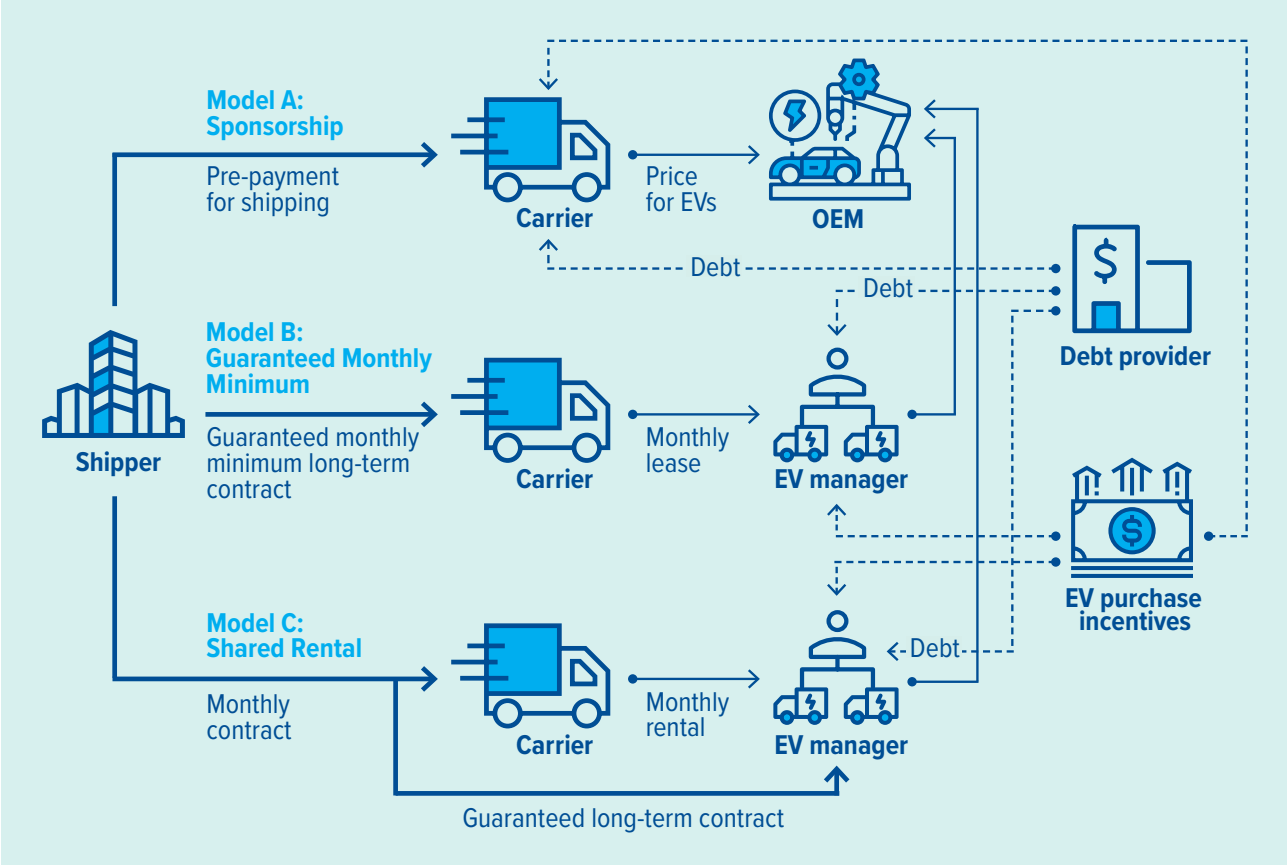
- **Sponsorship:** Shippers pre-pay for shipping and receive monthly discounts on a long-term contract.
- **Guaranteed monthly minimum:** Shippers sign a long-term contract with one carrier at a minimum monthly spend.
- **Shared rental:** Shippers sign a long-term contract with an EV manager guaranteeing vehicle use and requiring carriers to rent ZE trucks from the EV manager.

As with early commercial renewable energy deals, the first ZE truck sponsorship arrangements will likely take longer to arrange and cost more than paying for fossil fuel trucking services. The business opportunity is for capital providers and advisors to develop the capacity for a scalable pipeline of ZE truck adoption projects, based on systematised transactions, reduced deal costs and improved liquidity.



iv Ticket size refers to the minimum investment an investor is able to commit.

