Decarbonising Road Freight: GETTING INTO GEAR

Industry Perspectives

EXECUTIVE SUMMARY

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FOREWORD

The world today is going through a period of intense change. There are tremendous challenges from the immediate shock of the pandemic to the longer-term effects of climate change. But if there is uncertainty, 2020 also showed what the world can achieve when it works together: the hope that vaccines can provide. And across the world, businesses and governments are setting goals in line with the Paris agreement on climate change.

Almost 1,400 businesses, more than 450 cities and more than 120 countries are part of the largest ever alliance committed to stop adding to the amount of greenhouse gases in the atmosphere by 2050. In other words, achieving net-zero emissions and doing so in just a few decades. Such goals demand broad collaboration.

In April last year, Shell also announced our own ambition to be a net-zero emissions energy business by 2050 or sooner, in step with society and our customers. This will require working with others in a way and at a scale we have never seen before. In 2020, we published the Decarbonising Shipping: All Hands on Deck report. This amplified our work with customers and partners in sectors where it is hardest to reduce carbon emissions. The report helped to inform Shell strategy and encouraged carbon reduction commitments in the sector. It gives me great pleasure to introduce our second report, based on a second collaboration, this time with the road freight sector.

Trucks move almost everything that modern society depends on in daily life. During the pandemic, road freight played a vital role. With around 3 million companies operating about 217 million vehicles, the sector accounts for about 9% of global carbon dioxide emissions - and demand for road freight is set to double before 2050. So how can a sector made up of so many different parts jointly take the steps needed to reduce emissions?

This report is driven both by urgency and the need for collaboration. It is based on more than 150 interviews across the industry, from logistics companies to vehicle manufacturers and regulators. It identifies 22 solutions for the sector to start reducing emissions right now and increase the speed of the transition to low- and zero-emission vehicles.

The solutions include immediate action through the increased use of existing technology, such as battery-electric technology for the shorter-range, lighter vehicles used in cities. In the longer term, they include hydrogen as a fuel for heavier trucks that travel further with a greater load. The solutions include the need for greater regulation, increased production and improved infrastructure to sustain growth. The principle of collaboration runs throughout.

Shell uses a contracted fleet of around 3,000 heavy-duty trucks and delivers fuels to almost all of our 45,000 retail sites worldwide. As well as supplying fuels, lubricants and vehicle charging services, Shell is also expanding our hydrogen projects, from production to refuelling networks. In our companion report Decarbonising Road Freight: Shell’s Route Ahead, we set out the actions we are taking to help reduce emissions in this sector.

The solutions provide a plan of action, a path towards net-zero emissions by 2050 in the road freight sector. I believe this is possible because of the steps the industry has already taken - and its will to go even further. The report shows an industry that is not only engaged and prepared to change, but ready to get into gear for the journey ahead.
RESEARCH OBJECTIVES

This research paper reflects the perspectives of over 150 executives and experts, representing 123 organisations across almost all segments of the road freight sector and 22 different countries [see Exhibit 01]. It aims to:

- **Take a comprehensive view.** Many decarbonisation studies focus on specific challenges or stakeholder groups in isolation. Given the interdependency of factors, the sector needs a more comprehensive view, which includes economic, regulatory and organisational factors.

- **Clarify a practical way forward.** Road freight leaders who participated in this research are at a point where they need to make decisions around decarbonisation. We worked with them to converge on a set of solutions and a roadmap that can help the industry act now and clarify the path forward.

- **Reflect the voice of the industry.** No one stakeholder group can do this alone, and everyone will have a role to play. It is essential to understand the unique motivations and challenges of different groups and geographies, to develop solutions that will make an impact.

The primary driver for publishing this report is to highlight the insights participants shared with us through interviews and working sessions, not the views of Shell or Deloitte. All engagements with interviewees were conducted in a manner that respects competition law boundaries.
Executive Summary
DECARBONISING ROAD FREIGHT: GETTING INTO GEAR

Research highlights

Why should the sector change?
1. The sector is facing several barriers to decarbonisation ‒ especially limited infrastructure, insufficient regulatory incentives and lacking demand from shippers.

