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Electrification across transportation supply chains

Identifying electric vehicle charging opportunities beyond light vehicle use

Winter 2022

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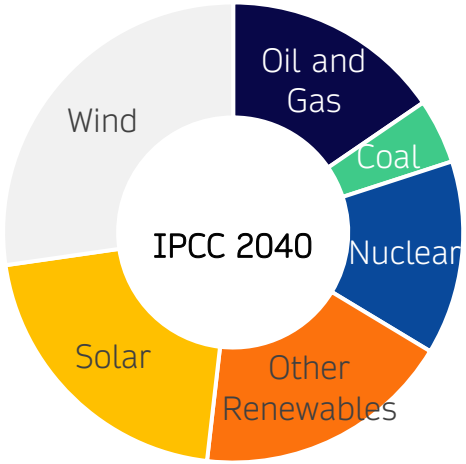
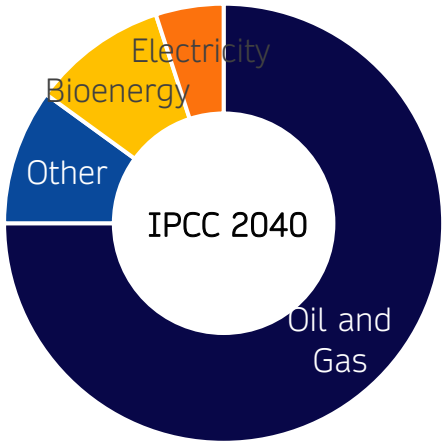
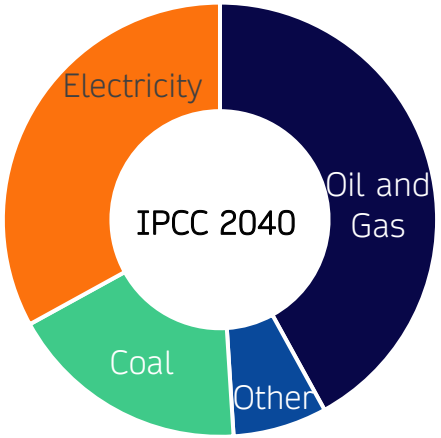
Electrification Key to De-Carbonisation

Transport has the highest reliance on fossil fuels of any sector and accounts for 37% of CO2 emissions from end-use sectors, with the IPCC expecting 75% of energy to still come from oil and gas in 2040

	Power Generation	Transportation	Industrial
	Need: 24/7 on-demand electricity	Need: rapid refuelling of energy-dense fuels	Need: fuel for high-temperature processes
			
Limitations	Solar and wind limited in poor resource areas and by intermittency	Battery weight and long charging time	Temperature intensity required for heavy manufacturing
Innovations required	• Lower-cost CCS and hydrogen • Battery energy-density breakthroughs	• Lower-cost biofuels and hydrogen • Batter energy-intensity breakthroughs	• Lower-cost CCS and hydrogen • Less energy-intensive processes

Source: Share of global greenhouse gas emissions by sector, IPCC 1.5°C Scenario and ExxonMobil

