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Transport Committee

Fuelling the future: motive power and connectivity

Third Report of Session 2022–23

Report, together with formal minutes relating to the report

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Transport Committee

The Transport Committee is appointed by the House of Commons to examine the expenditure of the Department for Transport and its associated public bodies.

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Committee reports are published on the Committee's website at www.parliament.uk/transcom and in print by Order of the House.

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The current staff of the Committee are Jonathan Arkless (Committee Specialist), Millie Bacon (Inquiry Manager), Judith Boyce (Clerk), Daniel Gillett (Committee Specialist), Alexandra Hunter-Wainwright (Committee Operations Manager), Abi Samuels (Second Clerk), Owen Sheppard (Senior Media Officer), and Mandy Sullivan (Committee Operations Officer).

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In July 2021, the Government published its Transport Decarbonisation Plan which outlined the pathway for the transport sector to be net zero by 2050 in the UK. It reaffirmed the Government's commitment to decarbonising all forms of transport including maritime, aviation, road and rail, and stated that this will primarily be achieved by a combination of modal shift and alternative decarbonisation technologies.

The Government has repeatedly stated its position as "technology neutral" regarding the decarbonisation fuel or technology chosen for each transport mode. We were told by witnesses that this has been a barrier to investment in decarbonisation technologies due to the financial risk posed to private companies who invest in infrastructure for a technology that may not be the eventual 'winner'. The Government should change its policy to one of 'targeted technology investment', allowing it the flexibility to make strategic investments in new technologies that offer evidenced solutions to lowering emissions, and giving the private sector more confidence to invest in its own infrastructure.

Synthetic fuels

The potential of sustainable fuels—biofuels and synthetic fuels—has been overlooked (intentionally?) in this debate. The key benefit of these fuels is their 'drop-in' capabilities, meaning they are usable in existing vehicles. They can be engineered over time to improve efficiency and reduce particulates and other emissions, while taking advantage of ever-more efficient engine technology. They can also be blended with fossil fuels until production ramps up sufficiently to replace them.

Various types of these fuels are already in production worldwide and have been used successfully in a variety of applications including motorsport, high-performance cars and an RAF test flight. The ability to provide existing private cars that will remain on the road for some time with drop-in replacement fuels from renewable sources seems a sensible and economically sound approach, making the best use of legacy assets. The current legislative framework, however, fails to capture the benefits of these fuels by focusing only on tailpipe emissions and not accounting for carbon savings elsewhere in the lifecycle.

The sidelining of sustainable fuels is particularly marked in the arena of private cars, where in contradiction to its stated policy of technology neutrality, the Government is currently succumbing to groupthink and putting all its eggs in one basket: battery EVs. Not everyone will be able to afford to replace their current car with an EV, nor will everyone easily be able to charge one at home. There are questions over the adequacy of infrastructure and the use of raw materials to produce the necessary batteries. An exclusive focus on battery electric vehicles risks failing to meet the UK's climate goals.

The huge potential for sustainable fuels to provide a low-carbon option for conventional engines must be further explored. Reducing greenhouse gas emissions right now by using increasing quantities of drop-in sustainable fuels would enable us to address the existing fleet and minimise cost and carbon emissions through the use of existing infrastructure.

Direction, guidance and regulation from the Department for Transport in respect of sustainable fuels is urgently required. A mechanism is needed to recognise the carbon savings associated with sustainable fuels which would incentivise investment and drive down costs, allowing automotive companies to provide the solution by applying the right mix of technologies.

Road

For cars and taxis, battery electric has already been chosen as the preferred decarbonisation technology. We also believe there is a case for many people right across the country in all areas, but particularly in rural and isolated communities, to continue to drive wholly diesel or petrol-powered cars, or hybrids (or EVs if they wish). Over time they will very likely account for a negligible proportion of transport emissions. The cost of introducing EV charging infrastructure is completely unrealistic and will require massive amounts of taxpayers' money through government subsidy for electricity generation, infrastructure provision and storage, and basic raw materials for battery production in order to be anywhere near acceptable as an alternative to ICE or hybrid personal vehicles, delivery, farming or construction vehicles.

The biggest decarbonisation challenge for the road sector is Heavy Goods Vehicles (HGVs), which need significantly more power. In November 2021, the Government announced that the UK will become the first country in the world to commit to phasing out new, non-zero emission heavy goods vehicles weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission by 2040. For lighter weight goods vehicles that are travelling shorter distances, battery electric appears to the most viable solution, but for heavier HGVs travelling long distances, there does not appear to be a single obvious solution. We recommend that the Government publish a long-term HGV decarbonisation strategy as a matter of priority.

Maritime

The maritime sector presents a significant challenge to decarbonisation. It appears to be the furthest behind of the transport sectors in terms of technology readiness, the global nature of the shipping industry means international consensus on the chosen decarbonisation technology is required for alignment of infrastructure, and the longevity of vessels means that fossil fuel-powered ships built today will likely still be in operation in 2050. The UK Government should use its influence at the International Maritime Organization to ensure that, globally, the path forward for investors in alternative maritime fuels becomes more secure.

Aviation

There will likely be significant remaining emissions in the aviation sector by 2050 due the limited decarbonisation options currently available. We were told that zero emission flight will mostly likely be achieved via hydrogen or battery electric. Both options, however, are currently only viable for short-haul routes and will likely remain so until after 2050.

Sustainable aviation fuels (SAF) are the most viable option for the immediate reduction of aviation emissions. In July 2022, the Government published its Jet Zero Strategy, which introduced a SAF mandate that will require at least 10 per cent of jet fuel to be made from sustainable sources by 2030. We consider that further measures are needed to stimulate uptake of SAF. We recommend that the Government should introduce a Contracts for Difference model to support the commercialisation of SAF and create price certainty to incentivise further investment.

Rail

Rail travel is a naturally low-carbon transport mode, but trains in the UK still heavily rely on diesel traction for their power. In 2018, the Government committed to phasing out all diesel-only trains by 2040, including freight trains. Electrification is currently the only decarbonisation technology that can deliver a full range of requirements including high-speed, long-distance passenger travel and freight haulage. To achieve its decarbonisation goals, the Government must electrify the network at a faster rate.

Electrification may not be viable on all routes as the long-term benefits may not justify the high investment cost and level of disruption caused by engineering works; in these cases battery electric and hydrogen may provide a solution, but neither are currently capable of delivering the power required by freight and high-speed train services because of their high energy demand. Biofuels may be the most viable option for decarbonising rail freight in the short and medium term. We reiterate a previous recommendation that the Department for Transport publish a long-term strategy for decarbonising the rail network, including a vision for what proportion of the future network will use electrification, battery and hydrogen, and a credible delivery plan.

1 Introduction

The decarbonisation challenge

1. We are aware that the UK Government is committed to achieving net zero emissions by 2050.[1] Transport, including shipping, aviation, farming and construction vehicles and rail, is currently the largest emitting sector of the UK economy, responsible for 27 per cent of total UK greenhouse gas emissions.[2] The combustion of fuel releases both energy and carbon dioxide (CO_2); the amount of CO_2 released by the production of one unit of power depends on the type of fuel that is burned meaning that switching to alternative, lower-carbon or zero emission technologies could significantly reduce the transport sector's proportion of emissions.

2. In 2021, the Government published its Transport Decarbonisation Plan which outlined the pathway for the transport sector to be net zero by 2050 in the UK. It reaffirmed the Government's commitment to decarbonising all forms of transport including maritime, aviation, road and rail, and stated that this will primarily be achieved by a combination of modal shift and alternative decarbonisation technologies. In the foreword to the Plan, Rt Hon Grant Shapps MP, the then Secretary of State for Transport, said the Government's approach to decarbonisation is:

> not about stopping people doing things: it's about doing the same things differently. We will still fly on holiday, but in more efficient aircraft, using sustainable fuel. We will still drive on improved roads, but increasingly in zero emission cars.[3]

Technology neutrality

3. The Government's 2019 Technology Innovation Strategy stated that "government standards are deliberately technology agnostic."[4] The Department for Transport told us:

> The government approach has been, and will remain, technology neutral. However, it is essential that the relative environmental performance of different technologies in the real world is considered when incentivising their adoption in order to achieve climate targets.[5]

4. The then Parliamentary Under Secretary of State at the Department for Transport, Trudy Harrison MP, told us "The decision to be agnostic is, quite frankly, because we do not yet know what the solutions are, which is why we have invested heavily in research and development and in trials."[6]

1 Department for Business, Energy & Industrial Strategy, Net Zero Strategy: Build Back Greener (October 2021) p 15
2 Department for Transport, Transport and Environment Statistics: 2021 Annual Report (August 2021)
3 Department for Transport, Transport decarbonisation plan (July 2021) p 4
4 Cabinet Office, 'Government Technology Innovation Strategy' accessed 23 September 2022
5 Department for Transport (FTF0051)
6 Q226

Our inquiry

5. We launched our inquiry, 'Fuelling the future: motive power and connectivity' in December 2021. The inquiry set out to examine how the Government could meet its aims for transport decarbonisation, what the best fuel choices for each mode are, and what further steps the Government should take to achieve its aims. The inquiry also examined the feasibility and effectiveness of the Government's 'technology neutral' approach to decarbonising the transport sector. We held three oral evidence sessions and received 66 written evidence submissions from the public, private companies and other organisations. We are grateful to everyone who contributed to and engaged with our inquiry.

