



Decarbonising Road Freight: **SHELL'S ROUTE AHEAD**

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INTRODUCTION

In the coming years, the biggest change we face as a society, is the transition towards low-carbon forms of energy. This is change on a global scale. It is change that will take years to be fully realised.

Societal expectations are moving fast, and we recognise that more must be done to tackle the challenge of climate change. As an energy supplier, Shell has been listening and we aim to establish pathways towards net-zero emissions in collaboration with those sectors that utilise our energy products.

Commercial road freight plays a critical role in the global supply chain, shown by its 3 million companies operating some 217 million vehicles globally. And it will play a critical role too in the coming energy transition. But with such huge scale comes significant challenge: approximately 9% of global CO₂ emissions are attributed to commercial road freight. And with road freight volume expected to more than double by 2050, this challenge will become more complex and collaboration even more important.

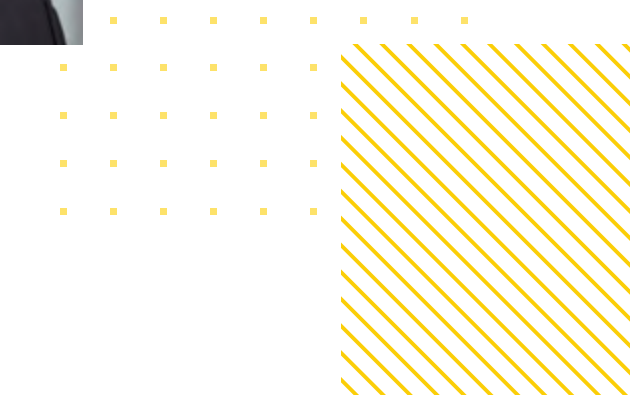
During the second half of 2020, Shell set out to understand the views of customers

and stakeholders across the road freight industry about how the sector can accelerate decarbonisation. I'd like to extend my sincere thanks to the more than 150 executives and experts who participated in interviews and workshops and generously shared their insights with us. We have gathered their views and outlooks into the Shell and Deloitte **Decarbonising Road Freight: Getting into Gear** report. It's very encouraging to see the high priority this industry places on decarbonisation, the high level of optimism and the number of solutions that are already in play. In this companion report, Shell builds on these industry perspectives and provides its view on the future pathway to decarbonise road freight.

It is crucial that the sector converges on a clear technology pathway to achieve net-zero emissions by 2050. Road freight leaders already see hydrogen and battery electric vehicles as leading zero-emission

technologies. Now the sector needs to synchronise the demand for these technologies with necessary investments in energy infrastructure and supply. Achieving this will require strong collaboration across the sector and robust policy frameworks that combine bold CO₂ targets and performance standards with the necessary incentives and compliance mechanisms to enable industry players to accelerate investments.

The vast number of vehicles in the global fleet, the fragmented nature of truck ownership and the reliance on the secondary truck market all contribute to the complexity of the decarbonisation challenge. While we prioritise investments in zero-emission technologies, we must also recognise that the transition will take time and that countries and regions will move at different speeds. This is why we must also prioritise investments in alternative fuels, vehicle design, digital solutions and carbon offsets. These and



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other solutions will play an integral role in progressing road freight decarbonisation.

In line with Shell's climate ambition to become a net-zero emissions energy business by 2050 or sooner, we recognise that our business plans need to change. We describe how we have started to do that in this report. There is a long and difficult route ahead but by leveraging our size, scale and capabilities, and by collaborating with others, we believe we have a role to play in helping the industry achieve net-zero emissions by 2050.

01 Summary of the key actions Shell is taking to help decarbonise road freight

PRIORITIES	ACTIONS
1. Increase the production and availability of hydrogen for heavy-duty and long-haul medium-duty trucks.	<p>Shell is investing in the production of green hydrogen to help decarbonise many sectors. This includes building one of the world's largest hydrogen electrolyzers of its kind in Germany (10 MW), plans for a second in China (20 MW) and another proposed project in the Netherlands (200 MW) that aims to produce enough green hydrogen to fuel approximately 2,300 hydrogen trucks per day by 2023.</p> <p>Shell will work with truck manufacturers, fleet companies and governments to coordinate hydrogen infrastructure investments along high-traffic freight corridors. We have approved plans to double our current network of 50 hydrogen refuelling stations for light-duty vehicles and have started to build the infrastructure to meet the specific high capacity refuelling needs of heavy- and medium-duty vehicles.</p> <ul style="list-style-type: none"> ▪ As part of a heavy-duty hydrogen truck pilot with Toyota and Kenworth, Shell is installing three new large-capacity refuelling stations between the Port of Los Angeles and a major warehouse district in California, USA. ▪ Shell is part of the H2Accelerate collaboration with Daimler, Iveco, OMV and Volvo that is focused on the large-scale rollout of hydrogen trucking infrastructure across Europe over the next 10 years.
2. Expand electric charging infrastructure and services for light-duty and short-route medium-duty freight trucks.	<p>Today, Shell offers drivers access to more than 200,000 electric vehicle (EV) charging facilities in more than 30 countries. We plan to expand our global presence and build charging services, including at fleet depots, to support the growing fleets of battery electric light- and medium-duty road vehicles. We will continue to invest in Shell Recharge, our retail site EV charging offer, as well as in two Shell Group companies - NewMotion and Greenlots - which provide a range of electric charging solutions to fleets and consumers.</p>
3. Provide low carbon fuels to reduce emissions on the journey to decarbonised road freight.	<p>Shell has built a leading position as a global marketer and trader of low-carbon fuels for road transport, including liquified natural gas (LNG), BioLNG and biofuels. We will continue to invest in these fuels as the road freight sector transitions to zero-emission technologies. Some of our investments include:</p> <ul style="list-style-type: none"> ▪ Developing a European LNG road network with our BioLNG EuroNet partners, and increasing our LNG stations from nearly 30 to 80 by the end of 2022; ▪ Constructing the first Dutch BioLNG production facility with consortium partners, Nordsol and Renewi; ▪ Producing our first waste-derived Compressed Natural Gas fuelling site for our haulier partners at our Carson facility in California, USA; ▪ Developing our IH² advanced biofuels technology in India to produce cost-effective transport fuels from biogenic and waste feedstock.
4. Advance a sector decarbonisation policy framework in collaboration with industry partners	<p>Shell will collaborate to advance a sectoral policy framework that includes:</p> <ul style="list-style-type: none"> ▪ Clear CO₂ emission performance standards and time-bound net-zero emission targets; ▪ Support of low- and zero-emission fuels through fuel regulations, product and distribution infrastructure investments, and incentives to purchase new vehicles; ▪ Appropriate use of high-quality carbon offsets and trading; and ▪ Taxation of energy products and electricity that is aligned with zero-emission targets.
5. Decarbonise Shell's contracted road freight fleet of heavy-duty vehicles	<p>Our supply and distribution teams are focusing on the commercial options available to deliver decarbonisation across our contracted fleet of 3,000 road haulage tankers. We are raising our ambitions as we learn more, see the development of new policy frameworks, and drive new technology development.</p> <ul style="list-style-type: none"> ▪ By 2025, we aim to deliver an average emissions intensity reduction of 10% across our fleet compared to 2018. ▪ By 2030, we aim to deliver an average emissions intensity reduction of 30% compared to 2018. ▪ In line with Shell's broader climate ambitions, we aim to achieve net-zero emission operations of our fleet by 2050 or sooner.