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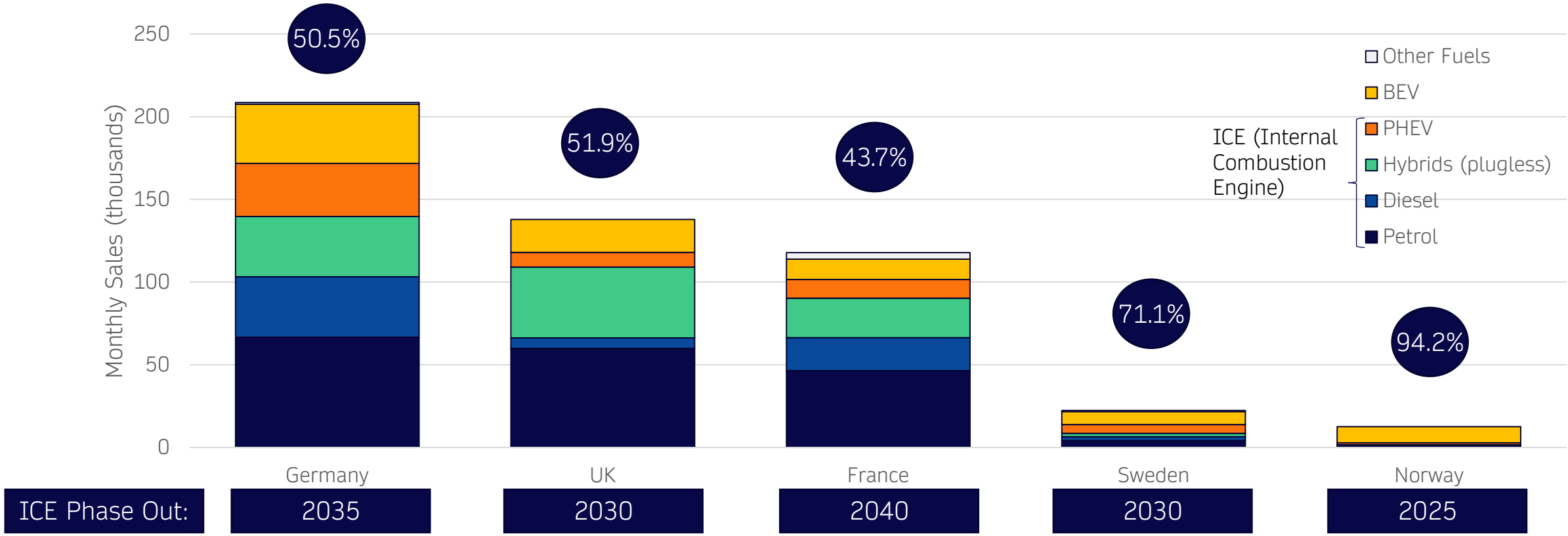
European Electric Vehicle Market Share October 2022

Electric vehicles are revolutionising transportation, and with ICE phase out targets approaching, investors are racing to discover disruptive technology that will support charging infrastructure rollout

Monthly New Vehicle Sales by Fuel | *OFV 2022, BIL Sweden 2022, KBA 2022, SMMT 2022, PFA 2022*



X.X% Non-Pure ICE Percentage Share

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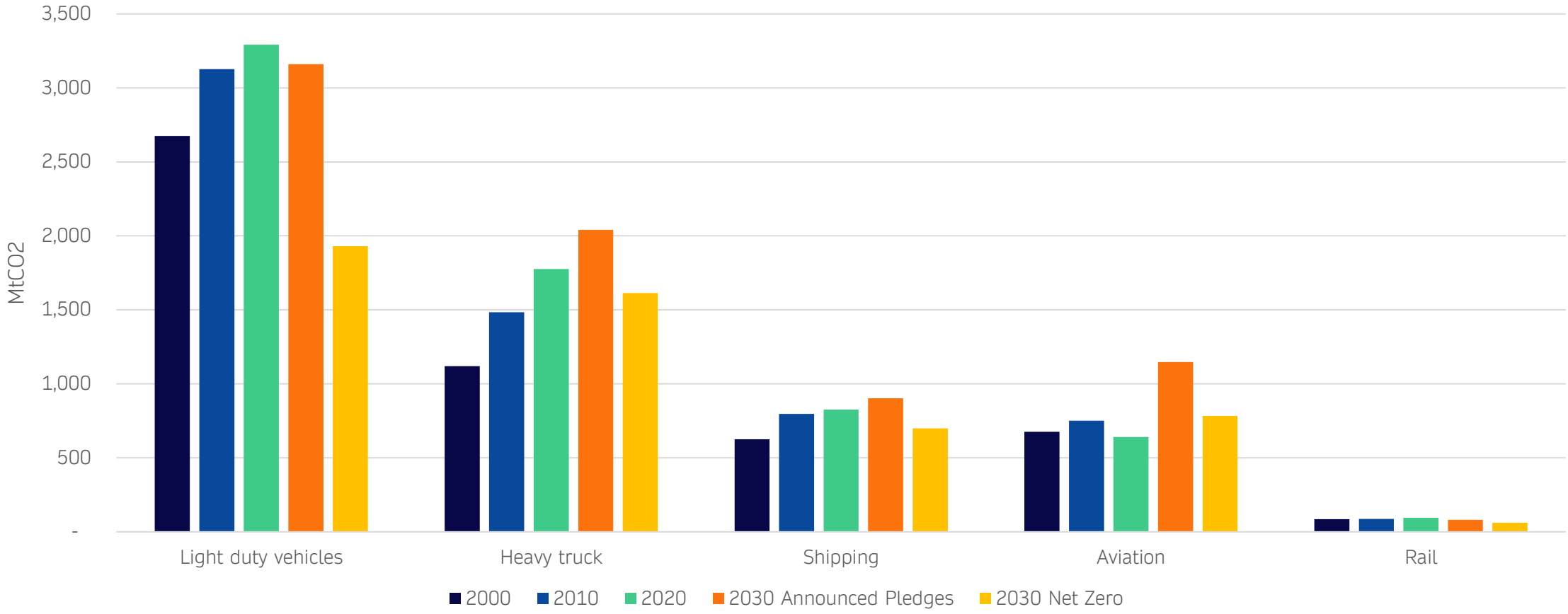
CO2 Emissions from Transportation