Figure 5: Summary of options for THE "Zero Emissions Delivery Zone" model



Source: EDF, Accelerating Zero Emissions Delivery

5 Barriers to the ZE truck transition

Unlocking the full potential of the ZE trucks opportunity also depends on overcoming pervasive barriers to zero emissions production and deployment of MHDVs. The economics of ZE truck manufacturing, the technical and economic challenges for certain use cases, the status of existing charging infrastructure, and the current policy landscape all challenge the transition to decarbonised commercial transport.

5.1 Economic barriers

The economics of ZE trucking can present a barrier to production and adoption, particularly as new technologies scale up. Altering manufacturing processes to produce ZE trucks or adding a new ZE truck to a commercial fleet involves upfront capital costs, different logistics (e.g. charging), different suppliers and reskilling the workforce. The payback period for these investments may be too long for financial institutions or companies with shorter time horizons, and involve logistic and technical challenges for different stakeholders (e.g. auto OEMs, automotive suppliers, grid operators, policymakers, banks). However, although cost may be a barrier today, many trucking applications are on a path to cost competitiveness by the end of the decade, and in some cases sooner.

Uncertainty surrounding the economics of ZE trucking can also deter investors and corporates from taking immediate action. The residual value, maintenance costs, total lifetime costs, and fuel costs savings of ZE trucks are not yet clear and depend on multiple factors. Better estimates of these costs, informed by successful early deployments, can help inspire more confidence in ZE transport.

5.2 Charging infrastructure barriers

The roll-out of public charging infrastructure has so far mostly focused on serving electric light-duty passenger vehicles. The electrification of heavy freight trucks requires more attention given currently limited incentives for private sector participants.[53]

The charging requirements for electric heavy trucks differ from those for electric passenger cars. Chargers with power output of 350 kilowatt (KW) or more are likely needed in order to charge trucks which travel long distances. For comparison, best-in-class passenger fast charging stations currently deliver between 50 and 150KW. So far, charging options for heavy freight trucks have tended to be early-stage demonstrations, proof-of-concept activities and efforts to facilitate standardisation.[54] Public-private initiatives in Asia, Europe and the USA are developing mega-chargers with power outputs closer to 1MW.

However, high upfront costs to build charging infrastructure presents a major barrier for adoption of ZE trucks. While existing technology can meet the operational needs of most trucking fleets, the cost of installing private charging infrastructure (e.g. at truckyards, logistic centres) is significant. Additionally, without a reliable and profitable network of public fast charging stations, long-haul trucks will be unable to electrify and operate efficiently. On top of this, 'en masse' transportation electrification without thoughtful grid upgrades and integration will put pressure on grid reliability. Advancing industry-wide movement towards ZE trucking requires investments in charging infrastructure and smart grid technology that can accommodate a surge of electric trucks. However, these challenges are not deterring truck makers and institutional investors from venturing into the EV charging infrastructure space. Traton Group, Daimler Truck, and Volvo Group signed a € 500 million joint venture agreement to build a European charging network specifically designed for heavy-duty trucks. BlackRock invested around USD 790 million in Ionity, an EV charging infrastructure network to facilitate long-distance travel in Europe.

Hydrogen refuelling for fuel cell trucks is still at early stages of development and would require investments across different sectors and value chains. Unlike electricity, hydrogen refuelling stations require a dedicated production and distribution network which is yet to be established at scale.[55]

5.3 Technology Pathways: Batteries versus Hydrogen

Given the diverse requirements of different commercial road transport vehicles – encompassing a variety of range, payload and operating conditions – a portfolio of technologies will be required to decarbonise MHDVs fully.

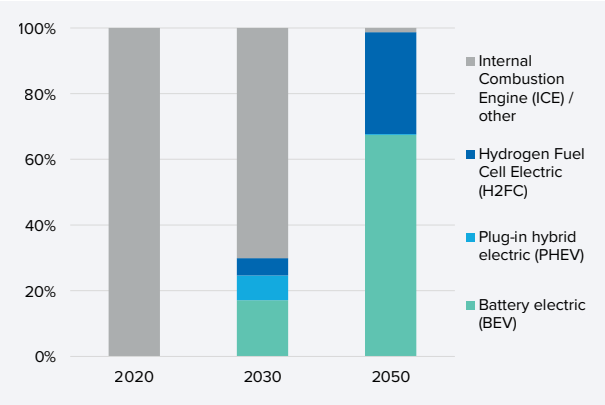
Over the next 10 years, biofuels and natural gas may become more viable commercial alternatives to diesel and could play a role in lowering emissions from heavy-duty trucks.[56, 57] However questions over the lifecycle emissions and scalability of these technologies cast doubt over their long-term role as a decarbonization pathway. Beyond 2030, the two leading zero emissions medium and heavy duty vehicle technologies – BEVs and FCEVs – are both likely to play a role in the ZE trucks transition, though BEVs are expected to dominate non-long haul road transport. Both use an electric motor, but while BEVs use electrochemical batteries (the majority being lithium-ion type today) to store and deliver energy, FCEVs use fuel cells which release energy from the chemical bonds of hydrogen. FCEVs are considerably less energy efficient than BEVs; however, hydrogen carries greater energy density, giving it some advantages in long haul trucking.