The road freight sector today



ROAD FREIGHT VOLUMES AND CO₂ EMISSIONS

Globally, there are approximately 217 million road freight vehicles comprising light commercial vehicles (LCV), medium-duty trucks (MDT), heavy-duty trucks (HDT) and buses.¹ Together, they represent the most flexible form of surface transport given their ability to access dense urban areas and remote rural locations. This mode of transport has become integral to our economy and our way of life, and we increasingly rely on fleet companies and truck drivers to deliver the goods we need safely and quickly. The COVID-19 pandemic and stay-at-home orders have radically increased people’s reliance on home delivery services.

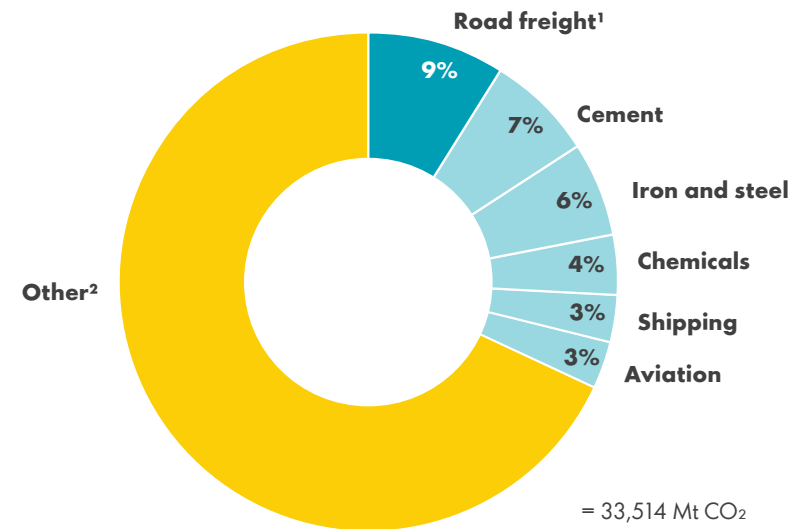
Over the last 20 years, the volume of goods transported by road freight vehicles has more than doubled, growing by double the rate of global GDP.² Today, CO₂ emissions from road freight account for around 9% of global

CO₂ emissions, emitting more than shipping and aviation combined, and over half of road freight emissions come from Europe, US, China and India (see Exhibit O2). The increasing prominence of e-commerce, infrastructure improvements along new trade routes and continued economic development will enable even further growth in demand over the coming years. It is estimated that road freight volumes will have a compound annual growth rate between 3 and 4% and that total volumes will more than double by the mid-2040s, compared to a 2018 baseline.³

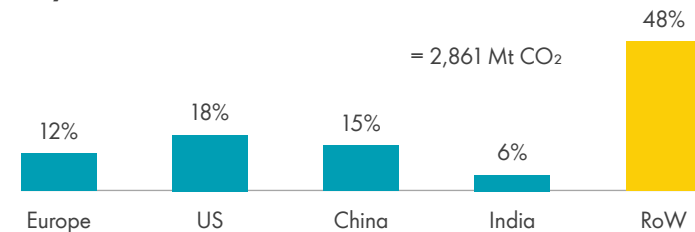
However, there is a major challenge to this growth. For society to achieve the goals of the 2015 Paris Agreement, the road freight sector will need to significantly reduce its CO₂ emissions and achieve net-zero emissions by 2050.

O2 Road Freight and other harder-to-abate sectors

Global road freight emissions



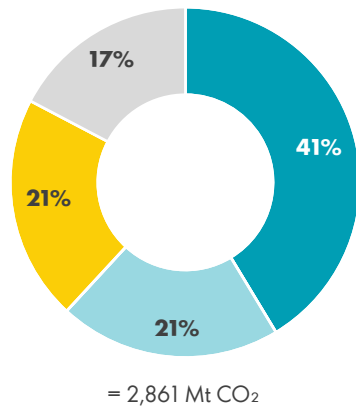
Road freight CO₂ emissions by region/country³



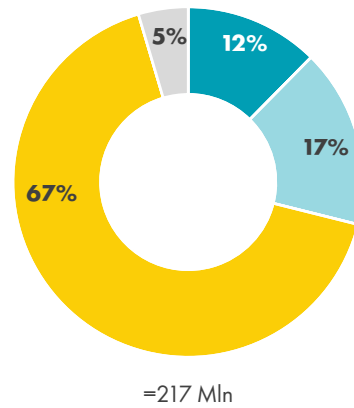
Sources: IEA, CO₂ emissions by sector, World 1990–2018; CO₂ emissions from 1) industry, 2) transport and 3) heavy-duty vehicles in the Sustainable Development Scenario 2000–2030; Deloitte analysis.
 Notes: 1) Including LCVs, MDTs, HDTs and 1.5% from buses; 2) Including power (46.5%), other transport (10.8%), buildings (8.6%), feedstock (1.9%), and other industry (1.6%); 3) Total emissions are divided over the countries by making use of number of trucks per country and average emission per stock vehicle, including buses.

03 Overview of road freight and global CO₂ emissions

Global road freight CO₂ emissions¹



Number of trucks and buses¹



Sources: IEA Future of Trucks, OECD; IEA Energy Technology Perspectives; IEA Tracking Transport 2020; Deloitte analysis.
 Notes: 1) Emissions for LCVs, MDTs and HDTs are taken from IEA Future of Trucks; emissions for buses is taken from IEA Tracking Transport 2020; 2) Buses, including coaches, are not the primary focus of this research.

Within road freight, the decarbonisation challenge is most acute for the 63 million heavy and medium-duty trucks in operation today (see Exhibit 03). They make up only 29% of the global fleet but are responsible for about 62% of road freight CO₂ emissions.

The unique power, weight and distance requirements of these trucks drives a need for an energy-dense fuel that is readily available throughout the world. Today, diesel accounts for approximately 90% of the fuel used by these trucks.⁴ To decarbonise in line with the

goals of the Paris Agreement, the global fleet will need to begin shifting to zero-emission technologies such as hydrogen fuel cell electric vehicles (FCEVs) and battery electric vehicles (BEVs) in the 2020s, but there are many barriers that could slow that transition.

Road freight is dominated by very small fleet companies that are highly sensitive to cost and which have limited risk appetite for new and unproven technologies. For example, in the United States 90% of truck fleets operate six trucks or less and in Asia only 0.1% of trucks are owned by companies with more than 100 trucks.⁵ The highly fragmented nature of vehicle ownership and low profit margins therefore limits capital availability for new trucks. It will be difficult for many fleet companies to introduce zero-emission

trucks into their fleets given their higher current prices and in the absence of financial incentives, particularly in countries with limited government support.

The secondary market for trucks presents another challenge given that many fleet companies depend on predictable resale values for their new trucks within the first six years of use. Relative to diesel trucks, resale values for zero-emission trucks will likely be lower and will remain unpredictable for some time. This could result in many fleet owners delaying investment decisions for zero-emission trucks and extending lifespans of diesel trucks to manage financial risks. Their lifespan could be further extended once these diesel trucks are sold on the secondary market.



INDUSTRY PERSPECTIVES

A new paradigm is emerging, despite the many barriers to decarbonising road freight. Leaders and experts across the sector are becoming more optimistic about the potential to accelerate the deployment of low- and zero-emission solutions and industry groups are coalescing to address the inertia.



The **Decarbonising Road Freight: Getting into Gear** report provides a comprehensive view of the economic, technical, regulatory and organisational factors influencing decarbonisation efforts. It provides a description of the unique motivations and challenges of different groups and geographies. And it sets out 22 solutions and a time-bound roadmap that is designed to help the industry take action today.