While light duty vehicles are still the largest emitters, heavy truck transport has seen the highest growth in emissions over the past decade, and is forecast to be the greatest source of transport emissions in the net zero scenario. The HDV sector is expected to overtake LDV by 2025

Global CO2 emissions from transport by subsector, 2000-2030 | *IEA 2021*



Decarbonising Commercial Transportation Supple Chains

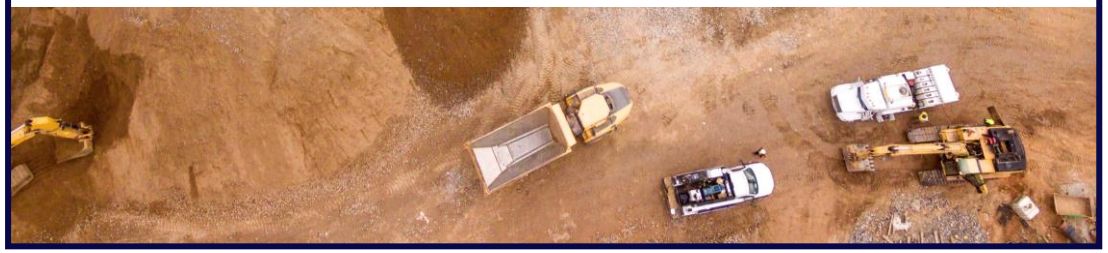
Businesses across supply chains are endeavouring to reduce emissions of companies globally as stakeholder pressure mounts

Complete electrification is way off, supply chains cannot wait on the battery, power technology and truck OEMs before making inroads into their decarbonisation journey. Companies across all industries have already begun implementing sophisticated plans to reduce carbon emissions, such as using ships with cleaner fuels or utilising companies using sophisticated warehousing techniques. Some example methods are below:

Emission Reduction in Mining

The industry is responsible for 4-7% of GHG emissions globally and is a key component of the EV solution. The mining industry is renowned for utilising large industrial equipment and requiring considerable infrastructure to operate. There is ample room to reduce emissions.
Progress has been made across:

- New drivetrain technology in trucks (EV's, Hydrogen)
- Automation solutions to increase efficiency and reduce staff required on site (increasing safety)
- Use of renewable energy – sites are large and can accommodate solar infrastructure for certain applications



