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Heavy Road Transport

Pathways to decarbonization

Sector Landscape

Envisaging a net-zero future

To meet Paris Climate Accord commitments, most transportation industry leaders have set targets to decarbonize by 2050 and have planned to invest significantly to become carbon-neutral. This focus is important given that the transport sector emits 7.7 gigatons (Gt) of CO_2 per year, accounting for 23% of global emissions.[1] Heavy road transport (heavy and medium trucks) alone emits 1.8 Gt, making it responsible for 4% of global CO_2 emissions.[2]

While these numbers dipped during the COVID-19 pandemic, emissions from heavy and medium trucks have since rebounded to their pre-pandemic levels.[3] As a result, by 2030, industry emissions must still drop by 16% relative to their current level for major economies to meet their interim emission reduction goals.[4]

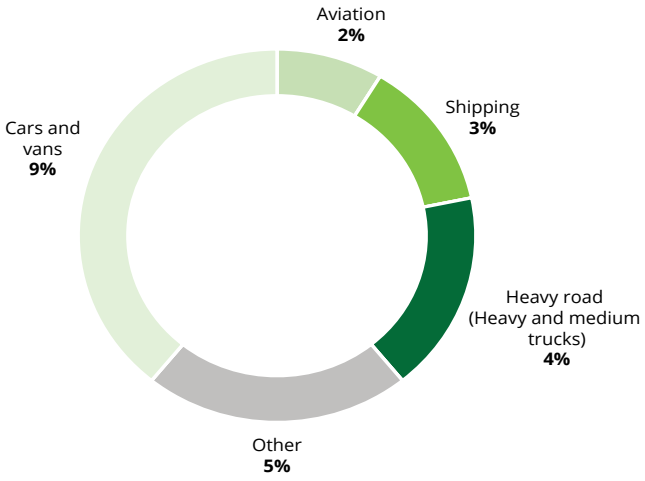
Given the complexity of road freight operations, developing a pathway for decarbonization will not be straightforward. Currently, the technology curve to support decarbonization for heavy-duty trucks (HDTs), which account for two-thirds of heavy road transport emissions, is still in its early stages. This includes technologies that utilize hydrogen, including fuel cells and High Pressure Direct Injection (HPDI) fuel systems.

Despite these challenges, there is reason for optimism. The current technology landscape supports the decarbonization of light-commercial vehicles (LCVs) and a portion of medium-duty trucks (MDTs) via electrification and alternate fuels, such as biodiesel.[5] Thanks to financial incentives available in most countries, the transition of LCVs and MDTs to green energy is becoming increasingly commercially viable. Additionally, zero-emission vehicles (ZEVs) and internal combustion engine vehicles (ICEVs) are approaching Total Cost of Ownership (TCO) parity in certain geographies, supporting the imminent decarbonization of short-haul fleets.

Given these disparate scenarios, the path to net-zero won't be linear. However, strategies do exist for the decarbonization of the heavy road transport sector. Here, we take a look at some of the challenges the industry faces and suggest a phased approach that may help the industry achieve its decarbonization goals.

Figure 1:

Contribution of global CO_2 emissions from Transport sector



Challenges on the pathway to net-zero

Slow transition away from internal combustion engines (ICE)

Battery electric vehicle (BEV) technology has matured significantly in recent years and has found its way into short-haul applications in certain geographies. However, while the use of BEVs is increasing, sector-wide transition is expected to be slow given both the size and scale of the sector and the lack of sufficient production facilities to meet rising demand. The bigger obstacle may be the lack of a commercially viable technology to transition long-haul vehicles away from ICEs, which could take several years to develop.

Infrastructure limitations

The impending growth in vehicle electrification will need to be supported by renewable energy-driven charging capabilities to feed green electrons in batteries, thus enabling decarbonization for the end-to-end value chain. While developments in charging infrastructure have begun in several regions, a combination of depot charging and public charging locations will be required to meet the rising demand. To make green infrastructure universally accessible and meet sector decarbonization goals, collaboration between public and private sector entities will be critical. Similarly, as research in hydrogen technologies expands, it will become increasingly necessary to proactively plan for a green hydrogen fueling infrastructure capable of accelerating on-the-ground implementation.