In total, over 70% of interviewees consider decarbonisation as either the number one or top-three priority for their organisation. Across the industry, many leading logistics providers, fast-moving consumer goods businesses and parcel and mail companies have made commitments to reduce road freight emissions. As we conducted the study, a number of vehicle manufacturers announced plans to produce and commercialise FCEVs and BEVs for road freight. As a result, many study participants believe that road freight decarbonisation is nearing a tipping point, and that zero-emission trucks can become commercially viable within the next ten years (see Exhibit 04).

04 Key findings from industry perspectives report

1. Most study participants recognise there are still major barriers to decarbonise the sector

- Insufficient access to hydrogen and battery charging infrastructure - 80% of participants
- Inadequate financial incentives will prevent uptake of zero-emission technologies - 80%
- Lack of demand for lower-emission road freight by shippers - 70%

2. Despite these barriers, decarbonisation will occur faster than many expect

- Bold emission reduction commitments by governments and businesses are fuelling optimism regarding the pace of decarbonisation
- Increasing customer, investor and employee support for decarbonisation is creating the opportunity for businesses to address supply chain emissions

3. The industry is already converging on a technology pathway that includes FCEV and BEV

- Over 70% of study participants view hydrogen FCEVs and BEVs as the most viable long-term zero-emission heavy-duty truck technologies
- Adopting a duty cycle perspective that considers how trucks are used in practice can accelerate the application of these technologies for specific use cases

4. The sector has identified 22 solutions to accelerate sector decarbonisation

- Solutions range from immediate interventions that can be made in specific regions through to longer term deployment of zero-emission technologies at scale
- Collaboration is necessary and all industry players will have specific roles to play

5. The sector has defined a 10-year solutions roadmap

- The roadmap calls for the sector to start deploying low- and zero-emission trucks at scale by the late 2020s
- In the initial years, the goal is to maximise the use of existing technologies to reduce emissions quickly, while expanding the reach and scope of alternative technology pilots

6. A global concerted effort is needed to accelerate change

- Countries and regions face unique challenges regarding fuel supply, technology maturity and access to energy infrastructure, which must be addressed using a range of energy solutions
- Cross-border collaboration will accelerate learning, so that as solutions mature in one geography, they can be applied in others and enable them to leapfrog ahead

Shell's view on future pathways



WHAT ROAD FREIGHT NEEDS FROM ENERGY PROVIDERS

As we developed the **Decarbonising Road Freight: Getting into Gear** report, study participants identified the lead and support roles that various players throughout the sector could take on to help decarbonise road freight. They also assigned several proposed solutions to each player, which included energy companies like Shell. In this section, we share our perspective on four focus areas that respond to the many solutions assigned to us.

1. **Shell's climate ambition:** we describe how we are changing our business to achieve net-zero emissions by 2050.
2. **Deploying fuels and energy infrastructure:** we outline our perspective on the leading energy technology options available to decarbonise road freight.

3. **Operational and design solutions for managing CO₂ emissions:** we share vehicle design options, digital tools and carbon offsetting solutions that are available to our customers.
4. **Advancing policy and collaboration:** we propose a number of policy levers that are meant to inspire greater collaboration with policy makers, businesses and other industry stakeholders to help accelerate decarbonisation.

In this section, we also highlight some of the actions we are already making available to help the road freight sector achieve net-zero emissions by 2050.

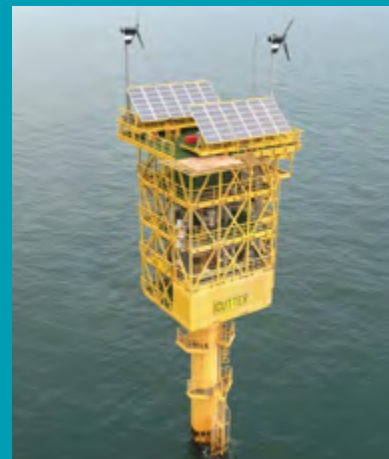


SHELL'S CLIMATE AMBITION

Shell has the ambition to be a net-zero emissions energy business by 2050 or sooner, in step with society and our customers, but our current business plans will not get us there yet.

We will seek to achieve our ambition in three ways. First, we aim to be net-zero emissions from making our products. Second, we seek to reduce the carbon intensity of the products we sell. This will mean selling more hydrogen, more biofuels, more renewable electricity. Finally, as a business that supplies energy, we will work with sectors that use energy like road freight and help them find their own path to net-zero emissions.

05 Shell's net-zero emissions ambition



A NET-ZERO EMISSIONS ENERGY BUSINESS BY 2050 OR SOONER

Own operations: net-zero emissions

Reduce the emissions from the manufacture of all our products¹ to net-zero by 2050 or sooner

Energy products: carbon intensity in line with 1.5 °C

Reduce the Net Carbon Footprint² of the energy products we sell by 30% by 2035 and by 65% by 2050. This is consistent with society's ambition to achieve a 1.5 °C future

Remaining customer emissions: fully mitigated

Work with customers to reduce the emissions from their use of our energy products³ to net-zero by 2050 or sooner

Notes: 1) Refers to the Scope 1 and 2 emissions in absolute terms associated with operations under direct Shell control; 2) The Net Carbon Footprint (NCF) is a weighted average of the lifecycle CO₂ intensities of different energy products sold by Shell normalising them to the same point relative to their final end-use. The calculation includes all emissions associated with bringing these energy products to the market as well as our customers' emissions from using them; 3) Refers to the Scope 3 emissions in absolute terms associated with the use by customers of the energy products Shell sells.

DEPLOYING FUELS AND ENERGY INFRASTRUCTURE

The road freight sector can be divided into two segments with distinct pathways to achieve net zero emissions by 2050:

1. **Heavy-duty freight trucks and long-haul medium-duty freight trucks:** This segment offers the largest opportunity for decarbonisation as it accounts for most of the sector's CO₂ emissions. In Shell's view, hydrogen fuel will likely provide the more practical, cost effective and less disruptive pathway to net-zero emissions. It is the pathway with the best prospects for providing the substantial power and travel range needed for these large trucks, without excessive onboard weight or volume. It could also allow the industry to optimise using existing energy distribution infrastructure.
2. **Light-duty freight trucks and short-route medium duty freight trucks:** Over the coming decade and into the 2030s this segment will likely continue to transition to BEVs as more effective and more numerous technologies are developed.

In 2019, approximately 70% of heavy-duty truck sales took place in countries and regions with fuel economy and CO₂ standards, and regulators in these locations are setting even more ambitious targets over the next ten years.⁶ As a result, there is growing pressure on the sector to decarbonise especially in the European Union (EU), China, South Korea, Japan and parts of North America. EU regulators are making a concerted push to launch zero-emission heavy- and medium-duty vehicles in the market. A regulation to reduce CO₂ tailpipe emissions of new heavy-duty trucks by 30% by 2030, compared to a 2019 baseline, is forcing truck manufacturers to look at new technologies such as bio-LNG platforms and new fuel and power train combinations, namely hydrogen-powered or battery electric vehicles.⁷

In China, regulators are adopting a combination of subsidies, incentives, local government directives and permits to promote both hydrogen and battery electric vehicles. In 2019, there were more than 6,100 hydrogen fuel cell buses and commercial vehicles on China's roads, and the country has ambitious future targets to reach 50,000 vehicles by 2025, and 1 million in 2030.⁸

There is much emphasis on electrification and hydrogen as the principal future zero-emission energy carriers for road transport, but natural gas and low-carbon biofuels – produced from biogenic and waste feedstock – will serve as transition fuels for decades. These alternative fuels will be needed to decarbonise the legacy fleet of diesel vehicles, even in regions with the most aggressive decarbonisation ambitions, and particularly in areas that rely on the secondary truck market and which are slower in adopting new technologies.

