Challenges and Opportunities to Decarbonize

Introduction

The Heavy-duty trucks, defined as commercial vehicles that can safely operate at a gross weight over 12 metric tonnes, constitute a significant and growing share of greenhouse gas (GHG) emissions. Globally, heavy-duty trucks emit 1.2 gigatons of CO2, roughly equivalent to more than 3% of global energy-related emissions, and emissions have increased by an average of 2.2% per year since 2000.

Solutions to decarbonize on-road freight exist but face compounding challenges: high capital costs, limited supply of zero-emission vehicles, and underdeveloped charging and fueling infrastructure. Despite these challenges, which are notably present for class 8 tractors, forward-looking companies continue to search for tools to take advantage of opportunities to decarbonize their on-road freight operations.

Challenges to Decarbonize On-Road Freight

Decarbonizing heavy-duty trucking is difficult for many shippers and carriers due to a set of overlapping factors.

For Shippers:

- *Complex stakeholder landscape:* Layered on top of multi-tier supply chains is the widespread use of third-party logistics (3PL) providers. While 3PLs offer shippers valuable flexibility and expertise in managing freight movements, they add a degree of separation between the shipper and the carrier actually hauling the shipper's goods. This lack of visibility makes it difficult to engage directly with carriers or apply purchasing leverage toward zero-emission services.
- *Limited supply of trucks, fuel, and infrastructure:* Even shippers with strong sustainability commitments and clear supply chain visibility face a practical constraint: the market for zero-emission heavy-duty trucking services is nascent and geographically uneven. The number of carriers operating zero-emission fleets remains small, available charging and hydrogen fueling infrastructure is concentrated in a handful of markets, and the routes that can reliably support zero-emission operations are limited. A persistent mismatch exists between where shippers need goods moved and where zero-emission trucking capacity is available.

- *Emissions deep in the value chain:* For many companies, on-road freight emissions are not generated by tier 1 suppliers they interact with directly, but are embedded several tiers back in the value chain. For example, a tech company may purchase construction material for a new building through a general contractor (tier 1). The general contractor may then hire a subcontractor (tier 2) who works with the material manufacturer (tier 3) to get the products delivered. For the tech company, the material manufacturer who is operating the heavy-duty class 8 tractor is many tiers removed from their control and influence. This structural separation can make it difficult to identify the specific carriers responsible for the emissions, let alone influence their vehicle choices or contract terms.

For carriers:

- *High capital costs:* Zero-emission heavy-duty trucks currently cost two to four times more than comparable diesel vehicles. While total cost of ownership models show that lower fuel and maintenance expenses can close this gap over the life of the vehicle, the upfront capital requirement is substantial and difficult to finance.
- *Short-term contract structures*: Logistics teams tend to favor short-term contracts (ranging from on-demand to one-year) driven by the need to respond to seasonal fluctuations and shifting business priorities. While this flexibility is operationally valuable, it creates a structural barrier to decarbonization. Zero-emission trucking services require carriers to make large upfront capital investments in new vehicles and infrastructure. Without long-term demand assurance from shippers, carriers lack the revenue visibility to justify or finance those investments which have long useful lives.
- *Infrastructure availability:* Charging and hydrogen refueling infrastructure remains a major operational constraint for carriers considering zero-emission trucks. Publicly accessible heavy-duty charging depots are limited in number and unevenly distributed, creating range anxiety and operational uncertainty for carriers whose routes extend beyond well-served urban markets.
- *Customer willingness to pay/commit:* Even when a carrier is committed to transitioning to zero-emission vehicles, the business case may break down at the customer relationship level. Shippers that are unwilling to pay a green premium or provide strong, multi-year commitments leave carriers absorbing the full cost differential between zero-emission and diesel operations, which makes the business case uneconomical and impossible to justify.

Opportunities to Decarbonize On-Road Freight

Despite numerous challenges to decarbonize the heavy-duty trucking sector, opportunities to shift to zero emission options do exist. There is no single correct pathway - companies are encouraged to pursue the options that are most economically feasible and operationally realistic given their shipping needs, supply chain data, contractual relationships, and geography. The options below are not mutually exclusive; many companies will find value in pursuing several in parallel.

- *Direct, physical procurement:* For shippers with direct visibility into their supply chains and consistent, mid-range routes in high volumes from a particular region, direct physical procurement is a great option. This involves working with identified carriers to arrange transport of goods on zero-emission trucks, whether through a green premium added to existing logistics contracts, a renegotiated service agreement, or a switch to a carrier that already operates a zero-emission fleet on relevant routes. Companies should also consider using their purchasing influence with incumbent carriers to encourage fleet electrification, particularly where long-term volume commitments can provide the demand assurance carriers need to justify investment.

- *Book and claim:* Book and claim systems enable organizations to support decarbonized goods and services that are otherwise physically inaccessible due to complex supply chains or limited geographic availability. Under a book and claim model, an organization provides financial support to a carrier to transition to zero-emission vehicles or cover the cost premium of operating them. In exchange, the shipper receives the right to claim the associated emissions reductions without their goods needing to be physically moved by that carrier. This decoupling allows companies to drive real-world decarbonization in the freight sector even when direct procurement is not yet feasible. For more information about book and claim systems visit https://gmacenter.org/ or learn more here.

- *Alternative fuels:* Renewable diesel and biodiesel are examples of alternative fuels that can reduce heavy-duty trucking emissions, especially in the near-term while the availability of zero-emission vehicles is limited.

- *Load and route optimization:* For companies with operational control over their freight logistics, load and route optimization represents a high-impact, near-term opportunity that does not require new vehicle technology or infrastructure. Minimizing deadhead[1]

[1] A "deadhead" trip is one where the truck transports goods from one location to another but returns to the original location empty.

trips, maximizing cargo space, reducing idling time, and opting for the most fuel-efficient route have proven effective in reducing on-road freight emissions.

- *Modal switching*: Modal shifting is the practice of employing more efficient transportation options, such as rail or ships, in place of long-haul trucking where operationally feasible and when low-carbon on-road freight options don't exist. Not only can this be a sustainable route for companies looking to reduce their carbon footprint, but it can be cost effective when the trucking industry is experiencing driver shortages.