Fragmented market dynamics and psychological barriers

Some transportation companies have committed to aggressive net-zero goals. However, due to the fragmented nature of the industry and reliance on small fleet owners/individual drivers, many face an uphill battle. Lack of operational familiarity with new technology (e.g., time to charge, charging station functionality, and limited access) may discourage drivers from adopting new transport technologies. This challenge is often more pronounced in developing countries, where resources stressing the importance of decarbonization may not be as prominent.

Difficulty tracking and reporting emissions

While major regulators have been setting guidelines for emissions reporting, many large transportation companies lack the technology to effectively track their Scope 1 and 2 emissions. Additionally, many lack visibility into their Scope 3 emissions as this information may come from small trucking companies that also lack emissions tracking and reporting capabilities. Their ability to report on comparable data is further challenged as emissions tracking and reporting guidelines are often not standardized across geographies.

The regulatory response

Favorable regulatory policies are emerging across major economies

Despite the real barriers facing the industry, regulators worldwide have made considerable strides in the push towards decarbonization, with many focused on achieving Nationally Determined Contributions (NDCs) in accordance with the Paris Agreement (Figure 2).

In Europe, the European Green Deal, approved in 2020, presents a road map for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across several policy areas. In the US, the Biden administration announced the Inflation Reduction Act (IRA) to combat climate change and the US Department of Transportation (USDOT) released an updated Climate Action Plan to make sure that transportation infrastructure is built to be resilient to climate change. Additionally, the state of California has mandated that 100% of new LCVs and MDTs sold in the state to be zero-emission by 2035. Meanwhile, China introduced its first national emissions-trading scheme, as well as defined emissions standards for new vehicles (China 6 legislation).

Several G20 countries have also made strong progress around policy, technology, feedstock, and supporting infrastructure to create an environment favorable for bio-energy development. For example, India achieved its 10% ethanol blending target ahead of its original June 2022 schedule, and is on its way towards achieving its national target of 20% blending by June 2026.

A strong push for electrification, biofuels, and hydrogen is needed now

To maintain this momentum, however, now is the time for major economies to set up additional incentive programs designed to make the transition to a clean vehicle ecosystem cheaper and easier.

For example, the Inflation Reduction Act introduced by the Biden administration in the US provides a tax credit up to US$40,000 per vehicle for new purchases of commercial clean vehicles, as well as a tax credit up to US$100,000 for refueling and charging stations for alternative fuels technologies, such as electricity, hydrogen, and biodiesel.[6] These new incentives make EV light-duty and medium-duty vehicles on par with—or cheaper than—conventional fuel alternatives over 15 years of ownership.[7]

A similar approach is needed for heavy-duty vehicles, which require significant technology advancement, as well as public-private collaboration across leading markets to encourage innovation, accelerate production, and facilitate adoption. To this end, regulatory bodies and major corporations will need to collaborate to create favorable economics and voluntary demand for hydrogen, a key solution for industry-wide decarbonization.

Figure 2:
Regulatory landscape in the United States, European Union, and Asia/Pacific