Low-carbon biofuels offer a material and affordable short-term option to decarbonise through their commercial availability and because they do not require wholesale infrastructure transformation. Several technologies that are commercial today produce fuels that have similar molecular structures to hydrocarbon fuels and can be blended up to 100%, thus eliminating blending ratio limitations typical with ethanol or biodiesel.



Hydrogen

Clean hydrogen⁹ is a zero-emitting fuel whose versatility as an energy carrier presents decarbonisation opportunities for many harder-to-abate sectors. For road freight, the cost competitiveness of hydrogen fuel cell technologies is improving, and they could become the lowest-cost way to decarbonise medium- and heavy-duty trucks by 2030.¹⁰ In the absence of significant advances in battery technology that address weight and recharging time, hydrogen fuel cell technology trucks could achieve cost parity with comparable BEVs as early as 2025.

Shell believes that scaling up hydrogen will likely be the most cost-effective and viable pathway to achieve net-zero emissions for heavy-duty freight trucks and long-haul medium-duty freight trucks. This outlook rests on two key factors:

1. the promise of near diesel-level range, power and refuelling speeds, and
2. the commitment and ability of fuel suppliers to provide the needed infrastructure.

Shell has developed a strong position in hydrogen with over 50 hydrogen fuelling stations for light-duty vehicles in locations around the world and has approved the construction of over 50 more. Shell has gained valuable experience in building this network and we have seen how a

well-functioning, integrated supply chain for hydrogen refuelling, together with larger equipment orders and supportive government policy, could lead to a reduction in costs. We are applying these learnings as we begin to deploy hydrogen fuelling infrastructure along high-traffic road freight corridors in partnership with truck manufacturers and fleet companies, and with support from governments. We are currently building three high-capacity hydrogen refueling stations in California, USA, and have announced an ambitious collaboration for mass-market roll-out in Europe (H2Accelerate). Over the next 10 years we aim to expand these efforts in other regions.

In addition, Shell is working with partners to accelerate the production of green electricity by integrating offshore wind and solar with electrolyser plants to produce green hydrogen. This includes projects in Germany, the Netherlands and China. Shell, together with its consortium partners, announced one of the largest green hydrogen projects in Europe in February 2020. The NorthH2 project, currently in feasibility study phase, is located in the north of the Netherlands and envisages the construction of wind farms in the North Sea, which can gradually grow to a capacity of about 10 gigawatts by 2040. The plan provides for a large electrolyser in the Eemshaven, a seaport in the north of the Netherlands, that will convert the wind energy into green hydrogen.



H2Accelerate

Photo credit: Daimler Truck AG

In December 2020, Daimler Truck AG, IVECO, OMV, Volvo Group and Shell announced a new collaboration for zero emission hydrogen trucking at mass market scale. Participants believe that synchronised investments across the sector during the 2020s will create the conditions for the mass market roll-out of hydrogen fuelled heavy duty transportation which is required to meet the European ambition of net-zero emissions by 2050.

Under H2Accelerate, the participants expect to work together to seek funding for early pre-commercial projects during the first phase of the roll-out. In parallel, the participants will engage with policy makers and regulators to encourage a policy environment which will help support the subsequent scale up into volume manufacturing for hydrogen trucks and a Europe-wide refuelling network for zero carbon hydrogen fuel.

PHASES FOR IMPLEMENTATION

PHASE 1

Rollout of first stations and trucks

- 100s of trucks
- >20 high capacity stations
- Proving high-capacity station concepts
- Selective locations/clusters

PHASE 2

Europe-wide coverage

- Second half of 2020s: Achieve volume manufacture '000's per years
- Rapidly reaching > 10,000 trucks
- Europe wide coverage of major corridors
- High capacity/reliability stations

Battery Electric Vehicles

BEVs already offer a leading decarbonisation pathway for light commercial vehicles and short-distance medium-duty vehicles. For vehicles that typically travel less than 200km per day, BEVs already offer a viable decarbonisation solution, especially vehicles operating on fixed routes such as buses.

Further commercial-scale deployment of BEVs is needed before 2025. To achieve this, power suppliers, charging infrastructure providers and vehicle manufacturers need to work closely together to develop an

adequate charging network that meets the needs of electric vehicle drivers and manage power supply system more efficiently.

Shell has an expanding power business and we are one of the world's largest mobility retailers. In tandem, we are now focused on developing world-class out-of-home and fleet depot charging services for the road freight sector. This requires us to be involved at almost every stage of the power system, from generating green electricity, to supplying it to customers to power their businesses and

vehicles. It also requires us to work with fleet customers on a range of charging services, including network software, grid balancing solutions and smart-charging optimisation. We want to make it easy for our customers to make the switch to electric vehicles and we are doing this by providing world-class services that are safe, reliable and easy to use.

In 2017, Shell acquired NewMotion to expand its network of public charging points in Europe, followed by the purchase of the US-based Greenlots in January 2019.

Today, Shell offers customers access to over 200,000 charging points around the world and the network continues to grow. This includes access to over 700 charge points at over 350 Shell retail sites under our Shell Recharge brand. Shell is also working with the fast-charging network operator IONITY to open 350 350kW chargers at 60 Shell sites within the next year.



newmotion®

A Member of the Shell Group

Providing drivers with access to a large network of reliable charging points is critical to the rapid adoption of electric vehicles. Shell's acquisition of NewMotion in 2017 offers our customers access to more than 175,000 public charging points across more than 35 European countries.

greenlots

A Member of the Shell Group

Our acquisition of Greenlots in January 2019 ensures that Shell will also play a leading role in the transition to electric mobility in the USA. Based in San Francisco, Greenlots combines private charging solutions with a growing roaming network of public charging points for electric vehicle drivers. Outside the USA, Greenlots also has a growing business in Canada, Thailand, Malaysia and Singapore.

Natural Gas

As FCEV and BEV technologies mature, liquified natural gas (LNG), biomethane liquified natural gas (bio-LNG) and renewable natural gas (RNG) will play an important role in the decarbonisation of heavy-duty freight trucks and long-haul medium-duty freight trucks.

LNG can help reduce greenhouse gas (GHG) emissions by up to 22% on a well-to-wheel (WtW) basis in the most modern heavy-duty engines compared to conventional diesel.¹¹ It also provides additional air quality benefits, emitting virtually zero sulphur and has

low particulate and nitrogen oxides emissions. LNG is already available in supply corridors and hubs in Europe and will play an important emission-reducing role during the transition to net-zero emissions in 2050. Its advantageous after-tax Total Cost of Ownership (TCO) relative to diesel and growing acceptance among hauliers will bolster its role.

Bio-LNG is methane produced through biological conversion (anaerobic digestion) and clean-up of organic material from landfills manure, food waste or agricultural

residues. It can be used in the same engines, distribution and refuelling systems as LNG. The European JRC-EUCAR-CONCAWE assessment of the GHG balance of road transport has showed in their recent update (Revision 5) that bio-LNG can reduce WtW emissions by as much as 80% to 95% compared to conventional fuels, depending on the fuel source and production pathway.¹²

Shell is investing in LNG to help decarbonise heavy-duty transport. Today, we operate nearly 30 Shell-branded LNG sites in Europe with plans to grow to 80 by the end of 2022. Our network covers major transit routes from Poland to Spain, and we have LNG stations in China. Shell is also part of the BioLNG EuroNet consortium with DISA, Scania, IVECO and Nordsol. The members plan to use their individual activities to put 2,000 more LNG trucks on the roads, build LNG service stations and open a new bio-LNG production facility in the Netherlands.

RNG, also known as biomethane, is gas derived from processing organic waste in a controlled environment until it is fully interchangeable with conventional natural gas. The use of RNG in natural gas-fuelled vehicles, either as compressed natural gas (R-CNG) or bio-LNG, also offers an attractive alternative for fleets to lower their carbon footprint compared to conventional diesel fuel.