Background: alternative fuel types

Hydrogen

6. Hydrogen is a clean fuel that, when burned or consumed in a fuel cell, emits only water as waste along with either heat and/or electricity, making it zero emission at point of use. Hydrogen can be produced either from methane (natural gas) or the electrolysis of water powered by a variety of low-carbon domestic resources, such as nuclear power, biomass, and renewable power like solar and wind. These qualities make it an attractive fuel option for transportation, heat and electricity generation applications. It can be used in cars, in houses, for portable power, and in many more applications.[7]

7. There are several types of hydrogen dependent on the type of production used. 'Green' hydrogen is produced without greenhouse gas emissions; it is made using electricity from renewable energy sources, such as solar or wind power, to electrolyse water. Electrolysers use an electrochemical reaction to split water into hydrogen and oxygen, emitting zero carbon dioxide in the process. This type of hydrogen makes up only around four per cent of hydrogen produced worldwide.[8] 'Blue' hydrogen is produced predominantly from natural gas, using a process called steam reforming, which brings together natural gas and heated water in the form of steam. This produces hydrogen, but carbon dioxide is also produced as a by-product. Carbon capture and storage (CCS) is used to trap and store this carbon. 'Grey' hydrogen is currently the most common form of hydrogen production; it is produced similarly to blue hydrogen but without capturing the greenhouse gases made in the process.[9]

8. Hydrogen is only viable as a zero-emission fuel if it is 'green'. Anna Ziou, Policy Director (Safety and Environment) at the UK Chamber of Shipping, told us, "Currently, the processes are using fossil fuel. If you use fossil fuels to produce hydrogen, obviously that is not going to deliver the targets, because you are just shifting the problem elsewhere".[10]

9. In August 2021, the Government published its UK Hydrogen Strategy, stating that

7 Office of Energy Efficiency & Renewable Energy, 'Hydrogen Fuel Cell Basics' accessed 22 September 2022
8 Climate Change Committee, Hydrogen in a low-carbon economy (November 2018) p 19
9 National Grid Group, 'The hydrogen colour spectrum' accessed 23 September 2022
10 Q129

> As part of a deeply decarbonised, deeply renewable energy system, low carbon hydrogen could be a versatile replacement for high-carbon fuels used today—helping to bring down emissions in vital UK industrial sectors and providing flexible energy for power, heat and transport.[11]

Battery electric

10. Electricity is a universal energy carrier and can be produced from all primary energy sources; this energy then requires a reliable storage medium, which batteries provide. Batteries are zero emission at the point of use, can be used to reduce peak electricity load and can work during a power outage.[12] However, they can also be very heavy, battery manufacturing produces a high amount of carbon and is raw-material intensive, and their disposal can be a high-energy process.[13] Currently, battery electric is predominantly used in zero emission road vehicles (ZEVs), using lithium-ion batteries as a frequent need for recharging makes it best for lighter vehicles, travelling shorter distances. The technology is also being invested in for use in maritime, rail and aviation.

Biofuels

11. The term biofuels typically refers to a liquid or gaseous fuel for transport produced from biomass, which is renewable organic material that comes from plants and animals. The Climate Change Council (CCC) has stated, "there is no universal answer to the question as to whether biomass is low-carbon."[14] However, the CCC does also state that there is low greenhouse gas biomass, which depends on preventing losses of land carbon stocks, and high greenhouse gas biomass, which "can be associated with much higher GHG emissions than fossil-fuel alternatives, particularly when it drives large losses in land carbon stocks."[15]

12. 'First generation' biofuels are normally made from conventional food crops such as wheat and sugar, which are converted into a liquid or gaseous form. They are usually blended into conventional fuels such as petrol and diesel and are commonly known as biodiesel, bioethanol and biogas.[16] 'Second generation' biofuels can be made from non-food feedstocks and residues from agriculture and forestry—such as straw, grass, and fast-growing woody crops. They may have greater greenhouse gas savings and smaller land take compared to first generation biofuels.[17]

13. Biofuels have been supported in the UK for over a decade, principally by the Renewable Transport Fuel Obligation (RTFO). The RTFO commenced on 15 April 2008 and delivers reductions in greenhouse gas emissions from fuel used for transport purposes by mandating the supply of renewable fuels.[18]

11 Department for Business, Energy & Industrial Strategy, UK Hydrogen Strategy, (August 2021), p. 4
12 Network Rail, Traction Decarbonisation Network Strategy: Interim Programme Business Case (July 2020), p 70
13 Network Rail, Traction Decarbonisation Network Strategy: Interim Programme Business Case (July 2020), p 180
14 Climate Change Committee, Biomass in a low-carbon economy (November 2018) p 55
15 Climate Change Committee, Biomass in a low-carbon economy, (November 2018) p 55
16 House of Commons Library, Research briefing: Biofuels, (October 2011) p 2
17 House of Commons Library, Research briefing: Biofuels, (October 2011) p 3
18 Department for Transport, Targeting net zero- Next steps for the Renewable Transport Fuels Obligation (March 2021) p 8

Synthetic fuels

14. Synthetic fuels can be made through "chemical conversion processes from 'defossilised' carbon dioxide sources such as point source capture from the exhausts of industrial processes, direct capture from air or from biological sources".[19] There are two types of synthetic fuels: electric fuels (efuels) made using captured carbon in a reaction with hydrogen, or synthetic biofuels made by the treatment (chemical or thermal) treatment of biomass or biofuel. Paddy Lowe, founder of Zero Petroleum, a synthetic fuel manufacturer, told us,

> Electro-fuels are fuels that come from, effectively, water and carbon dioxide in the air, rather than any other feedstock. The exciting point about that is that you can make fuels that will drop straight into existing engines, without modification. That is replacing the status quo with a fossil-free equivalent.[20]

Dr Andy Roberts, Director of Downstream Policy at the UK Petroleum Industry Association noted, however, that "Some synthetic fuels are electricity intensive. They tend to be more hydrogen intensive than conventional petroleum products, so there are additional costs involved in producing some of the fuels."[21]

19 The Royal Society, Sustainable synthetic carbon based fuels for transport, (September 2019) p 4
20 Q21
21 Q25

2 Sustainable and synthetic fuels

15. While battery electric, hydrogen and even ammonia have been widely talked about as alternatives to conventional fuel, sustainable fuels have generally received less attention. The attraction of sustainable fuels is their potential to capitalise on ever-more efficient engines by being usable in existing vehicles, rather than requiring new vehicles to be produced and old ones scrapped. While sustainable fuels themselves may currently come at a higher cost, Zero Petroleum, a synthetic hydrocarbon fuel designer and manufacturer, told us that their 'drop-in' capabilities mean there are no asset conversion costs and that they can be engineered over time to improve efficiency and reduce particulates and other emissions.[22] Advanced, second-generation (2G) biofuels (those generated from waste products) are already available in significant quantities and are direct drop-in replacements for their fossil counterparts. Calor, a supplier of LPG and LNG, argued that production of sustainable fuels at scale could "deliver carbon reductions today whilst the proposed future zero emissions technologies are being made to be both pragmatic and economic to use".[23]

16. Sustainable fuels fall into two main categories; biofuels and synthetic fuels. Biofuels rely on converting the carbon captured during plant growth via photosynthesis into hydrocarbon fuels via fermentation, esterification or hydrogenation. Biofuels can be first or second generation. First generation biofuels are made from crops and suffer the criticism that those crops could have been used for food rather than fuel. However, the focus has now shifted to second generation biofuels that avoid this by only using waste products as their feedstocks. In 2021, more than 2.5 billion litres equivalent of renewable fuel were supplied in the UK alone, which constitutes five per cent of total road and non-road mobile machinery fuel for the year. Typically, these fuels have an average greenhouse gas (GHG) saving of 83 per cent when compared to their fossil counterparts (this drops to 80 per cent when indirect land-use change is accounted for).[24] Types of biofuels include:

- Biogasoline; in the ethanol-to-petroleum process, the ethanol is first dehydrated into ethylene and then passed over a zeolite catalyst to produce longer chain hydrocarbons optimal for the petroleum range. Provided the ethanol feedstock is second generation bioethanol produced by fermentation of waste plant matter, the resulting petroleum is sustainable and can be used as a direct, drop-in replacement for fossil-derived petroleum and offers GHG savings in excess of 80 per cent.