The IEA estimates BEV heavy truck sales to have the largest market share (67%) in 2050 with hydrogen fuel cell trucks expected to have a smaller share (~30%). Bloomberg NEF,[58] however, expects a much smaller share of hydrogen fuel cell trucks at 3% in 2040, with hydrogen only having a relevant share in long-haul trucking operations.

Overall, for most MHDV classes, BEVs appear likely to be the leading zero emission technology because:

- Electricity is widely available, and the cost of zero emission electricity is already competitive with conventional fuels.
- By contrast, hydrogen is not yet being produced at scale, particularly from zero emissions technologies. Where available, green hydrogen is expensive, and it is unclear whether it will ever be cost competitive with electricity as a transportation feedstock.

Figure 6: Heavy trucks sales targets by powertrain type in IEA NZE 2050 scenario



Source: IEA NZE 2050

- The processes to produce hydrogen – electrolysis (green hydrogen) or steam methane reforming with carbon capture (blue hydrogen) – are also energy intensive, resulting in an electrical outlet to operation ("wall-to-wheels") ratio of 35%, compared with a ratio of 85% for battery storage.
- Battery charging infrastructure for trucks, while still limited, is expanding, and in many cases charging infrastructure can be installed at a reasonable cost. By contrast, hydrogen distribution infrastructure has not been yet established for truck refuelling, or for the distributed manufacturing of green hydrogen, outside a few pilot sites.
- Manufacturers have invested more resources in the development of BEV, rather than FCEV, trucks. In the United States, there are 48 medium-duty electrified models, 29 heavy-duty models, and 40 bus models offered across a range of end uses[v]. By contrast, only a handful of FCEV trucks have gone into production.

v Electric Vehicle Market Status – Update, MJ Bradley & Associated, 2020

However, FCEV technology holds advantages for heavy-duty trucks travelling long distances:

- BEV technology is constrained by the relatively low energy density[vi] of lithium-ion batteries. Average lithium-ion battery energy density of 250 Wh/kg means that a Class 8 BEV with a 600-mile range would need to give up 25% of its cargo capacity to battery payload and charging times could be prohibitive.
- Hydrogen's mass energy density of 35,000 Wh/kg, over 100 times greater, explains why some manufacturers continue to favour the technology for heavy payload, long distance uses where battery recharging is not feasible.
- Hydrogen refuelling time is equivalent to that of diesel trucks.

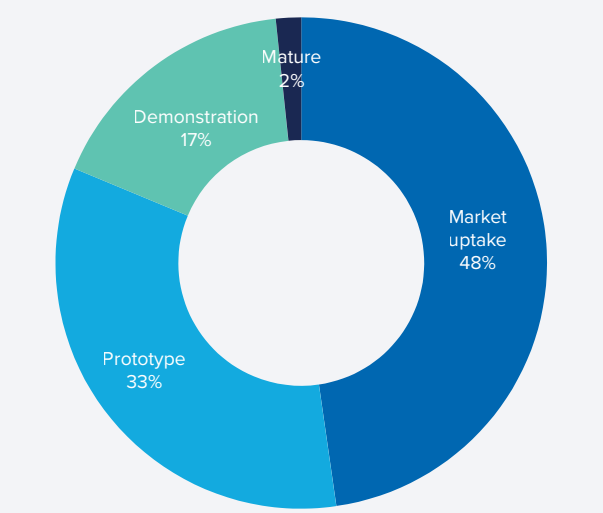
Challenges to implement just one of these technologies across all trucking use cases means that a combination of both might be needed, although battery electric trucks are likely to dominate. However, not-yet commercial technologies may change the current ZE trucking landscape. Only half of the decarbonisation technologies available for MHDV are currently available on the market, with the other half in prototype or demonstration phase.[59]