Nordsol

Photo credit: Nordsol

In November 2020, Renewi, Nordsol and Shell announced the start of construction of the first Dutch bio-LNG installation in Amsterdam Westpoort. When completed, the new bio-LNG installation will serve to extend the current processing of, among other things, waste products from supermarkets.

The three partners each fulfill a unique role in this waste-to-energy value chain. Renewi collects organic waste, processes it and converts it into biogas. Nordsol will then process the biogas into bio-LNG, which is designed to produce 3.4 kilotons of bio-LNG per year. Finally, Shell sells this bio-LNG at its growing network of LNG refuelling stations.

Low-carbon biofuels

Diesel will likely continue to have a major role in powering road freight in many parts of the world over the coming decades due to slow fleet turnover rates and the prominence of secondary markets for used heavy- and medium-duty trucks. As a result, a range of solutions will need to be made available to bring down the emissions from this legacy fleet, particularly in regions where the shift to zero-emission trucks is not possible or is cost-prohibitive. Supportive policies will also be needed through the 2040s for this legacy fleet to meet increasingly stringent emission regulations.

Low-carbon fuels made from biogenic and waste feedstock can play a valuable role in reducing road freight CO₂ emissions. They are available today and require truck owners

to invest minimal capital. Such fuels can be blended with existing fuels such as gasoline and diesel and used in today's vehicles and existing infrastructure. They offer practical and cost-efficient solutions for reducing CO₂ emissions from transport, while providing the same high energy density as traditional fuels.

New technologies and processes that produce fuels from alternative feedstocks, such as agricultural, municipal and wood waste, are improving the sustainability of low-carbon fuels and are likely to become the primary feedstocks in the future. These fuels, produced from advanced technologies, are Shell's primary focus for ongoing and future development and investment of low-carbon fuels. Fleet operators often have the flexibility to choose from a range of products that

include low percentage blends through to a product that is 100% advanced biofuel.

Shell is one of the world's largest blenders and distributors of low-carbon biofuels. In 2019, Shell blended more than 10 billion litres of low-carbon fuel components such as ethanol or fatty acid methyl esters and produced over 2.5 billion litres of sugarcane ethanol through its 50% Raizen joint venture in Brazil. Shell has also started co-processing low-carbon feedstocks at its Rheinland refinery for sales into European diesel markets. In 2020, this facility produced enough low-carbon fuel to fill 600,000 vehicles a year, abating 50 kilotonnes of CO₂ in the process.

Shell has also announced an investment in Varennes Carbon Recycling, the first waste to low-carbon fuels plant in Québec, Canada. Commissioning of the first phase of the facility is scheduled for 2023. Once completed Varennes Carbon Recycling will treat more than 200,000 tonnes of non-recyclable waste and wood waste per year with an annual production of nearly 125 million litres of low-carbon fuels.



IH² and Shell Technology Centre Bangalore

In 2017, Shell completed construction of a demonstration plant at the Shell Technology Centre Bangalore, India. The plant, now in its final research and development stage, uses a technology called IH² (a trademark of the Gas Technology Institute) that turns agricultural residues and other wastes into transport fuel. The process is an advanced hydrolysis technology that uses catalyst processes to remove oxygen from biomass and waste feedstock, to produce hydrocarbon products from the remaining material. Shell, through its catalyst company CRI, has acquired exclusive rights to use the technology.

OPERATIONAL AND DESIGN SOLUTIONS FOR MANAGING CO₂ EMISSIONS

Using today's solutions, commercial fleet managers and operators of medium- and heavy-duty trucks can reduce and offset emissions and help the industry to achieve net-zero emissions by 2050.

Vehicle design, operation and maintenance

Shell's investment in the next-generation Starship truck shows that currently available technologies and aerodynamics can significantly improve fuel economy, increase freight tonne efficiency of heavy freight trucks and reduce CO₂ emissions. These solutions include:

- **Reduce rolling resistance:** selecting the right tyres, axle oil and bearing grease and maintenance regime can improve fuel efficiency.
- **Reduce drag:** using add-ons such as side-skirts, trailer tails and reducing the gap between trailer and tractor can help to reduce drag and improve fuel efficiency.

- **Use premium lubrication:** high-quality, low-viscosity engine oil – with friction-reducing additives – cuts mechanical loss, helps to improve efficiency and reduces emissions.
- **Use vehicle automation:** automating simple things such as optimal gear changes to operate the engine in the most efficient range helps to improve fuel efficiency and reduce emissions.

Many large fleets are already adopting some of these solutions but smaller companies need help to recognise and capture the longer-term savings resulting from investments in newer truck models and from retrofitting old ones. This can be done by including these design improvements into standard truck models, designing financing options for truck upgrades and increasing awareness around the total cost of ownership benefits of adopting these improvements.



Shell Starship

In 2018, Shell partnered with the Airflow Truck Company to collaborate on a hyper-aerodynamic, super fuel-efficient heavy freight concept truck: Starship. By bringing together the best of today's existing and custom technologies, Starship's goal was to find out just how energy-efficient goods transport by road can be and elevate the conversation about the energy transition.

Shell's Starship successfully completed a 3,700 km coast-to-coast run across the USA and attained 178.4 tonne-miles per gallon (68.9 tonne-kilometres per litre) in freight tonne efficiency – a 2.5 times improvement on the North American average of 72 tonne-miles per gallon (127.8 tonne-kilometres per litre).

In 2021 a new Shell Starship will replicate the coast-to-coast run employing new technologies with the ambition to improve on the previous fuel economy and freight tonne efficiency results. The outcome of the 2021 journey will be available in June 2021.

For more information visit the Starship [website](#).

Optimising fleet management

In the **Decarbonising Road Freight: Getting into Gear** report, interviewees identify several inefficiencies in how trucks are used that contribute to road freight emissions. An often-referenced example is the 30-50% of journeys that trucks make without carrying goods or supplies between depots.¹³ This practice is partly driven by retailers and consumer expectations for short delivery times and the lack of modern fleet management software. By integrating data-

driven solutions into road freight operations, fleets can optimise a range of variables: driver behaviour, vehicle selection, fuel types, routes and maintenance practices. In turn, these improvements can result in cost savings and less CO₂ emissions.

Over the past few years, Shell has made investments in digital solutions to help road freight customers improve fleet management. Singapore-based Connected Freight, which

started as a Shell digital venture in 2017, connects a network of retailers, suppliers and third-party logistic providers so companies can have an integrated and systematic process for order, dispatch and fulfilment of their deliveries. This reduces the total number of miles travelled by delivering last-mile efficiencies. In 2020, Shell also announced an investment in Instafreight, a company that uses digitalisation to optimise processes and increase information transparency in the European freight forwarding industry. This investment builds on our expertise to optimise freight delivery, while also reducing emissions and road miles.

In 2020, Shell launched a partnership with Smart Freight Centre - a global non-profit organisation dedicated to sustainable freight - to deliver the Smart Transport Manager programme aimed at training fleet managers in reducing emissions and fuel consumption.¹⁴ The training focuses on five areas to improve fleet efficiency: fuel management, driver and staff skills, vehicles and maintenance, performance and monitoring and information technology. Together, these efforts are aimed at helping fleet companies lower CO₂ emissions per kilometre and reducing the number of kilometres travelled.



Shell Telematics

In 2020, we expanded our Shell Telematics service to new markets. The service integrates Shell fuel card data and on-board telematics hardware to better monitor and manage driver and vehicle performance and achieve greater fuel economy.