- Hydrotreated Vegetable Oil (HVO) is a biofuel made by the hydrocracking or hydrogenation of plant-based or waste oils. This creates a paraffinic diesel that can be used as a replacement for diesel in internal combustion engines. Some (mainly truck) engine manufacturers already warrant their engines to run on HVO.

- Biodiesel (also known as FAME) uses the same feedstock as HVO (that is, plant-based and waste oils) but these undergo an esterification process to create what is known as biodiesel. However, this has a lower energy density than diesel and HVO and is not a direct replacement for diesel, and consequently it can currently only be blended into pump diesel fuel at up to seven per cent (labelled at the pump as B7).

22 ZERO PETROLEUM LIMITED (FTF0039)
23 Calor (FTF0011)
24 Department for Transport, 'Renewable fuel statistics 2021: Final report' accessed 22 February 2023

Synthetic fuels

17. Synthetic fuels rely on more industrial-style processes that convert hydrogen and CO2 into hydrocarbons via processes such as Fischer-Tropsch (FT). The Fischer-Tropsch process is a collection of chemical reactions that converts a mixture of carbon monoxide and hydrogen, known as syngas, into liquid hydrocarbons. The source of the hydrogen is very important and can come from fossil sources such as coal or natural gas. Electrofuels, or e-fuels, are a very specific type of synthetic fuel that use hydrogen made from renewable sources such as electrolysis of water.

18. Methanol is also an option as a sustainable fuel and is a widely available commodity with around 100 megatonnes (Mt) produced globally, nearly all of which is from fossil fuels. E-methanol and bio-methanol are both considered green forms of methanol. E-methanol is manufactured from captured CO_2 and hydrogen from a renewable source (electrolysis with renewable electricity). Bio-methanol is manufactured from waste materials or biomass. Green methanol presents a pathway as a low carbon alternative fuel for engines (although research has been undertaken for its use in industrial gas turbines). Methanol production is expected to grow to 250 Mt per annum by 2050, of which 150 Mt will be 'green' methanol. Siemens Energy is pioneering a commercial scale e-methanol plant in Haru Oni in Chile which officially opened in December 2022 and is expected to be producing 55 million litres a year by the mid-2020s,[25] and will supply the electrolysers for European Energy's e-methanol plant at Kassø, Denmark.

19. Enabling internal combustion engines (ICEs) to operate on green methanol fuel or a very similar synthetic fuel could bring the same numerous benefits as those reported by Siemens Energy with its gas turbines running on green methanol fuel, such as: up to 97 per cent reduction in carbon emissions, up to 80 per cent reduction in NOx emissions (proven on non-Dry Low Emissions), almost no particulate emissions, smoke or sulphur oxide emissions and no expected impact to engine/gas turbine performance and operability. As methanol is widely available today, products and solutions that already exist for the handling, transportation, storage and safety make it an ideal alternative fuel for both vehicle engines and gas turbines. Some challenges exist particular around the supply and cost of green methanol, which is expected to grow and reduce significantly, and respectively, by 2030. The energy density of methanol is also much lower than petrol or diesel and so larger volumes are required and changes to fuel injection equipment are also required.

20. Gas turbine combustion, and alternatives to fossil fuel engine power is a specialised subject. Significant engineering, development and testing is required for any new fuel to ensure that combustion is efficient and NOx and other engine emissions are compliant and reduced of course. Dry Low Emissions (DLE) technology is a differentiator for gas turbines certainly, and the existing technologies can be readily applied to ICEs, ultimately enabling similar advantages as with gas turbines producing higher efficiency with lower emissions than existing technologies.

21. The DREEM Diesel Replacement with e-Methanol is a £3.25m UK project by Siemens which has been submitted to BEIS for funding. This project will demonstrate a DLE combustion system on an SGT-400 gas turbine operating on methanol fuel. The concept involves re-designing the DLE combustion system to be compatible with methanol whilst

25 Car Magazine, 'Porsche e-fuels pilot plant in Chile opens' accessed 22 February 2023

maintaining compliant emissions and not impacting overall gas turbine performance. The concept is compatible with the existing full combustion system allowing for continued fuel flexibility with natural gas and may well have an impact and application for aviation engines, space delivery vehicles potentially, as well as those vehicles powered by ICEs—smaller but collectively a larger testbed of usage, and potential refinement.

22. The methanol-to-gasoline (MTG) process is a sustainable approach for producing petroleum-range hydrocarbon biofuels. It starts with the production of syngas, followed by conversion of syngas to methanol. The methanol is first converted to dimethyl ether by being passed over a catalyst and this is then passed over a fixed bed shape selective ZSM-5 zeolite to produce liquid fuels in 75% selectivity at 100% conversion. Accordingly, 90% of the carbon in methanol is converted to petroleum. The liquid fuels are C12 and lower which is optimal for the petroleum range. Provided the syngas is synthesised from green hydrogen and recycled CO/CO_2, the resulting petroleum is sustainable and can be used as a direct, drop-in replacement for fossil-derived petroleum.

Uses

23. Zero Petroleum has already produced synthetic aviation fuel for use in a RAF trial flight and reported to us that there was clear demand for "a far more extensive range of applications than aviation".[26] These applications could include where battery weight and volume would be prohibitive to effective performance, or where electrification is not possible for practical engineering reasons. Helen Simpson of railway rolling stock company Porterbrook noted that synthetic fuels could have a viable use in the short term as an alternative to increasingly expensive electricity in rail.[27] The then Minister, Trudy Harrison MP, told us that hydrogen fuel cells and direct combustion using biofuels could be part of the solution for HGVs alongside battery electric: "It is horses for courses. It depends on the vehicle, on the weight, on its purpose and on its journey type."[28]

24. Dr Andy Roberts of the UK Petroleum Industries Association argued that "low-carbon fuels have a very important role to play […] in short-term decarbonisation of both the light vehicle fleet and heavier vehicles".[29] In comparing the possible solutions, however, Greg Archer of Electromobility UK, which represents companies and organisations supporting transition to battery electric vehicles, argued that, while the embedded energy required to produce an electric car is higher than that needed for a conventional car, "robust studies show that [that energy requirement] is paid off within about 16,000 miles of using the car". He also argued that, having been used in vehicles, batteries can then provide static storage in the grid, and precious metals used in their manufacture can be recycled.[30] Zero Petroleum noted that "private transportation is one of the few sectors for which [mandates for synthetic petroleum fuels] are relatively weak; hence the strong case for electrification in that sector".[31]

25. **It is our view that the case for full electrification in private cars is 'the received wisdom', and therefore needs further scrutiny and investigation.**

26 ZERO PETROLEUM LIMITED (FTF0039)
27 Q207
28 Q261
29 Q18
30 Q171
31 ZERO PETROLEUM LIMITED (FTF0039)

26. We asked the Department in December 2022 whether synthetic fuels and other emerging technologies were being considered alongside EVs for private cars. Although the Secretary of State reaffirmed that the Department itself is "not wedded to particular technologies", the Second Permanent Secretary said, "It is fair to say that, on cars, it does feel like the momentum is with electric […] Vans, similarly, look to be moving towards electric".[32] Caroline Low, Director for Energy, Technology, and Innovation at the Department for Transport said during our inquiry that "we have seen no evidence that e-fuels can deliver the air quality benefits that come from a battery/electric or hydrogen fuel cell car. That is the real challenge. They deal with the carbon, but they do not deal with the NOx and other emissions."[33]

27. The calculation may well be different for the 'legacy fleet' of private cars, however. While Government plans for all new passenger cars sold from 2035 to be zero emission at the tailpipe are expected by some EV evangelists to be largely fulfilled by EVs, millions of cars with conventional engines will remain on the road past that point, representing huge amounts of embedded carbon. The average age of a car at scrappage in 2015 was 13.9 years,[34] meaning that petrol and diesel-powered vehicles currently being manufactured will likely still be on the road well beyond 2035. All these vehicles used energy and raw materials to be constructed—they have many years of life left in them. According to FVV, addressing the existing fleet will be decisive in achieving our climate goals.[35]

28. **Given the existing private cars that will remain on the road for some time, drop-in replacement fuels from renewable sources could be a no-risk, very sensible and economically sound approach.**

29. Michael Steiner, Member of the Executive Board for Development and Research at Porsche AG, said in December 2022 when pilot production of synthetic fuels commenced at a plant in Chile:

> The potential of e-fuels is huge. There are currently more than 1.3 billion vehicles with combustion engines worldwide. Many of these will be on the roads for decades to come, and e-fuels offer the owners of existing cars a nearly carbon-neutral alternative.[36]