Last Mile Emissions

The "last mile" has been identified as the greatest contributor to emissions in the supply chain. Road freight emits more than 100x as much CO2 as a cargo ship to carry the same items. Green technologies won't work in all parts of the world, so improvements to diesel vehicles are required.
Improvements can come from:

- Fuel Burnt – greater quality can reduce emissions per given unit burnt
- Route taken – ideal speeds required and "smart routing" to reduce total miles driven

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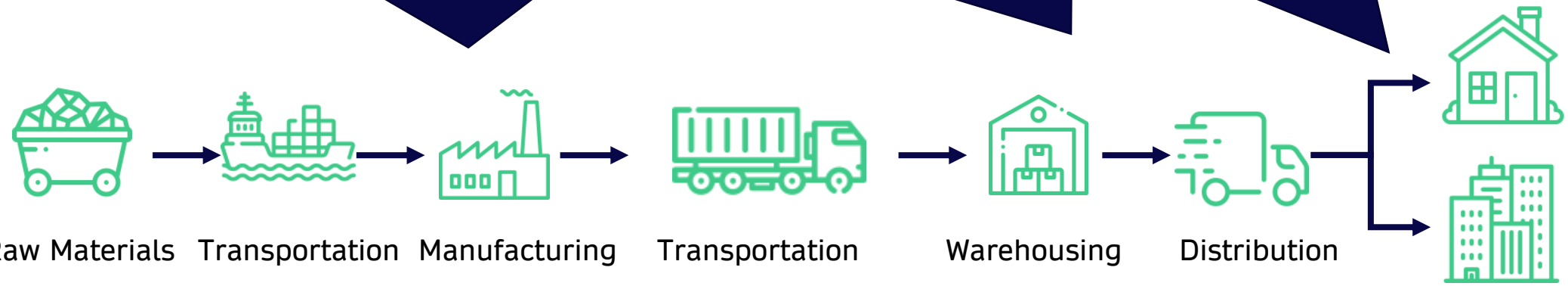
Decarbonisation of Supply Chains – Calash Experience

Heavy duty EV's have a growing share of total vehicles but are still an under adopted technology. Whilst popularity grows, supply chains continue to innovate and Calash has experience working with players that serve the logistic industry, assisting in its decarbonisation efforts

Reducing emissions during the manufacturing phase is vital for moving towards net zero compliance (scope 1). This phase is under increased external scrutiny.

Warehousing, logistics management and smarter ways of managing the transport of goods is key to decarbonising the sector.

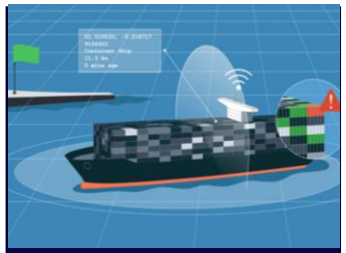
Electrification of the "last five miles" is the most viable in the short term, and has the added benefit of reducing air and noise pollution.



Where Calash has advised


BIS Industries


ARC Marine Fuels


Pole Star


ASCO Group


Coryton Fuels


Gilbarco

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Advantages and Disadvantages of Non-Fossil Fuels

Investment in EV infrastructure for the heavy duty category of vehicles remains light. This poses the question as to the best technology for low carbon powertrains; EV appears to be the front runner, given investment in the sector so far

	Biofuels	Hydrogen	Electric Vehicles
Advantages	• Viable with existing technology • Existing trucks can be converted to run on biofuels • Positive benefits for engine durability, with increased lubrication characteristics • Economic security for countries without domestic oil supply	• Reduced local emissions • Reduced refuelling time when compared to battery electric vehicles • It has the highest energy density of any common fuel • Long usage time – comparable to ICE technology	• Fuel Costs • Less Noise Pollution • No local air pollution • Increasing energy density of batteries and decreasing battery costs • Higher energy conversion than hydrogen
Disadvantages	• High cost of production • Competes for land with food and other natural habitats • Local air pollution • Increased need for fertilisers and water use	• Without CCS and renewable electricity, environmental benefits limited • Very little infrastructure • Economic case does not exist at the moment without government subsidies • High cost of raw materials	• Limited range and capacity with current technology • Lack of charging facilities • Grid issues • Growing competition for batteries from passenger cars and grid storage • No charger standardisation