Shell Telematics provides insights to fleet managers by combining vehicle and fueling data. This enables fleet managers to improve their operations safety, security, efficiency and sustainability. This solution caters to all fleet sizes and all vehicle types including electric vehicles. This service is now available in the UK, Benelux and Germany, and is also live in Asia and North America.

For more information visit the [Shell Telematics website](#).



Offsets

Until scalable decarbonisation technologies are deployed, carbon offsetting programmes can provide an immediate solution to manage CO₂ emissions and can play an important role in achieving net-zero emission road freight by 2050.

As countries and regions institute stricter emission standards for heavy- and medium-duty trucks, carbon offsets could be part of an alternative compliance mechanism for fleet companies to offset their CO₂ emissions, provided they do not undermine or substitute efforts to make emission reductions. In such a model, the need for offsets should decline over time as fleets shift to zero-emission vehicles.

Our fleet customers can choose to use offsets voluntarily. In 11 markets we currently offer those who use the Shell Card the opportunity to offset the CO₂ emitted from their fleets. The service enables them to calculate and offset the CO₂ emissions from their Shell Card fuel purchase. Some 230 fleet customers have signed up to participate and are offsetting the emissions of 53 million litres of fuel.

We are also helping to meet the growing demand from large businesses and organisations for carbon offsets from nature by buying and selling carbon credits from nature-based projects. We carefully select these projects to ensure high quality and properly accounted for credits.

ADVANCING POLICY AND COLLABORATION

Policy and Regulation

Decarbonisation of road freight will require close coordination and integration between policies that impact vehicles, fuels, infrastructure and customer choice. No single policy will be sufficient to create momentum for change throughout the industry's value-chain. A sectoral policy framework can help to deliver a set of complementary measures to accelerate demand and supply of lower-carbon energies, provide the necessary infrastructure and incentivise the right consumer behaviours.

Photo credit: ITF/OECD



Shell recognises that governments around the world face unique challenges and that disparate regions are moving at different speeds to address road freight CO₂ emissions. We also recognise that the various segments of the sector have different needs. However, Shell believes the following policy levers have broad applicability and can help accelerate decarbonisation efforts. Moving forward, we aim to partner with businesses, industry organisations and governments to advance our proposed sectoral policy framework (see Exhibit 06).

06 Proposed sectoral policy framework

Policy levers	Description
1. Set clear CO₂ emission performance standards and time-bound net-zero emission targets	<ul style="list-style-type: none"> Set achievable targets for zero- and low-emission vehicles and deployment targets for fuelling infrastructure in line with Paris Agreement goals Factor in manufacturing and supply chain obstacles when setting time-bound targets Accelerate target dates based on market penetration of zero-emission vehicles Approve a standard that certifies the CO₂ intensity of logistics operations as a means to promote low-carbon logistic services
2. Ensure fuels regulations continue to support a mosaic of low- and zero-emission fuel options	<ul style="list-style-type: none"> Low-carbon fuel standards should cover all fuels that meet sustainability criteria Set clear multi-year obligations that are consistent with the pace of building out fuel supply capabilities and infrastructure Set upper and lower carbon price signals that support fuel supply without being excessive, whereby funds collected should be reinvested into decarbonising the road freight sector
3. Invest in low- and zero- emission fuel production and distribution infrastructure	<ul style="list-style-type: none"> Incentives and support for direct and long-term investments in commercial-scale low- and zero-emission fuel production and distribution infrastructure (e.g. capital grants, investment tax credits, loan guarantees) Provide support so alternative fuels can be competitive for a long enough duration to justify investments Support first-movers by addressing investment risks
4. Incentivise fleets and owner-drivers to buy low- and zero-emission vehicles until they can compete on basis of TCO	<ul style="list-style-type: none"> Policy should provide consumers of low- and zero-carbon vehicles with: <ul style="list-style-type: none"> time-limited tax credits or rebates on purchases to equalise TCO; and/or exemption or reduction in road tolls based on vehicle CO₂ emissions; and/or preferential access to inner cities with low-emission zones. Carbon pricing or low-carbon subsidies are also needed to enable hydrogen to become cost-competitive with existing fuels
5. Allow appropriate use of high-quality carbon offsets and trading	<ul style="list-style-type: none"> Credit trading should be allowed Fossil fuel baseline should be based on a WtW analysis Ensure that offsets do not undermine efforts to avoid and reduce CO₂ emissions
6. Align the taxation of energy products and electricity with zero emission targets	<ul style="list-style-type: none"> Taxation of transport fuels should be based on the emitted combustion CO₂ (such as tank-to-wheel CO₂ emissions). Taxation should consider volumes, relative carbon and energy intensity of different fuels There should be a reduction or exemption in the level of duty applied to electricity that is used to produce green or blue hydrogen

Collaborating with others

Sectoral alignment and active support of a common decarbonisation pathway is fundamental to the road freight industry achieving net-zero emissions by 2050. This will require a strong coalition of leading vehicle and truck manufacturers, fuel and equipment suppliers and fleet operators. Shell will continue to partner and collaborate with other leading companies and organisations in the sector to work towards a clear and ambitious sector decarbonisation pathway.

In addition to the H2Accelerate and BioLNG Euronet collaborations already mentioned in this report, Shell is also working with

partners to build a green hydrogen hub in Rotterdam. Announced in July 2020, plans include building a 200 MW electrolyser in the Port of Rotterdam that will produce green hydrogen for our hydrogen retail network and industrial applications. It is important that as of 2023 there is enough green hydrogen available, which can be used to decarbonise trucks in the transport sector directly. This way, approximately 2,300 hydrogen trucks per day could run on this volume of green hydrogen as the market for hydrogen trucks further develops. A final investment decision on the electrolyser will not be made until later in 2021.

In November 2020, Shell signed a joint statement on the deployment of fuel cell and hydrogen heavy-duty trucks in Europe.¹⁵ The statement had 62 signatories comprising vehicle and truck manufacturers, technology providers, refuelling infrastructure and hydrogen providers, truck operators, road freight services users and related industry associations. Signatories committed to a joint target in Europe of 100,000 hydrogen fuel cell electric heavy-duty trucks from 2030 onwards and up to 1,500 hydrogen refuelling stations by 2030.

In January 2021, Shell joined the Road Freight Zero coalition that falls within the broader Mission Possible platform of the World Economic Forum.¹⁶ This coalition is a multi-stakeholder group designed to accelerate the deployment of zero-emission fleets and infrastructure by 2030. At the same time, Shell also joined the Corporate Partnership Board of the International Transport Forum (ITF) to support its initiative to decarbonise transport through advancing research and policy development in support of the Paris Agreement goals.¹⁷



Shell's role in decarbonising road freight



OUR EVOLVING BUSINESS

Shell aims to work with our customers on their path to decarbonisation. We will continue to grow our offer and provide the energy they require, where and when it is needed. And in line with our customers' aspirations we will change the energy we provide to accelerate and lead in the energy transition. In this chapter, we provide more detail on our current operations and the changes that we intend to make to accelerate progress.

Shell's Road Freight Operations

As Shell works with the sector to advance decarbonisation solutions, in parallel we will deploy solutions in our own fleet. We are investigating opportunities to reduce emissions across the contracted road freight fleet which serves our fuels network and we are setting medium and longer-term ambitions which put us on a path to net-zero emissions by 2050.

Our operations span the globe, covering a wide range of markets – some at the leading edge of energy transition and some focusing on growth and security of energy provision. Consequently, in some markets we will be able to outperform our global ambitions developing pace setter fleets, and in others we will continue to push the pace to decarbonise as quickly as the market allows.