Can the sector change?
3. To converge on a viable low- and zero-emission technology, the sector needs to adopt a duty cycle perspective.

How fast can the sector change?
4. Through collaboration around a catalogue of 22 solutions, the sector will be able to reduce emissions now and accelerate a shift to low- and zero-emission trucks.

5. The sector has defined a decarbonisation roadmap, which allows it to start deploying low- and zero-emission trucks at scale by the late 2020s.

6. Achieving significant emissions reduction requires a concerted global effort, with leading regions and companies sharing knowledge and supporting others to leapfrog ahead.

Road freight is the most visible and most flexible part of the global supply chain. Trucks move virtually everything modern society depends on for daily life. During the COVID-19 crisis, we have all experienced just how critical road freight is in bringing essential goods to where they are needed the most. However, road freight is a highly fragmented sector, and with around three million companies operating some 217 million vans, trucks and buses globally, it is also a major source of greenhouse gases (GHGs). The sector accounts for around 9% of global CO₂ emissions, with the US, Europe, China and India responsible for more than half of that total. As the global economy returns to growth in the coming years and decades, so too will carbon emissions from road freight.

Around 60% of the sector’s CO₂ emissions are generated by the around 63 million medium- and heavy-duty trucks (MDTs and HDTs respectively), which are the main focus of this research. These large vehicles are well served by today’s diesel powertrains, which allow them to carry loads that are many times their own weight, and over hundreds of kilometres each day. These characteristics mean emissions from MDT and HDT classes will be harder-to-abate.

To meet the targets set out in the Paris Agreement, absolute emissions from road freight will need to decline almost 60% by 2050, despite a possible doubling of road freight volume over the same period. This means that the sector will need to realise an emission intensity reduction of over 80% in less than 30 years. More pressingly, the sector’s emission intensity will need to decline by around 30% before 2030. On the current trajectory, the road freight sector will not meet the targets of the Paris Agreement. It is clear a concerted effort is needed to break down the challenge and co-ordinate the industry around meaningful solutions.

Through interviews with over 150 executives and experts across the global road freight sector, we have broken down what is often seen as an insurmountable problem into manageable components. We did that by applying a comprehensive, ecosystem-wide lens to decarbonisation, focusing on three core questions: “Why should the sector change, can the sector change, and how fast can the sector change?” The interviews generated six main highlights around the three core questions (see Exhibit 02).
Barriers to Decarbonisation

1. RESEARCH HIGHLIGHT

The sector is facing several barriers to decarbonisation—especially limited infrastructure, insufficient regulatory incentives and lacking demand from shippers.

Relatively cheap trucks and diesel fuel, and near-universal access to fuelling infrastructure, underpin the current attractiveness and flexibility of the road freight sector. Around 80% of interviewees consider insufficient access to fast battery charging and hydrogen fuelling infrastructure as a limiting factor, because “no operator will take a chance on a new truck unless they are certain they will be able to fuel or charge it,” in the words of one fleet owner. Interviewees highlight insufficient supply of renewable electricity as one of the key reasons for the lack of infrastructure. “We first need to overcome the shortage of green electricity and hydrogen. Otherwise, neither BEVs nor FCEVs will make a difference,” noted a road freight financier.

Interviewees indicate also that alternative technologies required to decarbonise—namely battery electric vehicles (BEVs) and fuel-cell electric vehicles (FCEVs)—are still “prohibitively expensive to buy and use.” Around 80% of interviewees believe that an absence of well-designed regulatory incentives to reduce this cost difference in the initial years of the transition will be a major barrier preventing fleet owners from investing in low- and zero-emission trucks at scale.

Around 70% of interviewees indicate that the shippers’ willingness to incentivise lower-emission road freight services is critical to free up investment in decarbonisation. Although many shippers make sustainability commitments at the boardroom level, and sometimes even ask their logistic partners about low-emission trucks, when it comes to procurement criteria, these incentives are currently lacking. “There is a huge pressure on transportation to be cheap,” noted an executive from a large logistics company.