30. Porsche CEO Oliver Blume said in November 2020 that the advantages of e-fuels "lie in their ease of application: e-fuels can be used in combustion engines and plug-in hybrids, and can make us of the existing network of filling stations".[37] Porsche's head of motorsport, Dr Frank Walliser, said in February 2021:

> The general idea behind these synthetic fuels is that there is no change to the engine necessary, unlike what we have seen with E10 and E20, so really, everybody can use it, and we are testing with the regular specs of pump

32 Oral evidence taken on 7 December 2022, HC (2022–23) 163, Q492 [Rt Hon Mark Harper MP]
33 Q265
34 Society of Motor Manufacturers and Traders, 'Average Vehicle Age', accessed 16 January 2023
35 FVV, 'Six theories on climate neutrality in the European transport sector' accessed 22 February 2023
36 Autocar, 'Porsche begins synthetic fuel production in Chile' accessed 22 February 2023
37 Porsche, 'Porsche and Siemens Energy, with partners, advance climate-neutral e-fuel development' accessed 22 February 2023

> fuel. It has no impact on performance—some horses more, so it's going in the right direction—but emissions are way better; we see less particles, less NOx—so that's going in the right direction.[38]

31. Dr Matthias Rabe, Member of the Board for Engineering at Bentley, said in March 2021:

> We're looking more at sustainable fuels, either synthetic or bio-gen. We think the combustion engine will be around for a long time yet, and if that's the case, then we think there can be a significant environmental advantage from synthetic fuels.[39]

32. Bentley's team at the 2021 Pike's Peak rally used a drop-in ExxonMobil synthetic fuel.[40] In December 2022, a production standard Mazda Roadster completed laps around and drove between racetracks in England, Wales, Scotland and Northern Ireland using sustainable advanced drop-in biofuel manufactured by Coryton,[41] a UK company, using the bioETG process, and both Toyota and Subaru planned to race in the 2022 Super Taikyu Series using carbon-neutral synthetic fuel derived from biomass.[42] Prodrive competed and placed highly in the Dakar Rally in 2022 and 2023 using a sustainable petrol made by Coryton using the bioETG process and with 90 per cent renewable content, saving over 28 tonnes of CO2 during the event. All cars competing in the 24 Hours of Le Mans endurance race in 2022 were supplied with 100 per cent renewable fuel by TotalEnergies which uses recycled biomass from the wine industry.[43]

33. Despite noting that there is a strong case for electrification in new private vehicles, Zero Petroleum argued that legacy assets across transport, industry and agriculture "can be better deployed to full life by the use of drop-in synthetic petroleum fuels".[44] Prodrive, a business founded in motorsport which develops alternative technologies, argued that sustainable fuels could "provide an immediate cost-effective solution that can be developed in parallel to EVs and promising technologies" and "maximise the utility of the UK's existing transport stock".[45]

34. FVV, a research association for combustion engines based in Germany, published in 2021 a study entitled "Six theories on climate neutrality in the European transport sector". The paper set out what it called "the most important boundary conditions for sustainable mobility", of which the first two were as follows:

> The 17 Sustainable Development Goals set out by the United Nations must be achievable around the globe and for all people. As combustion engines to date have primarily been powered with fossil fuels, particular importance is placed on the 13th goal: taking urgent action to combat climate change and its impacts. However, other Sustainable Development Goals (SDGs) must

38 This is Money, 'As clean as electricity: Porsche to start making synthetic fuel next year that could slash petrol-engined cars' CO2 emissions by 85%' accessed 22 February 2023
39 Autocar, 'Bentley engineering boss hints at plan to develop synthetic fuels' accessed 22 February 2023
40 Autocar, 'Synthetic fuels: made of the right stuff at Pikes Peak' accessed 22 February 2023
41 Renewable Energy Magazine, 'Mazda completes 1000-mile drive using sustainable 100 percent fossil-free fuel' accessed 22 February 2023
42 Motor1, 'Toyota, Mazda, Subaru connive to save ICE with carbon-neutral fuel' accessed 22 February 2023
43 Biofuels Central, 'All 24 hours of Le Mans race cars to use 100% renewable fuel produced by TotalEnergies' accessed 22 February 2023
44 ZERO PETROLEUM LIMITED (FTF0039)
45 Prodrive (FTF0067)

> also be taken into account, particularly affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, sustainable consumption and production and global partnerships.
>
> There are no 'good' or 'bad' technologies. The benchmark set out by FVV for technologies to defossilise the transport sector is solely the degree to which they can contribute to reaching the goals of the Paris Agreement without coming into conflict with other SDGs. In this regard, technology neutrality does not mean keeping all options open and not making any decisions, but assessing various existing options based on their climate effectiveness and the associated economic costs.[46]

35. FuelsEurope, a fuel manufacturers association, published a paper in 2020 proposing on behalf of the EU refining industry "a potential pathway to climate neutrality by 2050" through development of low-carbon liquid fuels (LCLF) for road, maritime and air transport. The paper states that:

> To deliver such pathway an investment estimated between €400 to €650 billion will be needed. Major investments, in addition to those already deployed, could start in the next years, with first-of-a-kind plants at industrial scale potentially coming into operation at the latest by 2025. Our LCLF pathway shows how a 100 Mt CO_2/y reduction could be delivered in transport by 2035, equivalent to the CO2 savings of 50 million Battery Electric Vehicles (BEVs) on the road, and how it could contribute to EU's climate neutrality by 2050.
>
> LCLF will play a critical role in the energy transition and in achieving carbon neutrality in all transport modes, as the global demand for competitive liquid fuels is expected to progressively increase. Therefore, alongside electrification and hydrogen technologies, LCLF will remain essential beyond 2050, bringing important benefits to the European economy and society.[47]

Production

36. Whilst the technologies regarding advanced biofuels and synthetic/e-fuels are well-understood they are not available in sufficient volumes and investment is needed to scale up production. Fortunately, due to their drop-in nature, they are able to be blended with fossil fuels, enabling to start small and increase the blend over time. However, the carbon savings of these fuels does not count in the current legislative framework (which is focused on tailpipe only and hence does not account for the carbon savings associated with making the fuel). This means that there is no business case for that investment as there is no commercial benefit. Indeed, FuelsEurope have called for the creation of a market for low-carbon fuels, with a significant carbon-price signal, as this is a prerequisite to unlock investments in low-carbon technologies and fuels. They have also called for the

46 FVV, 'Six theories on climate neutrality in the European transport sector' accessed 22 February 2023
47 FuelsEurope, Clean fuels for all: EU refining industry proposes a potential pathway to climate neutrality by 2050 (2020) p 5

CO_2 standards in vehicles to be amended, whereby the actual Tank-to-Wheel (TTW) approach currently in place is corrected by considering the CO_2 footprint of fuels as well (a well-to-wheel or WTW approach).[48]

37. Regarding production of biofuels, HVO is expected to grow substantially over the next few years, rising from around 9 billion litres per year globally in 2020 to an average of 17 billion litres per year in 2023–25.[49] Over 2,500 million litres equivalent of renewable fuel was supplied in the UK in 2021, 99.9 per cent of which was certificated under the Renewable Transport Fuel Obligation, and 10 per cent of which was produced from UK origin feedstocks. 52 per cent of the total was made of biodiesel, 32 per cent bioethanol, and four per cent biomethane.[50]

38. To make a substantial contribution to reducing greenhouse gas emissions over multiple transport modes, sustainable fuels would be needed in large quantities. Zero Petroleum argued that:

> The development of a [synthetic hydrocarbon fuels] capability and industry at scale is critical to the UK meeting its emissions targets. Moreover, it presents a colossal opportunity for UK innovation and global leadership in the associated technology and the consequent export trade in the medium and long term. Other players (notably Germany, Scandinavia) are presently taking the lead in this sector.[51]

39. Prodrive stated that synthetic fuels "are being produced in countries such as Chile with plentiful renewable energy sources and companies such as Porsche plan to produce 550 million litres by 2026".[52] Calor argued that e-fuels and synthetic fuels could be produced at significant scale and to an economic cost over a 15 to 20-year period, given "a clear policy framework".[53]

40. Coryton has argued that advanced biofuels (part of the sustainable fuel family), which are already categorised in the Renewable Transport Fuel Obligation under development fuels are available immediately. They offer the same 'drop-in' characteristics of synthetic fuels with no major changes to technology needed. All that is needed is investment to scale up.