Our global road freight fleet

- Shell uses a large contracted fleet of around 3,000 road haulage tankers.
- Deliver fuels to almost all our 45,000 branded retail sites worldwide and our end customers.
- Safety is our top priority.

Ambition

- By 2025, we aim to deliver an average emissions intensity reduction (measured by CO₂e Kg/tonne of product delivered) of 10% across our fleet compared to 2018.
- By 2030, we aim to deliver an average emissions intensity reduction of 30% across our fleet compared to 2018.
- In line with Shell's broader ambitions for operational emissions we aim to achieve net-zero emissions operations by 2050 or sooner.
- We will achieve this through strong working partnerships across the supply chain.

What we are already doing:

Given the range of markets in which Shell operates, the solutions will not be uniform. What is available in every market is efficiency.

- We expect telematics to deliver in the range of 3-5% savings by 2025.
- We are increasing our capability and roll-out of advanced analytics across our fleet and expect this to deliver in the range of 7-10% savings by 2025.

As part of our contracting process we require all hauliers to track and report their emissions and, if not already developed, produce a sustainability plan to reduce emissions over time.

Accelerating change:

- Shell is changing half of our road haulage fleet serving the Netherlands to LNG by Q1 2021, and our whole fleet by 2025. As the Netherlands bio-LNG production facility comes online it will serve CO₂-neutral bio-LNG to our retail network, which in turn will ensure Shell's contracted fleet is planned to run CO₂-neutral by the end of 2025. In Germany, Shell also aims to change its road haulage fleet to use this CO₂-neutral fuel as it becomes available.

- In 2021, we will review our contracting and procurement criteria for road haulage services to ensure alignment on decarbonisation and sustainability criteria with our ambitions.
- In 2021, Shell will begin to investigate the applicability of other new technologies such as hydrogen fuel cell electric vehicles and battery electric vehicles within our contracted fleet.



Deploying hydrogen for heavy-duty and long-haul medium duty trucks

Shell is focused on deploying hydrogen fuelling infrastructure along high traffic road freight corridors in partnership with truck manufacturers, fleet companies and governments. In Europe and the United States, Shell has already started this work and is prepared to expand these efforts globally in the 2020s in select regions.

What we are already doing:

Hydrogen Refuelling

- In December 2020, Shell and its partners Daimler Truck AG, IVECO, OMV and the Volvo Group, announced a new collaboration for zero emission hydrogen trucking in Europe at mass-market scale.
- In California, Shell is part of a consortium that is developing three new large-capacity refuelling stations for heavy-duty hydrogen fuel-cell trucks, in partnership with Toyota and Kenworth Truck Company. These stations will form the first hydrogen truck refuelling network in California. In doing so they will help reduce CO₂ emissions along a heavily polluted road that connects the Port of Los Angeles with a major warehouse complex inland.
- In Germany, Shell is a partner in the H2 Mobility joint-venture for developing a nationwide network of hydrogen fuelling stations for passenger cars. The venture already operates more than 80 stations across the country, with plans to reach 100 in 2021.
- Shell has also opened 8 hydrogen refuelling stations for light-duty vehicles in California, USA, and this number is set to grow beyond 50. Shell also has hydrogen stations in Canada, the Netherlands and in the UK.

Hydrogen Production

- In the North East of Scotland, Shell is part of a hydrogen and CCS project called Acorn, which is being led by Pale Blue Dot Energy. Using existing oil and gas infrastructure at the St Fergus gas processing terminal, the project will refine North Sea natural gas into blue hydrogen. The hydrogen produced would then be used in transport, and in the gas grid to decarbonise heating in homes and in industry.
- At the Shell Rhineland Refinery in Wessling, Germany, we are building one of the largest hydrogen proton exchange membrane (PEM) electrolyzers in the world. It will have a peak capacity of 10 megawatts and produce 1,300 tonnes of hydrogen a year. The plant will be built by ITM Power and operated by Shell. This project, REFHYNE, will be under development until 2021, and is being funded by the European Commission.
- Shell is working with partners to deliver the world's first liquefied hydrogen carrier. The ship, Suiso Frontier, was launched in Q4 2019 and will enter sea trials in late 2020/early 2021. It will be a demonstration case for potential large scale distribution of hydrogen between Australia and Japan.

Accelerating change:

- In February 2020, Shell, together with its consortium partners, Gasunie and Groningen Seaports, announced one of the largest green hydrogen projects in Europe, the NorthH2 project. This project expects to produce around 800,000 tonnes of hydrogen per year by 2040. This would avoid about seven mega-tonnes of CO₂ per year.
- Shell has formed a joint venture with Zhangjiakou City Transport to build a 20 MW renewable power-to-hydrogen electrolyser project and hydrogen refueling stations in Zhangjiakou City, China. The joint venture will support the development of hydrogen and the clean energy industry in the Beijing-Tianjin-Hebei region.
- In the Port of Rotterdam, Shell is working on large-scale electrolysis for provision of hydrogen to its Pernis refinery. Fuel infrastructure linked to ports will be a critical enabler in the transition to zero-emissions fuels for the sector.
- Carbon capture and storage will be needed to create blue hydrogen. Shell is involved with project Porthos to work in parallel on preparations for the capture, transport and storage of CO₂ in Rotterdam.
- In the Port of Rotterdam, Shell is supporting H-vision, a consortium of companies looking to decarbonise energy by replacing natural gas and coal with blue hydrogen.
- Shell plays a leading role in the standardisation of hydrogen refuelling protocols.
- Shell is also leading research into alternative methods of producing hydrogen using methane pyrolysis.¹⁸

Deploying charging solutions for battery electric vehicles

Shell already has an electric power business and is one of the world's largest mobility retailers, and we are now focused on developing world leading out-of-home and fleet depot charging services for the road freight sector.

What we are already doing:

EV charging

- In 2017, Shell launched Shell Recharge which offers rapid and ultra-rapid vehicle charging at Shell retail forecourts across the UK and the Netherlands. Today Shell Recharge offers fast charging at over 700 charge posts at over 300 sites in 18 countries.
- In 2017, Shell partnered with IONITY, a joint venture between BMW Group, Daimler AG, Ford Motor Company and the Volkswagen Group, to create a network of 350-kilowatt chargers next to major highways in Europe.
- In 2017, Shell acquired NewMotion, one of Europe's largest electric vehicle charging providers. NewMotion operates over 65,000 private electric charge points across Europe. It also provides access to more than 135,000 public charging points in over 35 European countries.
- In 2019, Shell acquired Greenlots, a California-based company that provides electric vehicle charging points, charging network software and grid services across the USA and beyond. Greenlots is a leading provider of electric vehicle charging solutions, enabling municipalities, businesses, utilities, vehicle fleet operators and automakers to deploy and manage electric vehicle charging infrastructure at scale.

Products

- In October 2020, Shell launched a range of E-fluids for battery electric vehicles. These E-Transmission Fluids, E-Thermal Fluids and E-Greases improve EV efficiency and help improve their performance.

Research and Development

- In November 2018, Shell signed a partnership with the Nissan Formula E team with the aim to accelerate track to road technologies in the e-mobility space.

Accelerating change:

- In a first for Shell, we are planning to convert a conventional fuels service station into an all-electric vehicle charging hub. This hub in central London, UK will feature up to 10 high powered, 150kW charging points. The design of the site will include solar panels. To ensure that customers can use the time they spend charging more effectively, this forecourt will also offer a new, on-the-go charging experience including a seating area for waiting EV drivers and a more extensive shop offer.
- In the Netherlands, we will pilot the use of battery storage on a Shell forecourt to support EV fast-charging by balancing grid capacity constraints and storage for excess renewable power.
- In late 2020, Shell opened our first Shell-Recharge off-site charging hub in the heart of a large residential community in China. It has 22 60KW chargers available to the local community of EV drivers. China is one of the fastest growing EV markets globally and we are excited to bring more Recharge offerings to our Chinese customers in the months ahead.
- We recently completed a minor investment in Envoy, a community-based shared mobility platform based in the US that provides electric vehicles as an exclusive amenity for apartments, hotels, and workplaces. Envoy currently provides 200+ vehicles and 300+ chargers to over 100+ properties in 10 states. Following the completion of our recent investment round Envoy are aiming to expand to 300-400 new locations in 2021.