These three barriers were mentioned most frequently by interviewees, but several other challenges were also identified. For example, many fleet owners pointed out that while alternative technologies are already available, original equipment manufacturers (OEMs) have been slow to produce new trucks at scale. These interviewees explained that OEMs are waiting for more certainty of demand—especially as they need to balance the needs of the dominant diesel business and short-term investor expectations. Some interviewees explained that demand for new trucks will be limited by uncertainty about their residual value, namely the ability of first owners to resell them at an attractive price in the secondary market.

Conversely, many interviewees noted that there are opportunities to reduce emissions even before alternative technology trucks are introduced—particularly as the way current fleets are managed is often inefficient, with “up to 50% of trucks driving empty,” as noted by one logistics executive.
### Barriers to decarbonisation

<table>
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<th>Readiness questions</th>
<th>Readiness factors</th>
<th>Participants’ view on criticality of barriers</th>
<th>The line represents the relative criticality of the barriers, but its absolute position differs depending on the context in each region</th>
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<td><strong>Why should the sector change?</strong></td>
<td>1. Market and Customer Demand</td>
<td>~70% Major barrier 100%</td>
<td>Minor barrier 0%</td>
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<td>2. Regulatory Incentives</td>
<td>~80% Major barrier 100%</td>
<td>Minor barrier 0%</td>
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<td><strong>Can the sector change?</strong></td>
<td>3. Technology Alignment</td>
<td>~65% Major barrier 100%</td>
<td>Minor barrier 0%</td>
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<td>4. Clarity on Roles and Decision Making</td>
<td>~55% Major barrier 100%</td>
<td>Minor barrier 0%</td>
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<td><strong>How fast can the sector change?</strong></td>
<td>5. Ease of Asset Replacement</td>
<td>~40% Major barrier 100%</td>
<td>Minor barrier 0%</td>
</tr>
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<td>6. Ease of Infrastructure Replacement</td>
<td>~80% Major barrier 100%</td>
<td>Minor barrier 0%</td>
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Although sector stakeholders are acutely aware of the challenges ahead, a real sense of optimism is emerging. That optimism is underpinned by bold commitments to emission reduction made by business and political leaders around the world, such as the plans to achieve climate-neutrality in the European Union (EU) by 2050 and in China by 2060. Many interviewees indicated that over the past few years, unprecedented progress has been made in almost all aspects of decarbonisation, from increasing demand and accelerating regulation to maturing technology. The sector is entering a new phase on its decarbonisation journey, with some interviewees going as far as saying that “road freight is not ‘hard-to-abate’ any more.”

On the demand side, large shippers of goods are under increasing pressure from their customers, investors and employees to tackle emissions in their supply chains. This pressure has started to translate into tangible action, with shippers that operate their own truck fleets in particular making flagship commitments and large-scale investments in low- and zero-emission technologies.

“We are now starting to really walk the talk on decarbonisation as it’s clear that what is good for society is good for business,”

Global Shipper

Regulators are not standing still, and almost every week brings new announcements about even more ambitious decarbonisation pathways at a regional, country or even city level. Many interviewees welcome these developments because “while Fortune 500 companies might be able to do it themselves, everyone else will need policy support.” Interviewees expect the next five years to bring further regulatory acceleration, with a possible convergence of targets across most geographies in the second half of the decade. The growing investment in green energy projects, such as the EU’s Hydrogen Roadmap, also reflects a concerted move to lower the cost and create a more abundant supply of sustainable fuels.

Against this backdrop, over 70% of interviewees perceive road freight decarbonisation as a top or top-three priority for their organisation. Many stakeholders believe the sector is close to an inflection point due to increasing regulatory and market pressure, and will evolve faster than many expect.
point and that decarbonisation will evolve faster than many expect. Contrasting road freight with other sectors undergoing the transition, one interviewee pointed to studies that show that during major transitions “everything can look like a failure in the middle – even while significant progress is being made.”