Heavy Duty Electric Vehicle Solutions

The best method for the delivery of energy to the battery system remains inconclusive. Several solutions have been, and continue to be, assessed by industry players

Catenary Infrastructure – In 2020, the Centre for Sustainable Road Freight (SRF) concluded that building a network of overhead catenary cables along 7,500 km of the UK's major road network would electrify approximately 65% of HGV kms, at an estimated cost of £19.3b. It is technically viable and could prove economically attractive if completed before the late 2030s. This could lead to almost complete decarbonisation of UK heavy vehicles. Functioning systems exist on public roads in Germany, Sweden and soon-to-be Italy.

Smaller Battery sizes – Most would attest to it being easier to equip highways with fast charging infrastructure than to build an electric road, but this comes with its inherent challenges. HGV batteries are bulkier than the automobile equivalent, however existing legislation and design of infrastructure can help prevent transporting excessive battery masses.

1) Drivers are obliged to break >45 minutes for every 4.5 hours of driving time - providing a natural charging opportunity. Because of the relatively short driving time, unnecessary heavy batteries can be avoided.
2) Grid connection via buffer battery, can help reduce the size of the connection to the grid. The buffer battery is located at the rest stop, charged slowly at low power, and trucks then charge from the battery rather than a charging station.

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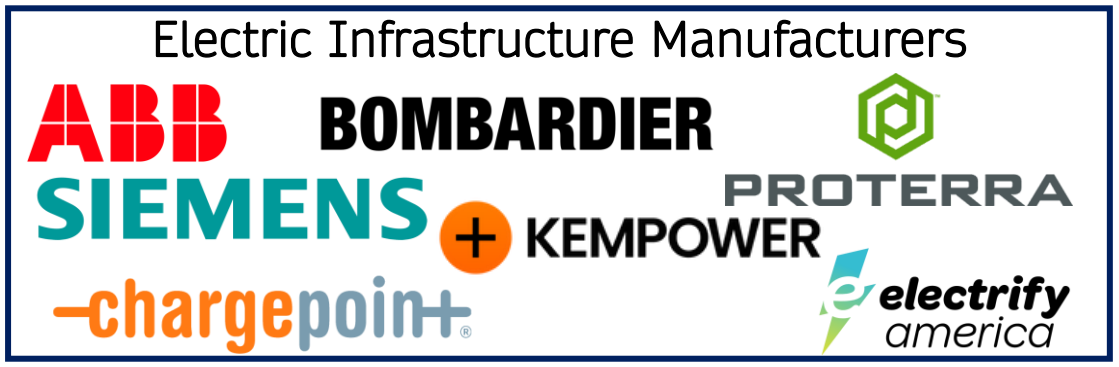
Industry Players

Solutions to decarbonise freight transport are more opaque than for cars. Issues with standardisation and the infrastructure to deliver the power required, have created challenges. Mega charger infrastructure (1MW capacity) needs to be developed, with several competing designs



The Megawatt Charging System (MCS) is a charging connector in development for large battery electric vehicles. The connector will be rated for charging at a maximum rate of 3.75 megawatts (3,000 amps at 1,250 volts) direct current (DC).

CharIn is the global association dedicated to promoting interoperability based on the Combined Charging System (CCS). It has been tasked with developing the MCS, along with the global standard. The goal is to develop the standard charging connector for large and medium commercial vehicles on land, water or in the air. As of June '22, CharIn demonstrated a working system on an Alpitronic charger and a Scania electric truck, delivering more than 1 MW of power. The publication of the final MCS standard is expected in 2024.

In July '21, Volvo signed a non-binding agreement to build a public charging network for battery electric heavy-duty long-haul trucks and coaches across Europe. Volvo intends on installing over 1,700 charging stations.