Scaling production of low-carbon fuels for the transport sector

Over many years, Shell has built a leading position as a global marketer and trader of low-carbon fuels for road transport. Shell's expertise, customer focus and global footprint provides a strong foundation from which to support the immediate decarbonisation ambitions of governments and customers with low-carbon fuels.

What we are already doing:

Bio-LNG

- Shell is part of the BioLNG EuroNet consortium along with DISA, Scania, IVECO and Nordsol. The members will use their individual activities to put 2,000 more LNG trucks on the roads, build 39 LNG service stations across Europe and build a bio-LNG production facility in the Netherlands.
- In November 2020, Shell, with partners Renewi and Nordsol, started construction on a bio-LNG production facility that will use organic waste as feedstock. Shell will sell the bio-LNG at its filling stations, supplying enough bio-LNG to allow more than 13 mln km of CO₂-neutral transportation.
- Shell has plans to expand its LNG station network in Germany to 35-40 facilities, and is now operating nearly 30 Shell-branded LNG sites in Europe. This makes Shell the largest international LNG supplier on the road, covering major international transit routes from Poland all the way to Spain, as well as LNG stations in China.

R-CNG and RNG

- Shell plans to build its first R-CNG fuelling site in the US at its distribution complex in Carson, California. The R-CNG will come from Shell's portfolio of anaerobic digestion projects. Pending permit approvals, the fuelling site will substantially decarbonise product movements from the terminal by providing 100% R-CNG to its contracted hauling company.
- Shell, has begun activities at its first US biomethane facility, Shell New Energies Junction City in Oregon, USA. Upon reaching a steady state of operations, the facility will utilize locally-sourced cow manure and excess agricultural residues from grass and wheat straw to produce approximately 736,000 MMBtu a year of RNG.
- Shell is building a dairy manure to RNG project to be co-located at the High Plains Ponderosa Dairy in Plains, Kansas. Pending necessary permit approvals, once operational Shell Downstream Galloway is expected to produce more than 500,000 MMBtu a year of negative carbon intensity RNG using cow manure from the dairy.

Accelerating change:

- IH² technology can provide a very cost-effective route for producing fungible, liquid hydrocarbon transportation fuels from biogenic and waste feedstock. The IH²-5000 demonstration facility, which processes 5 t/d of feedstock on a dry, ash-free basis, at the Shell Technology Centre Bangalore, has completed several runs and the technology performance outcomes have been in line with expectations.
- Shell's involvement with Porthos – a project to capture, transport and store of CO₂ produced in Rotterdam – is well situated to improve the carbon intensity of low-carbon fuels produced at our Pernis refinery. This potential partnership and integration could allow Shell to provide customers low-carbon fuels that reduce CO₂ emissions up to 80%.
- With support of the Canadian and Québec governments, Shell announced plans to invest in Varennes Carbon Recycling in December 2020. This is a joint venture partnership with Enerkem, Suncor, Proman and Hydro-Québec, that aims to derisk and commercialise an advanced technology that produces low-carbon fuels from waste.
- Shell has proposed a gas liquefaction plant at its Rheinland refinery to supply Shell LNG filling stations and their customers in Germany with CO₂-neutral fuel in the future. Shell will use biomethane for this purpose. The planned liquefaction plant is expected to have an annual capacity of around 100,000 tonnes.

CONCLUSION



CONCLUSION

Fleet companies, shippers, truck manufacturers, energy companies and policy makers will need to work together if the road freight industry is to achieve net-zero CO₂ emissions by 2050. The scale and complexity of the task cannot be overstated, but there are reasons to be hopeful. Solutions are multiplying and many are already being implemented across the sector. Shell is working to support decarbonisation efforts across the industry by investing in the production and distribution of low- and zero-carbon forms of energy, alongside other solutions, to reduce emissions.

As the sector converges on a zero-emission technology pathway that includes both hydrogen and battery electric vehicles, Shell is investing in the production and distribution of low-carbon energy to meet increasing demand for these decarbonisation solutions. And by collaborating with businesses and governments, we want to accelerate the pace at which these technologies are adopted. As road freight makes this transition, we must also deploy solutions for conventionally powered trucks that will exist in the global fleet for many years to come. LNG and biofuels offer material and affordable solutions that are

already available to fleet companies and they will play an important role in achieving net-zero emissions.

Immediate opportunities exist for the road freight sector to reduce emissions and create savings through more efficient practices. Many of these solutions – such as fitting more efficient tyres, amending maintenance schedules, fitting vehicle design add-ons and using high-quality engine oils – can be implemented relatively easily. The introduction of digital tools to optimise how fleets are managed can also reduce unnecessary truck travel and encourage more energy efficient driving practices. Fleet companies also have the opportunity to offset those emissions that cannot be avoided or reduced.

Shell believes that a robust sectoral policy framework that sets clear CO₂ emission performance standards and time-bound net-zero emission targets is needed to accelerate decarbonisation efforts. Where possible, governments should provide adequate financial incentives to stimulate investments in the manufacture of zero-emission trucks, low-carbon energy production and distribution and the purchase of low- and zero-emission

trucks. However, we recognise that we cannot simply rely on governments to create the conditions for success. Through industry collaboration, businesses and stakeholders across the sector can agree on ambitious

decarbonisation roadmaps and start making progress on them today. Together, with the right policies and active industry collaboration, we can and we will transform the industry to achieve net-zero emissions by 2050.



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LEGAL DISCLAIMER

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this Decarbonising Road Freight: Shell's Route Ahead report, "Shell", "Shell Group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Royal Dutch Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. "Subsidiaries", "Shell subsidiaries" and "Shell companies" as used in this Decarbonising Road Freight: Shell's Route Ahead report refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

This Decarbonising Road Freight: Shell's Route Ahead report contains data and analysis from Shell's Sky scenario. Unlike Shell's previously published Mountains and Oceans exploratory scenarios, the Sky scenario is based on the assumption that society reaches the Paris Agreement's goal of holding the rise in global average temperatures this century to well below two degrees Celsius (2°C) above pre-industrial levels. Unlike Shell's Mountains and Oceans scenarios, which unfolded in an open ended

way based upon plausible assumptions and quantifications, the Sky scenario was specifically designed to reach the Paris Agreement's goal in a technically possible manner. These scenarios are a part of an ongoing process used in Shell for over 40 years to challenge executives' perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes.

Additionally, 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.

This Decarbonising Road Freight: Shell's Route Ahead report contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements

concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", "anticipate", "believe", "could", "estimate", "expect", "goals", "intend", "may", "objectives", "outlook", "plan", "probably", "project", "risks", "schedule", "seek", "should", "target", "will" and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this Decarbonising Road Freight: Shell's Route Ahead report, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is

provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this Decarbonising Road Freight: Shell's Route Ahead 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: Shell's Route Ahead report and should be considered by the reader. Each forward-looking statement speaks only as of the date of this Decarbonising Road Freight: Shell's Route Ahead 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: Shell's Route Ahead report.

We may have used certain terms, such as resources, in this Decarbonising Road Freight: Shell's Route Ahead 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.

Discover more at

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