A phased approach

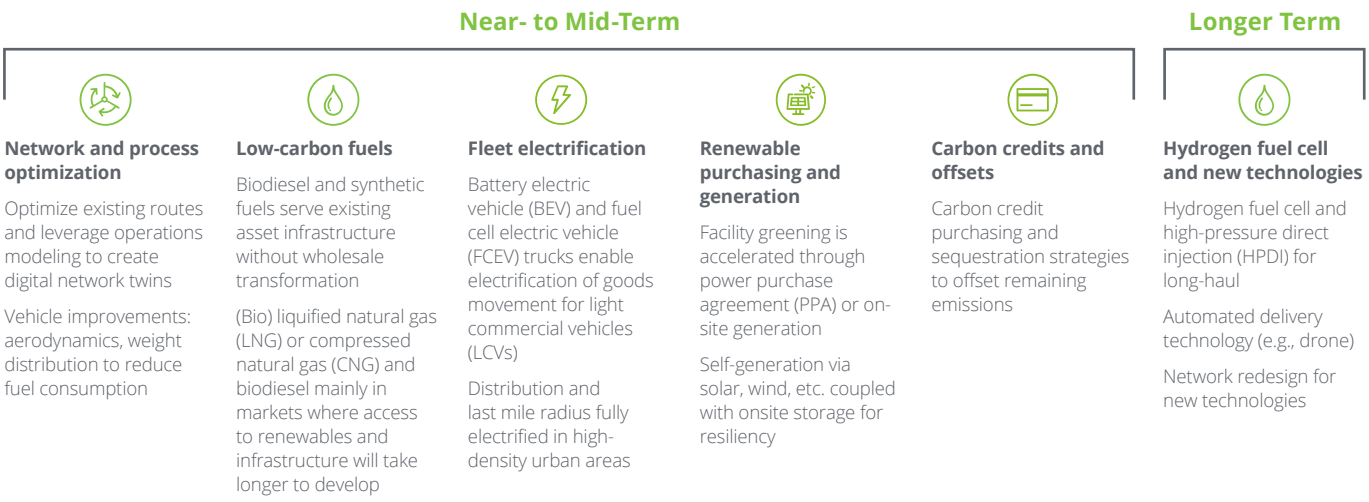
Even with a supportive policy environment, the heavy road transport industry's path to net-zero won't be linear. As such, organizations need to understand the key trigger points that may cause certain scenarios and pathways to play out.

Initially, the sector will likely decarbonize in phases by deploying a variety of technological levers and abatement strategies to reduce baseline emissions (Figure 3). In the near- to medium-term, optimizing routes and transport networks, along with electrifying short-haul fleets, are likely to be some of the highest-impact solutions for the sector in receptive markets that have supportive policies and incentives. Electrification is expected to take longer in certain developing geographies, where biodiesel and synthetic fuels may play an important role during transition.

Transitioning to ZEVs will require companies to develop a data-driven approach to support decision-making for planning and implementation, since the combination of drive and duty cycle variables can result in a sizeable number of business case applications and there is no "one-size-fits-all" solution. Several key variables impacting road freight operations, such as distance driven, number of stops, average and maximum speed, drive time, geographical coverage, and route predictability and repeatability, need to be analyzed to establish a baseline of current utilization, greenhouse gas (GHG) emissions, and operational costs. An actionable, multi-year implementation road map needs to be built through the lens of different key priorities such as maximum GHG reduction, maximum savings, or vehicle obsolesce, projecting annual cash flow and GHG reduction. This plan will help determine most suitable ICEVs that can be replaced with EVs, Biofuels or other alternatives based on battery usage, fueling access, lifecycle, temperature, and electricity costs along with identifying prioritized routes and terminals to achieve desired reduction in emissions. To further decarbonize the end-to-end value chain, companies may also investigate facility greening options through power purchase agreements or by investing in renewable self-generation.

Eventually, hydrogen powered vehicles are expected to support industry-wide decarbonization for longer distances, but the technology cycle for hydrogen has not yet reached the point of mass production. As such, decarbonization of long-haul fleets can only begin in earnest with substantial technological advancement and the emergence of a viable hydrogen economy. Until such time, transportation industry leaders will need to rely on a combination of strategies, such as using biofuels, converting short-haul fleets to BEVs within optimized networks, greening their facilities, and investing in carbon offsetting and sequestration mechanisms to meet their decarbonization commitments. It will be equally critical for organizations to take a scenario planning approach to achieve their decarbonization ambitions. Being clear on the "no regrets" actions that should be taken relative to various scenarios will help enhance agility and responsiveness.