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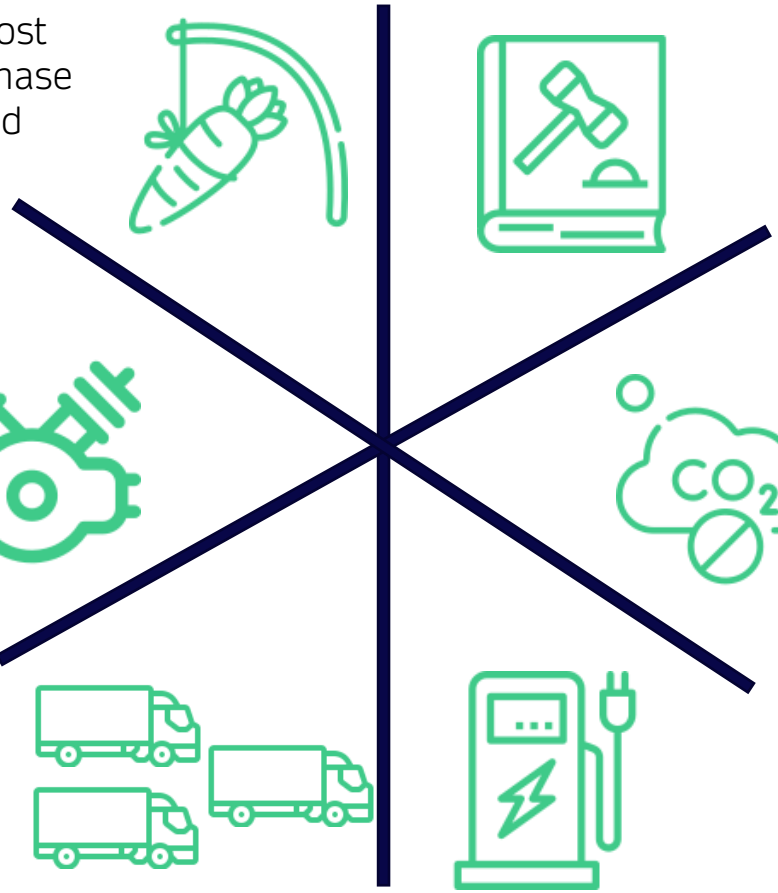
Major Policy Levers

There are six major policy levers for an accelerated zero-emission HDV transition. Countries do not necessarily need to implement all six policies to be successful

Incentives
Supplementary measures to reach cost parity with ICE. Introduction of purchase incentives, tax, reduced road tolls and fee benefits on new vehicles

Regulations
Increasing tightening of fuel economy and emissions standards. OEMs increasing share of zero-emission vehicles.



ICE Phase-out Targets
Serve as guidance for industry and businesses for developing suitable fleets and investments.

Zero/Low Emissions Zones
City level policies, setting geographic policy setting boundary when zero emission vehicles operate. A demand based policy, with payment for non compliant vehicles.

Fleet Purchase Requirements
Induce demand by requiring fleets have minimum % of zero emission vehicles.. This could apply to replacement or retrofitting programmes.

Infrastructure Development
Support private sector innovation. Tax breaks for import of chargers and infrastructure OEM's. Increase Public-Private Partnerships