5.4 Policy barriers

Improving the economics of ZE trucking and charging depends in part on public policy. National and subnational governments can introduce measures that encourage ZE truck usage and discourage fossil fuel-based trucks. A combination of policy incentives and disincentives can create a more favourable regulatory environment for the ZE truck transition. A 'Total Cost of Electrification' (TCE) approach, as outlined in EDF's 'Financing the Transition: Unlocking Capital to Electrify Truck and Bus Fleets,'[60] presents ideas for how public funds can be used creatively to address the mix of costs, risks and frictions facing particular fleets. By being strategic with limited funds, the public sector can become a real partner in increasing the flow of private investment into this sector.

vi Energy density is the measure of how much energy a battery contains in proportion to its weight. This measurement is typically presented in Watt-hours per kilogram (Wh/kg) and its widely use to compare progress on battery technology.

Figure 7: Trucks decarbonisation technology by maturity in IEA NZE 2050 scenario



Source: IEA EV Outlook 2021

To encourage zero emissions MHDVs, policymakers should also utilise non-financial tools, such as zero emissions requirements for trucks in government procurement contracts and public investment in research and development, workforce training, and charging infrastructure. To discourage the use of diesel trucks, governments can impose strict performance standards and ZE mandates, end fossil fuel subsidies and tax breaks, create zero emissions zones or other access preferences, and more stringent enforcement of air quality and emissions rules.

5.5. Health and Equity Barriers

Warehouses, distribution centres, recycling facilities and other truck-dependent businesses are often concentrated in low-income communities. As a result, air pollution, including emissions from diesel trucks, is disproportionately concentrated in these areas. Air pollution can have worse impacts on health in these communities due to other socio-economic and environmental factors.

Without concerted action, the early ZE trucks may be concentrated in wealthier communities that are better able to advocate for them. Companies will need to work collaboratively with public sector leaders to ensure the early ZE trucks go where they can do the most good.

TOTAL COST OF ELECTRIFICATION:
A NEW FRAMEWORK FOR EVALUATING FLEET ELECTRIFICATION BARRIERS

HARD COSTS	SOFT COSTS	RISKS + UNCERTAINTIES	FRICTIONS
Costs from investment in new assets and fixed infrastructure	Costs from additional activities and processes to switch to electric MHDVs	Costs from uncertainties that make financing more expensive or electric MHDVs appear less cost competitive	Limitations that increase the psychological or practical cost of switching to electric MHDVs

PRIORITY BARRIERS

• High upfront vehicle capital cost • High upfront and replacement battery costs • Technical infrastructure costs, including chargers and system upgrades	• Changes to business operations (including routes and schedules) • Permitting and approvals • Practicalities of switching to new maintenance logistics • Knock-on effect of missed charging events	• Uncertain residual value of vehicles and batteries • Uncertain future capital costs and total lifetime cost • Uncertain battery technology performance and life • Uncertain maintenance costs • Uncertain fuel cost savings • Uncertain evolution of incentives and policy standards	• Lack of capacity to plan and implement fleet switches to electric MHDVs • Lack of capacity to use new financing approaches • Inertia in procurement and contracting process

DEEP DIVE EXAMPLE

High upfront capital cost	Changes to business operations	Uncertainty around residual value	Lack of capacity to plan and implement switches
Despite significant declines in vehicle and battery costs, upfront costs of electric MHDVs remain a major obstacle to increased deployment. This price tag differential remains a powerful deterrent despite numerous studies that indicate electric MHDVs have a lower TCO than internal combustion equivalents.	Switching to a different vehicle type involves more than just addressing a difference in purchasing price. There are also costs associated with adapting business operations, identifying and procuring new equipment, interfacing with the utility, training employees and optimizing charging and route management.	Electric MHDVs and the batteries that power them are new technologies without long track records of performance and resale prices in secondary and tertiary markets. The uncertainty makes potential buyers nervous about recouping residual value from used electric vehicles, as they usually do with internal combustion engine (ICE) vehicles, and makes financing more difficult as the expected residual value for the asset may be set low or at nothing due to high uncertainty.	Even with a high-level commitment to transition to electric MHDVs, many organizations face inertia and lack of internal bandwidth to take on the challenge. As with any new priority, resources must be deployed to ensure that staff have the time, training and support needed to overcome frictions, try new things, and scale successes based on initial learnings.