Although not yet commercially viable, the technologies to decarbonise road freight exist, and most OEMs are developing FCEVs and BEVs. Once the pieces start falling into place, with aligned incentives, trucks being produced at scale and visibly accessible infrastructure, the progress will become clear to the whole sector.

“There are a lot of opportunities that we couldn’t have imagined 10 or 20 years ago.”

Logistics Company

When analysing alternative technologies applicable for road freight, most studies focus on truck size. Looking through that simple lens, the bigger the truck, the more difficult it is to decarbonise. In reality, the around 63 million MDTs and HDTs are used in very different ways. They are part of an intricate logistical network in which their roles range from connecting production sites thousands of kilometres apart to delivering food to supermarkets in urban areas.

Developing a view on how the sector might decarbonise calls for a deeper understanding of the way trucks are used. We must apply different lenses, such as distance driven, geographical coverage, how predictable and repeatable the routes are, and number and length of breaks. This allows the sector to make progress in specific duty cycles early, instead of waiting for a solution that is optimal across the board. In some cases, the sector stakeholders may choose to fundamentally reorganise their supply chains to take advantage of the emerging technologies and make their fleets more efficient. It is also becoming clear that in the long-term “no one size fits all,” and the sector will need to work with different technologies for different applications. Both battery electric and hydrogen trucks have a role to play.

3. RESEARCH HIGHLIGHT

To converge on a viable low- and zero-emission technology, the sector needs to adopt a duty cycle perspective.
Solutions

4. RESEARCH HIGHLIGHT

Through collaboration around a catalogue of 22 solutions, the sector will be able to reduce emissions now and accelerate a shift to low- and zero-emission trucks.

Interviewees recognise that the challenge of decarbonising road freight is too large for any one organisation or even one stakeholder group alone. Only a joint, collaborative effort will allow the sector to take advantage of the changing paradigm and make progress quickly, with one logistics company executive urging: “Let’s not ponder about the chicken-and-egg problem of infrastructure and truck production, but start to collaborate and enable the ecosystem to make it happen.”

The 22 solutions, or recommendations for actions, that emerged from research, interviews and workshops, provide more clarity on why and where the ecosystem should collaborate. These solutions demonstrate not only the breadth of ideas and initiatives already present in the sector, but also the variety of actions that must be undertaken and the range of stakeholders that must be involved. The sector stakeholders should work together by sharing the costs and benefits of the transition, to make sure the initiatives become self-sustainable, and to overcome the remaining decarbonisation barriers.

The 22 solutions fall under four main categories, based on their shared characteristics:

- **Make impact now.** Solutions that can be started immediately, using existing technologies, leading to significant short- and medium-term reductions in emissions. Firstly, last-mile delivery and city buses can be largely electrified, reducing pollution and noise in cities. Secondly, the sector should focus on reducing emissions from the current fleet through proven cost-saving technologies. This can be done by implementing digital and data analytics tools to reduce the number of empty trucks on the road, or improving the efficiency of the trucks themselves through low-friction tires and lubricants, improved aerodynamics and driver assistance devices. Thirdly, where sufficient supply exists, the sector can deploy transition solutions such as liquefied natural gas (LNG), compressed natural gas (CNG), bioLNG and biodiesel to begin reducing tailpipe emissions. This may in some cases include offsets, in those situations where they do not substitute investment in zero-carbon technologies, and should be directed at programmes that contribute to decarbonisation pathways, like renewable electricity generation.
• **Create a snowball effect.** To deploy zero-emission vehicles at scale, fleet owners, infrastructure providers and OEMs should launch joint truck and infrastructure pilots in high-volume clusters and corridors. Demand for alternative technologies needs to be further stimulated by shippers putting greater emphasis on emissions in transport procurement, and by financiers creating green products – aimed at smaller fleet owners in particular. With fleet owners coming together to make joint purchasing commitments, OEMs will be more willing to invest. Through technology partnerships – for example, with fuel-cell and battery producers – OEMs can accelerate the commercialisation of trucks. And novel revenue models could reduce the risk for fleet owners by creating secondary-market certainty. More trucks on the road means more reliability, lower cost and yet more infrastructure, which in turn creates incentives to invest further. “If you build it, they will come,” said one financier, indicating the need for decisive action and suggesting that the bold first-movers are set to reap disproportionate rewards.