41. Large-scale production would be expensive in both cash and energy terms. Paddy Lowe of Zero Petroleum told us that, while he had not analysed this in detail, scaling up the production of synthetic fuels to displace or replace the use of leaded petrol in cars and HGVs by 2050 would be "an enormous challenge", requiring huge capitalisation and renewable energy generation.[54] Greg Archer of Electromobility UK argued that it would be possible to produce small amounts of synthetic fuels for particular use cases (such as classic cars) as a by-product of use in, for example, the aviation sector.[55] He questioned, however, whether large-scale production for a wider range of vehicles was feasible:

48 FuelsEurope, Clean fuels for all: EU refining industry proposes a potential pathway to climate neutrality by 2050 (2020) p 13
49 International Energy Agency, 'Global biofuel production in 2019 and forecast to 2025' accessed 22 February 2023
50 Department for Transport, 'Renewable fuel statistics 2021: Final report' accessed 22 February 2023
51 ZERO PETROLEUM LIMITED (FTF0039)
52 Prodrive (FTF0067)
53 ZERO PETROLEUM LIMITED (FTF0039)
54 Q20
55 Q174

> if we were to try to create synthetic fuels, and use them in all vehicles, the energy demands would be astronomical. The reason for that is that it is at least three times more efficient to use renewable electricity directly and put it into a battery than it is to turn it into hydrogen and combine that hydrogen with a source of carbon to create a synthetic fuel […] We cannot create enough renewable energy by 2050 to be able to convert everything into a synthetic fuel.[56]

The Grantham Institute, Imperial College's hub for climate change and the environment, similarly told us that, among alternative fuels, electricity, hydrogen and synthetic fuels "show increasing energy cost" in terms of the input required per passenger kilometre.[57]

42. With this lesser efficiency in mind, Transport and Environment, a transport think tank and environmental group, argued that use of synthetic fuels and hydrogen should be limited to transport modes "in which there is no alternative".[58] They identified these as long-haul aviation and international shipping. The UK Chamber of Shipping agreed that, in the maritime sector, "biofuels and synthetic fuels provide a pathway to significantly reduce GHG emissions in the short and long term while using existing infrastructure".[59] The eFuel Alliance expressed concern, however, that aviation and maritime usage alone would not provide sufficient markets to make biofuels or synthetic fuels widely available.[60]

43. Louise Kingham of BP commented that the potential use of synthetic fuels for legacy vehicles "depends on where you can get the cost of synthetic fuels to. It is potentially a question of when. It is not right now."[61] Having noted the challenges that would be encountered in scaling up significantly by 2050, Paddy Lowe of Zero Petroleum went on to say that:

> The exciting point that we see is in the long term. While combustion today has unwanted side effects, quite aside from global warning, those aspects can be improved dramatically because combustion can be improved with new fuels. The fact that they are synthesised opens whole new avenues for new types of fuels that are far superior in combustion properties and things like contrails. I see that in 100 years we will have far superior fuels around us in a synthetic world than we have today in a fossil-based petroleum world.[62]

44. Louise Kingham of BP added:

> With synthetic fuels, it is about the cost and how we get it to a level that is something that can bring scale. That is the challenge we have. That is not to say, 'Don't do it,' but it needs to happen in parallel to the quick wins […]. […] it is what can you do on biofuels blending, to have that running in parallel to support ICE vehicles alongside the ramp-up of EVs and, ultimately, the slightly different solutions that were mentioned earlier for heavy-duty transport and aviation.[63]

56 Q171
57 Grantham Institute - Climate Change and Environment at Imperial College London (FTF0042)
58 Transport and Environment (FTF0053)
59 UK Chamber of Shipping (FTF0057)
60 eFuel Alliance (FTF0059)
61 Q30
62 Q21
63 Q22

45. Prodrive argued that there should be policy incentives for "affordable alternative sustainable fuels such as second-generation biofuels or synthetic fuels"; such incentives would encourage production "in the huge volumes needed for multiple industries". They further said, "The critical question is how do we create a level playing field and provide an immediate cost-effective solution that can be developed in parallel to EVs and promising technologies".[64] Calor argued that "if a policy and fiscal framework is not developed to allow the cohesive and pragmatic support and introduction of [low carbon fuels] then achieving the Government's [decarbonisation] target will fade quickly into the distance".[65]

46. Development of synthetic fuels can contribute towards energy security when it relies upon domestic biomass and coal rather than petroleum-derived fuels and imported oil. Some nations such as Japan are progressing down this route to enable their populations and manufacturing businesses to be 'future-proofed' regarding energy and transport requirements and provision in the future.

47. The Institution of Mechanical Engineers stated in a 2020 report on accelerating road transport decarbonisation that it

> believes sustainable and low carbon fuels offer an immediate opportunity to accelerate the decarbonisation of road transport, by employing existing technologies in a complementary approach to the long-term transition to fully electric vehicles.[66]

Dr Jenifer Baxter, the Institution's Chief Engineer, said in the report that "Sustainable and low carbon fuels offer us another option in the continuing challenge to reduce our impact on the planet."[67] The report recommended that substantial investment—similar to that provided for battery electric vehicles and charging infrastructure—should be made in sustainable and low-carbon fuel development and associated ICE technology. It concluded that

> there is not a 'one-size-fits-all' solution [to decarbonising road transport]. We need to pursue all the potential powertrain solutions in parallel, because we simply do not have time to wait for the increasing share of electric vehicles to make a dent on the passenger car CO2 footprint. Indeed, as we accelerate the adoption of electric vehicles, it is possible that we are accelerating the production of GHG emissions, unless battery manufacture and recycling improves from its current environmental footprint.[68]

48. **While maintaining an official line on technology neutrality with respect to achieving zero emissions in private cars, the Government is in fact 'putting all its eggs in one basket': battery EVs. The reality is that not everyone in the UK can afford a new or second-hand electric vehicle, and if they could, cannot easily charge one at home. The infrastructure is not adequate to deliver sufficient electricity to homes, and there are insufficient raw materials to produce the battery banks needed for all vehicles to be**

64 Prodrive (FTF0067)
65 Calor (FTF0011)
66 Institution of Mechanical Engineers, Accelerating road transport decarbonisation (January 2020) p 4
67 Institution of Mechanical Engineers, Accelerating road transport decarbonisation (January 2020) p 2
68 Institution of Mechanical Engineers, Accelerating road transport decarbonisation (January 2020) p15

EVs. We therefore caution against the promotion of electric vehicles as being the only solution to reducing carbon emissions from private vehicles; as the cliff edge of 2030 (2035, 2040 and 2050) approaches and minds are concentrated, reality will bite.

49. ***We reiterate the message of our July 2021 report on zero emission vehicles that Government needs to take account of legacy petrol and diesel-powered motoring and continue to explore the potential of alternative fuels where possible. This includes the huge potential for sustainable fuels to provide a low-carbon option for conventional engines. A reality check is needed. High-end premium and supercar manufacturers and smaller bespoke and specialised manufacturers—which have a much smaller construction carbon and other energy and pollutant footprint compared to EV manufacturers—need direction, clear guidance, and regulation from the Department for Transport, sooner rather than later.***

50. ***Furthermore, while long-haul aviation and international shipping are often identified as the most likely users of sustainable fuels, we believe that the Government must open-mindedly consider all alternative fuels for all modes of powered transport, including private cars.***

51. **All the propulsion alternatives have a significant role to play so the Government needs to stop demonising specific technologies that could really help. Addressing the existing fleet will be decisive in achieving the UK's climate goals. Reducing greenhouse gas emissions right now by the use of increasing quantities of drop-in sustainable fuels enables us to address the existing fleet and minimise cost (and carbon emissions) through the use of existing infrastructure. It would also enable more socially equitable access to carbon reduction technologies for everyday transport as it would not be necessary to buy a new electric car and have access to charging infrastructure. However, sustainable fuels still produce emissions at point of use so offer no 'apparent' benefit in the current, misleading, legislative framework. We need a mechanism to enable the carbon savings associated with sustainable fuels to count, which would incentivise investment, drive down costs and offer a better-managed and complementary set of solutions.**

52. **The continued focus on battery electric vehicles alone risks failing to meet the UK's climate goals. Demand for more and more range from electric vehicles makes them very heavy and very expensive, tying up precious resources in an energy store that might rarely be used. Distributing those resources across more plug-in hybrid vehicles with smaller battery packs that enable 80 per cent of our journeys to be completed electrically yet retaining extended range using an ICE running on a sustainable fuel might be a better compromise.**

53. **The ideal solution may be to allow automotive companies to fix the problem and provide the solution by applying the right mix of technologies. Plugin hybrids (petrol and diesel) offer the best options when in urban areas they can make a switch to electric propulsion on entry (such as at low emission zones) or pay the charge and revert back to ICE (on sustainable/synthetic fuels) propulsion if required. They can also utilise such ICE propulsion outside of urban environments where they are very efficient and 'cleaner' over long distances and/or at higher average speeds, and hence 'range anxiety' becomes a thing of the past.**

54. We return to sustainable fuels in some of the discussions in following chapters about specific transport modes, particularly in relation to aviation, where sustainable fuels are included in the category of Sustainable Aviation Fuels, and in the next chapter where we discuss legacy motoring.