Increase actual costs of electric MHDVs

Increase actual and perceived costs of electric MHDVs

Increase costs of switching to electric MHDV fleets

Total Cost of Electrification (TCE) is a new framework for evaluating the barriers to fleet electrification efforts. In the above graphic, the four pillars of TCE – hard costs, soft costs, risks and uncertainties, and frictions – are defined and described using a sampling of illustrative barriers.

6 Recommendations

Reflecting on the levers and barriers assessed in this report, a list of recommended stakeholder actions and solutions are proposed. Taken together, these provide investors a preliminary guide to engage with companies in the trucking value chain in the search of solutions to accelerate the decarbonisation on the sector.

Truck Manufacturer Challenges and Solutions

What's the problem?	What's the solution?	What near-term actions should **companies** take?
Lack of urgency and accountability on ZE truck transition	Set time-bound, ambitious decarbonisation commitments	Commit to transition to 100% ZE truck sales. Set incremental sales targets and disclose progress
Air pollution from diesel trucks concentrated in low-income communities	Assess and disclose emissions in low-income communities	Ensure reporting frameworks attribute in-use emissions back to manufacturers
Slow deployment of ZE trucks	Allocate capital to new technologies and research and development	Disclose share of capital expenditures allocated towards ZE truck research and development, and increase on a path to 100% ZE sales
Insufficient corporate support for ZE transport policies	Align public policy engagement with a 1.5°C scenario	Support supply-side policies in addition to demand-side policies

Challenges and Solutions for **Companies with Contracted Shipping**

What's the problem?	What's the solution?	What near-term actions should **companies** take?
Lack of accountability on truck-related Scope 3 emissions	Provide robust Scope 3 transport disclosure and science-based reduction targets	Commit to 100% ZE truck shipping. Disclose transport emissions and set a plan tailored to level of control over vehicles. Implement efficiency improvements at facilities using existing technologies
Air pollution from diesel trucks concentrated in low-income communities	Assess and disclose Scope 3 transport emissions in low-income communities	Disclose facility-related emissions and set a plan, including contracted carriers, trailers, and yard trucks
Net zero commitments without change to status quo	Send demand signal to carriers for ZE transport	Commit to shipping with carrier that has committed to 100% ZE trucks fleet
Insufficient corporate support for ZE transport policies	Align public policy engagement with a 1.5C scenario	Release annual report disclosing direct and indirect lobbying, and demonstrate lobbying alignment with a 1.5C scenario

Fleet Owner Challenges and Solutions

What's the problem?	What's the solution?	What near-term actions should **companies** take?
Lack of urgency and accountability on ZE truck transition	Set time-bound, ambitious decarbonisation commitments	Commit to transition to 100% ZE truck usage and 100% ZE truck purchase. Set incremental targets and disclose progress
Air pollution from diesel trucks concentrated in low-income communities	Assess and disclose emissions in low-income communities	Commit to deploying ZE trucks first in low-income communities. Ask for help from local authorities to understand demographics and health burdens
Stranded asset risk from fossil fuel trucks	Allocate capital to new ZE trucks	Disclose share of capital expenditures allocated to ZE truck purchase; share of opex to ZE truck miles travelled (VMT)
Insufficient corporate support for ZE transport policies	Align public policy engagement with a 1.5C scenario	Release annual report disclosing direct and indirect lobbying and demonstrate lobbying alignment with a 1.5 scenario

Investor Challenges and Solutions

What's the problem?	What's the solution?	What near-term actions should **investors** take?
Lack of disclosure on non-owned shipping	Support robust Scope 1 and 3 transport disclosure from truck users	Collaborate with disclosure standards bodies and ESG data providers
No urgency or accountability on ZE truck transition from truck users	Change investment decisions, board of director votes based on ZE truck plans	Commit to engage with all portfolio companies that make, buy, or depend on goods transport. Commit to end financing or lending for new fossil fuel trucks to companies without clear science-based and time-bound emissions reduction targets
Lack of electrification targets from truck manufacturers	Create time-bound electrification goals	Advocate for more comprehensive and ambitious targets
Unmet demand for creative financing	Explore asset-based lending, residual value guarantees, and other innovative solutions to unlock early investment opportunities	Create investment vehicles for lending, debt finance
Policy not at scale or well-designed	Increase communication with public sector to accelerate efficient, effective public-private ZE truck finance	Support policy opportunities to accelerate ZE truck deployment; make policy alignment with a 1.5C scenario a central tenet of company engagement

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