• **Build conditions for success.** In parallel, the sector should give stakeholders incentives to move to widespread adoption of zero-emission trucks. Regulators will play a key role here, expanding incentives for OEMs, energy companies and truck owners, clarifying regulatory pathways and creating joint-city campaigns. Especially in the early stage of the transition, the role of regulatory incentives will be important because “we will need to invest in new trucks long before the market demand for green trucks scales. We need help to bridge that timing gap,” in the words of one technology provider. Regulators will also work with energy companies and industry bodies to set standards for battery charging and hydrogen fuelling. Standards and certification programmes can also be set up by industry bodies to assess the carbon intensity of fleets and serve as a reliable metric in transportation tenders. Shippers will focus on increasing consumer awareness around low carbon transport, while OEMs will scale up research and development (R&D) in collaboration with other sectors. Finally, key sector stakeholders will share non-competitively-sensitive information to encourage uptake of alternative technologies.

• **Scale.** As demand and supply grow, the sector will focus on mass production of trucks and fuels, ensuring maintenance capability and integration with other technology roadmaps.
The Roadmap

5. RESEARCH HIGHLIGHT

The sector has defined a decarbonisation roadmap, which allows it to start deploying low- and zero-emission trucks at scale by the late 2020s.

Road freight decarbonisation has already started. Sector stakeholders have at their disposal the products of enormous technical, market and regulatory progress made to date. Importantly, in comparison with other, harder-to-abate sectors, like shipping, road freight trucks are small, less expensive and have shorter lifespans. This allows the road freight stakeholders to iterate through technology cycles faster - for example, by making investments in LNG, CNG, bioLNG or biodiesel now, and changing to BEV and FCEV when they become viable.

To meet the Paris Agreement targets, zero-emission trucks must be commercially viable and must enter the fleet at scale by the late 2020s. Many interviewees believe this can be done, but it requires the sector to act decisively, starting to work on the first ten solutions within the next two years. In these initial years, the goal is to take maximum advantage of existing technologies to reduce emissions quickly, while dramatically expanding the reach and scope of alternative technology pilots. Simultaneously, the shippers need to start translating board-level decarbonisation commitments into consumer propositions, while the regulators at all levels need to chart the policy pathway for the next decade.

“Don’t wait for the perfect solution; pilots, learning fast and deploying is the way to go.”

Shipper

Understanding the triggers and behaviours of different stakeholders will be a key to success. For example, shippers with their own truck fleets already play an important role in kick-starting decarbonisation, as they have greater control over the technology used and see greater benefits from sustainability investments. Conversely, for financiers to fund alternative technology trucks, they will require additional assurances that debts will be repaid. These could include longer-term contracts between shippers and transport companies, or truck value guarantees. Targeted incentives from the regulators will also go a long way toward stimulating technology uptake.

Before the mid-2020s, the sector will need to step up its R&D efforts and start deploying FCEV and BEVs to commercial operations. Incentives provided by shippers, financiers and OEMs will be critical to stimulate initial
Demand. At that stage, battery charging and hydrogen fuel cell infrastructure will also need to be standardised, to enable wider roll-out and cross-operability.

In the late 2020s, as infrastructure providers and OEMs scale up production, low- and zero-emission trucks will get close to cost parity with diesel and will start entering the fleet at scale.