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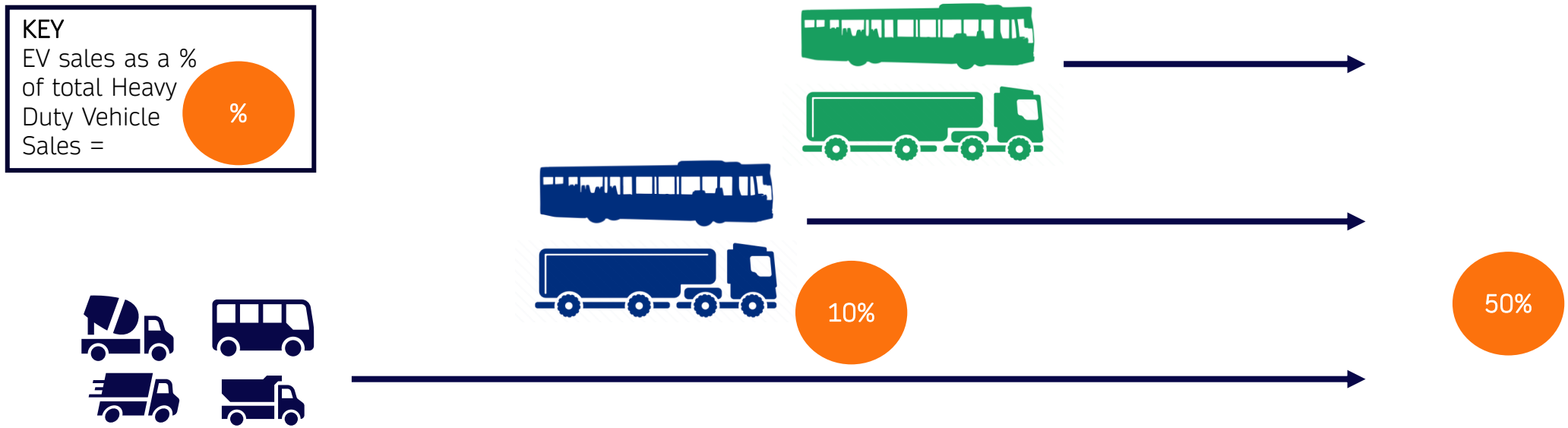
Electrification Roadmap

Heavy duty EV's have been in production since the early 2010s. Historically, they have been limited by range, however recent developments in battery and charging technology have meant its is more commercially viable



Today

130 – 250 km driving per charge

40 GTW 4h driving per full charge, 280 km per 1h charging

60 GTW, 3h driving per full charge, 210 km per 1h charging

40 GTW >4.5h driving per full charge, 560 km per 1h charging

60 GTW, 4h driving per full charge, 420 km per 1h charging

2030+

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Key Figures

There is considerable interest in electrification of transport. Substantial investment is flowing into the technologies, both through private companies and government incentives

$53 Trillion

Size of the electric vehicle market opportunity between today and 2050 in the Economic Transition Scenario

Global EV sales jumped to over 6.5 million in **2021, reaching 8% of global passenger car sales. H12022 saw +62% increase in BEV & PHEV compared to H12021**

27%

Increase in global electricity demand in 2050 caused by electrifying almost all of road transport in the Net Zero Scenario

2027

Peak year for road transport oil demand

From 2015 – 2021. Government spend as % of total EV purchases reduced from over 20% to 10%. Whilst more 5x its total incentives

Commodity Price increases (Oct 20–Oct 22):
Lithium – +895%
Cobalt – +59.4%
Nickel – +90.9%
Copper– +17.8%

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About Us

Calash offer a broad range of strategic consultancy support to investors and trade clients; independent market reviews and referencing, benchmarking, commercial turnarounds, strategic development, technical and product assessments and environmental reviews. Areas of expertise include energy (upstream, midstream, downstream), Renewables, Chemicals and Mining; covering development, operations, project management, engineering, IRM, supply chain, manufacturing and financing.

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Strategy

- Strategic reviews, corporate assessments and change management
- Growth, new market and internationalisation support
- Target Identification & Market Entry
- Competitor intelligence
- Market sizing, identification and supporting initiatives

Transactional

- Calash pre-transaction 'sniff test'
- 100 day planning, post-merger integration and execution support
- Restructuring, divestment and cost-reduction
- Commercial, Operational and Technical Diligence

Energy Transition

- Incubator development and refinement
- Calash 'ESG Investor Filter' & market sizing
- White space potential client & monetisation identification
- Energy Transition strategic alignment and risk mitigation
- Guided technical workshops