Figure 3:
Technological levers and abatement strategies: Various offset mechanisms, including nature-based solutions



Key drivers for transformation

Collaboration across players within the heavy road transport ecosystem will be critical to meet the sector's decarbonization ambitions.

As customers (wholesalers, retailers, and manufacturers) look at their entire end-to-end supply chains from a net-zero perspective, logistics providers will be assessed holistically against their carbon footprint, cost-to-serve, and reliability/on-time performance. This could result in customers evaluating the trade-offs and choosing different transportation mode solutions for certain parts of their supply chains. To prevent revenue loss due to this potential competitive disruption (e.g., alternative or substitute freight/logistics mode options, such as rail and drones), many different players in the HRT ecosystem, beyond fleet operators and owners, will have to come together to chart the sector's transition to decarbonization. Cross-functional partnerships between key ecosystem players will drive the pace of technological advancement and infrastructure development to create a win-win situation while mitigating investment risk.

A combination of enabling policies, incentives, and infrastructure availability in first-mover regions is essential to stimulate demand through pilot applications. Success in these regions can strengthen business case and performance confidence for ZEVs and can act as a catalyst for market expansion of vehicle component technologies, thus enabling flow of innovation across borders.[8]

While technology for BEVs has matured and biofuels are becoming readily available in certain economies, paving the path for short-haul fleet conversion, the question of long-haul fleet decarbonization is more difficult to answer. It is imperative for key stakeholders to understand their roles and responsibilities in the sector's journey to decarbonization and align on key priorities to help bridge the technology gap for long-haul fleets. Financial and policy support for developing a hydrogen economy is needed, and early adopters can influence the direction of transition in their favor and reap the long-term benefits.

Figure 4:
Key stakeholders in the HRT value chain for decarbonization

Regulators should work with infrastructure developers to set standards for battery charging, biofuels, and hydrogen fueling and develop actionable plans to cover entire road networks.

Policymakers should implement a combination of policies and incentives to enable Total Cost of Ownership parity between ZEVs and diesel vehicles across all regions.

Energy providers should support the transition through favorable utilities pricing to stimulate investment in building charging and fueling infrastructure.

Given the fragmented nature of the sector (90% of companies own fewer than 10 trucks),[9] **fleet owners** should form buyers' coalitions to pool demand and make joint purchasing commitments to drive original equipment manufacturers' (OEM) investment in ZEV production.

Shippers should build end consumer awareness around benefits of low carbon transport, while establishing long-term contracts with fleet owners/ operators to convey a robust demand signal up the value chain.

Financiers should create tailored funding products to support small fleet owners with ZEV procurement.

Research institutions in collaboration with other players should play an active role to drive innovation in alternate technologies and accelerate the economic viability of hydrogen.

The path forward

With a supportive regulatory environment and investment dollars allocated to the decarbonization of the heavy road transport industry, the path towards net-zero is becoming increasingly clear. As light-commercial vehicles and a portion of medium-duty trucks begin to electrify and shift to alternate fuels, the industry is bound to experience initial wins. Although the decarbonization of heavy-duty trucks and long-haul fleets will require technology investment and the emergence of a viable hydrogen economy, a phased approach to implementation is already in sight.

Authors and Contacts

This paper is part of a collection of insights on possible pathways to decarbonization for high-impact sectors. Each sector perspective offers a foundational starting point for leaders who would like to better understand the landscape across these critical sectors. For additional sector papers and links to in-depth reports, please visit Pathways to decarbonization on Deloitte.com.

At Deloitte, we believe that transformation hinges on cross-industry collaboration and a long-term commitment to sustainability—both within the industry and within society at large. Our Transportation team has proven experience helping companies identify and accelerate their path to decarbonization by facilitating private-public partnerships, creating customized decarbonization solutions, and providing in-depth expertise.

To learn more about how we can help your organization lay the foundation for a net-zero future, contact us.

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Endnotes

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