Road freight decarbonisation is a global challenge. Europe and the US together account for 30% of global emissions, and as the other markets grow, this share will further decline. Although Europe has historically been seen as a champion of sustainability, in many respects China already leads the road freight decarbonisation agenda, with one industry group representative noting that “China is heavily investing in alternative technologies for buses, and leading the hydrogen economy for heavy trucks.” To achieve significant emissions reduction at a global level, other large countries such as India – and increasingly those in Africa and South America – will need to accelerate their efforts.

Although the solutions identified in this study are globally applicable, each market has unique conditions and challenges that must be addressed as part of the transition. Fuel supply, technology maturity and access to infrastructure will determine which solution is the best to start with. For example, in some countries or regions, like India, transition fuels and even modernisation of diesel engines might play an important role longer, while in others, like China and the EU, hydrogen forms part of the industrial strategy and as such will be favoured early on.

In all cases, cross-border collaboration and multinational actors will be key to accelerating learning, so that as solutions mature in one geography, they can be applied in others, allowing them to leapfrog ahead to a decarbonised future.

At the start, it will likely be a very small group of like-minded companies that will lead the charge and work together to create momentum around the transition. These first-movers will reap the benefits of early access to differentiated insights, and will have the ability to share risks and investments and to influence the direction of the transition in their favour. The engagements they make with their customers and other ecosystem players during the early phases of the transition can reconstruct and strengthen these relationships into the future.

As these early initiatives bear fruit, more companies will join to create the necessary scale and make impact across the sector. The path forward is clear, and it is time to ‘get into gear’.

6. RESEARCH HIGHLIGHT

Achieving significant emissions reduction requires a concerted global effort with leading regions and companies sharing knowledge and supporting others to leapfrog ahead.
Solutions Roadmap

**Scale**

14. Expanded policies for energy providers
13. Expanded policies for OEMs
12. Joint city campaigns
11. Regulatory pathways
10. Consumer awareness and choice
6. Joint truck-purchasing commitments
5. Technology partnerships
4. Pilots in clusters and corridors
3. Operational and design efficiencies
2. Targeted deployment of transition technologies
1. Transition of viable duty cycles

**Build conditions for success**

In parallel with the first three solution groups, some activities to enable **Scale** should be started early

18. Cross-sector R&D
17. Charging, fuelling and fuel standards
16. Information democratisation
15. Expanded policies for fleet owners and shippers
9. Green finance
8. Green transport procurement
7. New OEM revenue models & secondary-market certainty

**Create a snowball effect**

6. Joint truck-purchasing commitments
5. Technology partnerships
4. Pilots in clusters and corridors
3. Operational and design efficiencies
2. Targeted deployment of transition technologies
1. Transition of viable duty cycles

**Make impact now**

3. Operational and design efficiencies
2. Targeted deployment of transition technologies
1. Transition of viable duty cycles

In the period between **2027 and 2030** many national emission requirements come into effect or intensify

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**Short term** (2021–2023)

**Medium term** (2023–2028)

**Long term** (2028+)

Note: Timing of solution is related to period in which most activities are expected; however, most solutions require effort across short, medium and/or long term.
ACKNOWLEDGEMENTS

We wish to thank all those who were involved in the development of this research. We appreciate your time, energy and enthusiasm – particularly during the period of disruption caused by the COVID-19 global pandemic.

SOURCES


2 It is important to note that as of January 21, 2021, Shell’s operating plans and budgets do not reflect Shell’s Net-Zero Emissions ambition. Shell’s aim is that, in the future, its operating plans and budgets will change to reflect this movement towards its new Net-Zero Emissions ambition. However, these plans and budgets need to be in step with the movement towards a Net-Zero Emissions economy within society and among Shell’s customers.


Decarbonising Road Freight: Getting into Gear report are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell’s Form 20-F for the year ended December 31, 2019 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in Decarbonising Road Freight: Getting into Gear report and should be considered by the reader. Each forward-looking statement speaks only as of the date of this Decarbonising Road Freight: Getting into Gear report, January 21, 2021. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this Decarbonising Road Freight: Getting into Gear report.

We may have used certain terms, such as resources, in this Decarbonising Road Freight: Getting into Gear report that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.