3 Road

55. In 2019, road transport made up 91 per cent of the greenhouse gas emissions from the transport sector.[69] The biggest contributors to this were cars and taxis, which made up 61 per cent of the emissions from road transport, followed by Heavy Goods Vehicles (HGVs) (18 per cent) and vans (17 per cent).[70] Official statistics are not available for the summed totals of all air pollutants, that is, not just greenhouse gas emissions.[71]

Cars and taxis

56. Battery power has been chosen by the Government as the preferred decarbonisation technology for cars and taxis, as evidenced by the amount of investment into this singular technology. In November 2020, the Government announced the end of the sale of new petrol and diesel cars in the UK by 2030;[72] it also pledged £1.3 billion to accelerate the roll-out of charge points for electric vehicles in homes, streets across the UK and on motorways across England.[73] As of March 2022, there were 29,600 public electric vehicle charging devices available in the UK.[74] Of these, 5,400 were rapid devices.[75]

57. In March 2022, the Government published its electric vehicle infrastructure strategy in which it stated that although the UK is a leader in the EV transition, the current pace of rollout is still too slow. The strategy admits that:

> Even the recent surge in charge point deployment is not at a pace consistent with what is needed for a wholly zero emission new car fleet in 2035. This is particularly true for local, low power, on-street charging which is so crucial for drivers without driveways. Many fleet drivers also rely on this type of charging. Planning arrangements can be complex to manage. Charge point installers can sometimes need multiple permissions, consents and licences, which adds time and cost to deployment.[76]

58. In our July 2021 report on zero emission vehicles, we drew attention to the need for rollout of charging infrastructure to keep pace with the increase in electric vehicles, and argued that funding, local strategies and changes to the planning regime must all be used to ensure that the right type and number of charge points are provided in the right locations. We drew particular attention to the need to prevent electricity grid 'not-spots' emerging, and urged the Government to do more to ensure that rural areas have access to sufficient charging infrastructure so that "no area is left behind."[77] In response to our report, the Government said the Electric Vehicle Infrastructure Strategy would set out "as part of its vision that no region or demographic should be left behind in the rollout of EV charging infrastructure and will outline the roles and responsibilities necessary to ensure

69 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 5 September 2022
70 Department for Transport, Transport and Environment Statistics: 2021 Annual Report (May 2021) p 5
71 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 23 February 2023
72 Department for Transport, 'Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030' accessed 5 September 2022
73 Department for Transport, 'Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030' accessed 5 September 2022
74 Department for Transport, Taking charge: the electric vehicle infrastructure strategy (March 2022) p 6
75 Department for Transport, Taking charge: the electric vehicle infrastructure strategy (March 2022) p 6
76 Department for Transport, Taking charge: the electric vehicle infrastructure strategy (March 2022) p 6
77 Transport Committee, First Report of Session 2021–22, Zero emission vehicles and road pricing HC 27, para 45

this is realised."[78] The Electric Vehicle Infrastructure Strategy, published in March 2022, states that ensuring "everyone can find and access reliable public chargepoints wherever they live—be that city centre or rural village" is one of the Government's targets for the EV infrastructure rollout.[79]

59. We also asked the then Minister about what the Government is doing to ensure adequate charging infrastructure in rural areas. She told us that this issue would be looked at in the forthcoming future of transport rural strategy (the consultation for which ended in February 2021); at the time of writing this has not yet been published.[80]

60. The number of public chargepoints in the UK increased from 28,375 in January 2022 to just over 37,000 in the same month this year, or from 42.3 to 55.3 per 100,000 people.[81] While this is welcome, at this rate of increase around 106,000 would be installed by 2030, far short of the Government's own target of 300,000 by that year. By comparison the Netherlands has 610 public charging stations per 100,000 people, Germany 71 per 100,000[82] and at January 2023, Scotland 68.6.[83]

61. ***We recommended in our July 2021 report on zero emission vehicles that some of the £950 million rapid charging fund be used to provide fully future-proofed grid capacity, and that the Government work with National Grid to map the electricity network to assess potential weak areas. In October 2021 a proof-of-concept version of a National Energy Systems Map was published. We reiterate our previous recommendation that this kind of information be used to develop a plan to prevent 'not-spots' in grid capacity from emerging.***

A continued role for petrol?

62. As noted above, in our July 2021 report on zero emission vehicles, we noted the need to take account of legacy petrol and diesel-powered motoring, and recommended that the Government continue to explore the potential of alternative fuels, such as hydrogen or other alternatives to petrol and diesel, where possible. Ed Birkett, Head of Energy and Environment at Policy Exchange, argued that there may be a case for allowing rural drivers to continue using petrol in areas where battery charging infrastructure is not viable, as the resulting emissions would be insignificant.[84] He stated, "if we got to a point where there were certain rural areas where you could not get enough electricity, I would probably rather just stick with petrol and not worry too much about the small residual emissions."[85] We also heard from Guy Lachlan, Director at the Historic and Classic Car Alliance, who made a similar case for allowing drivers of classic or historic cars to continue to use petrol, as converting the vehicles to battery electric could "[waste] more emissions in that process

78 Transport Committee, Fifth Special Report of Session 2021–22, Zero emission vehicles: Government Response to the Committee's First Report HC 759, p 4
79 Department for Transport, Taking charge: the electric vehicle infrastructure strategy (March 2022) p 5
80 Q260
81 Department for Transport, 'Electric vehicle charging device statistics: January 2023' accessed 23 February 2023
82 ACEA, 'Electric cars: Half of all chargers in EU concentrated in just two countries', accessed 9 January 2023
83 Department for Transport, 'Electric vehicle charging device statistics: January 2023' accessed 23 February 2023
84 Q84
85 Q84

of conversion than we are ever going to save through their continued very limited use."[86] He also stated that he believed leaving the vehicles in their current state and not converting them is a way of "preserving our heritage."[87]

63. In response to the evidence from Mr Lachlan, the then Minister said:

> Combustion engines in classic cars and cherished motors will continue. We are committed to ensuring that the E5 petrol is available for those vehicles. […] Ensuring that people can continue to drive those cherished vehicles, in particular, is very important.[88]

64. **We believe there is a case for many people right across the country in all areas, but particularly in rural and isolated communities, to continue to drive wholly diesel or petrol-powered cars, or hybrids (or EVs if they wish). Over time they will very likely account for a negligible proportion of transport emissions. The cost of introducing EV charging infrastructure everywhere is completely unrealistic and will require massive amounts of taxpayers' money through government subsidy for electricity generation, infrastructure provision and storage, and basic raw materials for battery production in order to be anywhere near acceptable as an alternative to ICE or hybrid personal vehicles, delivery, farming or construction vehicles.**

65. ***We recommend that the Government publish its future of rural transport strategy as a matter of priority. The strategy should include the Government's plan to ensure people living in rural areas have adequate access to charging infrastructure.***

66. ***The Government should examine the roll-out of public charging networks in other European countries and in Scotland, to see how best to harness government expenditure on chargepoints—particularly in rural and more economically marginal locations—to help increase the pace of the rollout and increase coverage and EV-to-charger ratios.***

Heavy Goods Vehicles (HGVs)

67. After cars and vans, HGVs are the largest contributor to domestic transport CO_2 emissions.[89] In 2019, cars made up 79 per cent of the road vehicle miles travelled within the UK, but produced 55 per cent of transport emissions, while HGVs made up a much smaller proportion of the vehicle miles (five per cent) but their emissions were disproportionately greater (16 per cent).[90]

68. The decarbonisation of HGVs poses more of a challenge than cars, as due to their heavier weight they need significantly more power. Many HGVs travel long distances, making frequent recharging impractical. Currently, there is not a singular alternative decarbonisation technology that appears to be the solution. Logistics UK stated that we are "still a long way away from having a reliable, market-ready zero emission HGV that can transport goods across the entire UK."[91]

86 Q172
87 Q178
88 Q240
89 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 7 September 2022
90 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 7 September 2022
91 Logistics UK (FTF0010)

69. In November 2021, the Government announced that the UK will become the first country in the world to commit to phasing out new, non-zero emission heavy goods vehicles weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission by 2040.[92] In May 2022, it also announced the Zero Emission Road Freight Demonstrator Programme, a three-year comparative programme to help decarbonise the UK's freight industry with initial competitions for battery electric and hydrogen fuel cell technology.[93] On 15 June 2022, the Department for Transport published 'Future of Freight: a long-term plan', in which it stated that the Government:

> recognises the importance of a widespread, reliable refuelling and recharging network to provide confidence in the commercial viability of zero emission HGVs. We will convene industry stakeholders to work together to develop a plan for zero emission HGV infrastructure rollout and the role of the public and private sectors to achieve this.[94]

70. The Government is still undertaking feasibility trials for HGVs in heavier weight categories that travel long distances; these include battery power and hydrogen. Also underway are trials of 'electric roads': roads that have conductive or overhead charging, for example through electric power cables overhead to which HGVs can attach. Electric roads allow HGVs to charge as they drive, enabling them to drive for longer without stopping to charge or to have smaller batteries on board.[95]

71. However, for lighter weight goods vehicles that are travelling shorter distances, electrification appears to the most viable solution. In July 2021, the Department for Transport published a consultation on when to phase out the sale of new, non-zero emission heavy goods vehicles which stated:

> Lighter zero emission HGVs are already coming onto the market in increasing numbers. Primarily using battery electric technology, they are suitable for a range of duty cycles and operations but are currently more expensive than their diesel equivalents. This technology is largely mature and, as batteries get cheaper and the supply chain scales up, this technology could be a direct swap for diesel vehicles in the lighter weight categories.[96]

Logistics UK told us that, while they agreed that battery-power is a suitable option, this "must not result in other options for operators being ruled out too early, including hydrogen and low carbon fuels."[97]

Technology neutrality

72. Witnesses from the road freight sector were relatively critical of the Government's current technology agnostic approach. Logistics UK told us, although they support the

92 Department for Transport, 'UK confirms pledge for zero-emission HGVs by 2040 and unveils new chargepoint design' accessed 7 September 2022
93 Department for Transport,'£200 million boost to rollout of hundreds more zero-emission HGVs' accessed 8 September 2022
94 Department for Transport,'£200 million boost to rollout of hundreds more zero-emission HGVs' accessed 8 September 2022
95 Department for Transport, Future of freight: a long-term plan (June 2022) p 65
96 Department for Transport, Consultation on when to phase out the sale of new, non-zero emission heavy goods vehicles (July 2021) p 14
97 Logistics UK (FTF0010)

assertion that all technologies must be explored given the complexity of the industry and urgency of the need to reduce emissions, their "members do, however, need long-term certainty over which zero tailpipe emission solutions will be commercially viable."[98] The Road Haulage Association told us that they had noted "a backdrop where independent reports are calling for ministers to provide strong co-ordinated leadership" for the decarbonisation of the road freight sector.[99] Witnesses to our inquiry on the road freight supply chain also expressed this view; Ken McMeikan, Chief Executive of Moto Hospitality, said his company needed to know which decarbonisation technology is expected to be the fuel of choice for HGVs in the future so they can begin investing in the appropriate infrastructure to supply vehicles at their service stations.[100]

73. ***There is not yet a solution for the decarbonisation of HGVs in heavier weight categories that travel long distances. We recommend that the Government publish a long-term HGV decarbonisation strategy as a matter of priority.***

98 Logistics UK (FTF0010)

99 Road Haulage Association (FTF0041)

100 Oral evidence taken on 8 December 2021, HC (2021–22) 828 , Q259 [Ken McMeikan]

4 Maritime

74. In 2020, five per cent of the UK's transport greenhouse gas emissions came from domestic shipping, more than domestic rail and bus emissions combined.[101] Official statistics are not available for the summed totals of all air pollutants, that is, not just greenhouse gas emissions.[102] The International Maritime Organisation (IMO) estimates that international shipping currently accounts for around three per cent of total global greenhouse gas emissions, with emissions increasing by around ten per cent between 2012 and 2018.[103] At present, the maritime sector relies almost entirely on fossil fuels, mainly heavy fuel oil, for power.[104]

75. In April 2018, the IMO adopted key short-term measures designed to cut the carbon intensity of all ships by at least 40 per cent by 2030 and 70 per cent by 2050, and to cut total annual greenhouse gas emissions from international shipping by at least 50 per cent by 2050 compared to 2008.[105] In July 2019, the Government published its Clean Maritime Plan, which committed to achieving zero emission shipping by 2050, an aim significantly more ambitious than the IMO"s target. The Plan stated that "a significant increase in technology commercialisation and uptake will be necessary by 2025 and 2035 to make it possible to reach zero emission shipping by the latter half of the century".[106] However, the Plan makes clear that these targets are not mandatory; they are instead "aspirational goals".[107]

76. 'Environment'—including the path to decarbonisation—is one of the seven themes of the Department for Transport's Maritime 2050 strategy, published in 2019.[108] In March 2022, the Department for Transport announced £206m for the UK Shipping Office for Reducing Emissions (UK SHORE).[109] The role of the unit is to tackle shipping emissions and advance the UK towards sustainable shipping.

77. In April 2021, the Government for the first time committed to including its share of international shipping emissions in its carbon budget.[110] This follows a recommendation of the Climate Change Committee (CCC), which is an independent statutory body providing advice to the Government.[111] It will begin with the sixth carbon budget for the period 2033 to 2037.

101 Department for Transport, UK Domestic Maritime Decarbonisation Consultation: Plotting the Course to Zero (July 2022) p 6
102 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 23 February 2023
103 International Maritime Organisation, 'Fourth Greenhouse Gas Study 2020' accessed 7 July 2022
104 European Parliamentary Research Service, Sustainable maritime fuels 'Fit for 55' package: The FuelEU Maritime proposal (April 2022) p 2
105 International Maritime Organisation, 'Initial IMO GHG Strategy' accessed 21 Oct 2022
106 Department for Transport, Clean Maritime Plan (July 2019) p 6
107 Department for Transport, Clean Maritime Plan (July 2019) p 6
108 Department for Transport, Maritime 2050, (January 2019) p 24
109 Department for Transport, 'DfT launches UK SHORE to take maritime 'back to the future' with green investment' accessed 20 September 2022
110 Department for Business, Energy & Industrial Strategy, 'UK enshrines new target in law to slash emissions by 78% by 2035' accessed 20 September 2022
111 Climate Change Committee, The Sixth Carbon Budget - The UK's path to Net Zero (December 2020) p 418

Challenges to decarbonisation

78. Maritime is the furthest behind of the transport sectors in terms of technology readiness, with no single alternative decarbonisation technology being a clear choice as the most viable.[112] One of the main causes of this is the diversity of vessels within the sector, which makes a one-size-fits-all solution impossible. Anna Ziou, Policy Director at the UK Chamber of Shipping, told us, "We have vessels from very small tugs to very big vessels that trade internationally, and different sizes and ship types. That makes it very complex."[113] This complexity means that "the technology readiness of the industry is very far behind that of other sectors" making it extremely difficult to predict which alternative decarbonisation technologies will be the most viable.[114]

79. The global nature of the shipping industry is also a challenge, as international consensus as to which alternative decarbonisation technologies will be the 'winners' will be needed in order to align international infrastructure. Ms Ziou explained that the UK's actions alone cannot deliver a deliver a solution.[115] She said:

> it is not about the action of a single country. Whatever technology the UK decides to proceed with, if the other countries globally are not going to provide the fuel, there is no point, and we are never going to achieve the target.[116]

80. Longevity of vessels is a further barrier; most ships have a lifespan of 20 to 30 years, meaning that conventional ships built today are still likely to be in operation in 2050. To achieve the net zero by 2050 target, these vessels—making up approximately 26 per cent of the global fleet—would either need to be retrofitted or replaced earlier than the end of their lives, which would be a significant cost to the shipping industry.[117]

Liquefied Natural Gas

81. Due to the relative infancy of alternative decarbonisation technologies for maritime, many options are still being explored within the sector. One of these is Liquefied Natural Gas (LNG). LNG is natural gas that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport. Although it is still fossil fuel-based, depending how it is produced, it can produce up to 20 per cent less CO_2 than the other alternative fossil fuels, meaning it is considered a transition fuel.[118] Anna Ziou told us that:

> Currently in Japan, there are studies looking at LNG which can be produced in the future through renewables and through bio LNG, and that could maximise the utility of the current infrastructure and investments.[119]

112 Q112
113 Q112
114 Q112
115 Q112
116 Q132
117 UK Chamber of Shipping (FTF0057)
118 Q121
119 Q11

There is some concern, however, that the use of LNG could result in 'stranded assets' as new vessels that are LNG-capable will have to either be adapted to use other scalable zero-emission tech or be scrapped earlier than their expected end of life.[120] This is not an environmentally friendly nor economically sustainable way forward.

Biofuels

82. Biofuels are another low-carbon option being trialled by the sector. The primary advantage of biofuels is their 'drop-in' capability; in other words, they can be used in the existing fleet, meaning that they can readily replace hydrocarbon liquid fuels. However, the IMO warns that it is "imperative" that such biofuels are produced from sustainable feedstocks and using sustainable energy supplies.[121] The UK Chamber of Shipping told us that "there is a strong business case for sustainable biofuels in the sector."[122] This is because the combination of improvements most likely to achieve an overall reduction in maritime emissions—in ship design, port infrastructure, and zero-emission fuels and technologies—are not currently available, and realistic alternatives are needed in the meantime to replace fossil fuels in the existing fleet.[123]

83. The International Council on Clean Transportation has also highlighted the benefits of utilising biofuels to decarbonise shipping.[124] However, the Council notes that "while blended biofuels have been used extensively in road transportation, the deployment of marine biofuel is in its infancy".[125] It cautions that "policies to promote alternative fuels should take into account that many fuels will need to be blended with conventional fossil fuels, and that they can only reduce life-cycle emissions relative to their blending ratio."[126]

84. In its UK Maritime Decarbonisation Consultation, published in July 2022, the Department for Transport stated that "no biofuels are assumed to be used by UK domestic maritime under the Net Zero Strategy pathway". The Department states that this is due to advice from the CCC.[127] The CCC in its report said:

> Our analysis of the best-use of bioenergy shows that use of biofuels in shipping achieves lower GHG savings compared to uses in other sectors. Transitioning shipping to a carbon-free fuel such as ammonia, rather than a biofuel that releases CO_2 on combustion, allows finite bioenergy resources to be used in other applications that sequester the biogenic carbon, leading to lower overall UK emissions.[128]

120 University College London, Exploring methods for understanding stranded value: case study on LNG-capable ships (September 2022) p 7
121 International Maritime Organisation, 'Initial IMO GHG Strategy' accessed 21 Oct 2022
122 International Maritime Organisation, 'Initial IMO GHG Strategy' accessed 21 Oct 2022
123 UK Chamber of Shipping (FTF0057)
124 International Council on Clean Transportation, The potential of liquid biofuels in reducing ship emissions (September 2020) p 3
125 International Council on Clean Transportation, The potential of liquid biofuels in reducing ship emissions (September 2020) p 3
126 International Council on Clean Transportation, The potential of liquid biofuels in reducing ship emissions (September 2020) p 3
127 Department for Transport, UK Domestic Maritime Decarbonisation Consultation: Plotting the Course to Zero (July 2022) p 20
128 Climate Change Committee, The Sixth Carbon Budget: Shipping, (December 2020) p 9

The Government has not included, mistakenly perhaps, but no doubt due to worldwide maritime interests, biofuels for shipping in the Renewable Transport Fuels Obligation.[129]

Synthetic fuels

85. We asked Rhona Macdonald about the capabilities of synthetic fuels; she told us that there is a need for fuels that have 'drop-in' capabilities , in other words, they are able to be used in the existing fleet without changing the engines. They can also be blended with existing fuel to make it lower-carbon. Discussing the possible use of synthetic fuels, she said, "we are going to need transition fuels to get there, so we support the idea of fuel blends to get us there, to get to a point eventually where we are using fully renewable fuels."[130]

Hydrogen

86. Hydrogen is another decarbonisation option for maritime, though this depends on producing it without the use of fossil fuels.[131] However, even 'green' hydrogen presents challenges, the key one being the amount of space required to store it due to its low energy density compared with heavy fuel oil and marine gasoline.[132] A cubic metre of compressed hydrogen contains only 28 kg per cubic metre whereas a cubic metre of heavy fuel oil contains 580 kg.[133] The Grantham Institute told us that "converting a traditional ship to be powered by hydrogen would likely lead to less optimal configurations and loss in cargo space and therefore efficiency."[134] Storing hydrogen safely at ports also requires space. Rhona Macdonald, Sustainability Adviser at the British Ports Association, told us that:

> For storing hydrogen at ports you need a certain exclusion zone, and that can impact on port operations as well. That is a big question that needs to be answered before ports can move forward and invest in it to store it at ports.[135]

Ammonia

87. Similarly to hydrogen, ammonia is also zero-emission at the point of use, but it needs significantly less storage space which makes it potentially more viable.[136] While a significant issue with many decarbonisation technologies for maritime would be the need for new refuelling infrastructure, the Grantham Institute told us that "ammonia is considered as potentially viable through existing LNG fuelling infrastructures."[137] However, Anna Ziou told us that, although ships have been transporting ammonia for decades, burning it presents significant safety concerns. She said:

129 Q254
130 Q139
131 Q129
132 Q118
133 Q118
134 Grantham Institute (FTF0042)
135 Q128
136 Q120
137 Grantham Institute (FTF0042)

> There are definitely some technological challenges on how to make ammonia safe to burn on board vessels due to the high toxicity. It is also highly corrosive. […] Currently there is no regulation at the IMO on how you build and structure a vessel for ammonia.[138]

Battery electric

88. Due to the power required by large ships and the need for frequent recharging, battery electric power will most likely only be viable for smaller vessels travelling shorter distances. Rhona Macdonald told us:

> Batteries will have their role, but more so for short sea shipping and ferries. Ferries are looking at battery power at the moment, but, again, the sheer size of these batteries and the storage capacity on ships would reduce efficiency. It will have its role, certainly, but not for larger cargo vessels sailing longer journeys.[139]

A combined diesel electric hybrid ferry has been in service since 2018 on the Portsmouth to Fishbourne crossing which can carry approximately 1,200 passengers.[140] The ship has a 408kWh battery array onboard, to supplement four high efficiency marine diesel engines.[141]

The UK's role within the International Maritime Organisation

89. Our witnesses told us that in order to push for a more global solution, the UK must further its role within the IMO.[142] Rhona Macdonald told us:

> We need to take a leadership role and help push things forward. We saw that especially with the argument over absolute zero and net zero, where we pushed that forward, and with green [shipping] corridors. Having these frameworks developed on an international level, IMO will certainly help our sector pushing fuels forward.[143]

Technology neutrality

90. Witnesses acknowledged that due to the nature of maritime, there is not going to one clear 'winner' that will be capable of decarbonising the whole sector.[144] Rhona Macdonald also told us, however, that while "we do not want [the Government] homing in on one fuel, […] we need a clearer pathway for investment".[145] The UK Chamber of Shipping also told us that the Government's decision not to allow biofuels for maritime in the Renewable Transport Fuels Obligation goes against its technology neutral policy and "is placing the sector in a disadvantaged position in reducing its emissions in a cost-efficient matter, leading to market distortion."[146]

138 Q128
139 Q130
140 Department for Transport, Transport decarbonisation plan (July 2021) p 109
141 Department for Transport, Transport decarbonisation plan (July 2021) p 109
142 Q56, Q131
143 Q131
144 Q102, Q112, Q116
145 Q116
146 UK Chamber of Shipping (FTF0057)

91. ***The UK Government should support the International Maritime Organization's work to develop global standards for vessel construction that enable ships to utilise alternative fuels such as ammonia, synthetic fuels and hydrogen. The UK should use its influence at the IMO to ensure that, globally, the path forward for investors in alternative maritime fuels becomes more secure.***

5 Aviation

92. In 2019, domestic and international aviation accounted for approximately eight per cent of the UK's total greenhouse gas emissions.[147] Official statistics are not available for the summed totals of all air pollutants, that is, not just greenhouse gas emissions.[148] The Climate Change Committee (CCC) has identified aviation as a sector that is likely to have "significant remaining positive emissions by 2050, given the limited set of options for decarbonisation."[149] It added that "zero carbon aviation is highly unlikely to be feasible by 2050."[150]

93. In February 2020, Sustainable Aviation, a coalition of UK airlines, airports, aerospace manufacturers, air navigation service providers and sustainable aviation fuel (SAF) producers, published a 'Decarbonisation Road-map'. This road-map states that low-carbon aviation fuels have the potential to reduce UK aviation carbon dioxide emissions by at least 30 per cent by 2050 and offer at least 70 per cent lifecycle reduction in carbon emissions compared to current fossil fuels.[151]

94. The aviation sector has for several decades been making technical improvements to aircraft and engines in pursuit of better efficiency of fuel consumption.[152] The CCC estimates that by 2050, technical improvements could reduce emissions per aircraft in the UK by 40 per cent relative to the year 2000.[153] Low-carbon aviation fuels could generate further reductions in emissions.

95. In July 2022, the Government announced its Jet Zero Strategy, which outlined its plan to reach net zero in aviation by 2050. The Strategy also included an additional target for all domestic flights to achieve net zero by 2040.[154] In November 2021, Zero Petroleum's synthetic UL91 fuel was used by the RAF to complete a short flight in an Ikarus C42 microlight aircraft, the world's first successful flight using only synthetic fuel.[155]

Zero emission flight

96. The Jet Zero Council, a partnership between industry and government stakeholders to reduce aviation emissions, has a dedicated delivery group focused on initiatives aimed at achieving zero-carbon emission flight. This work is led by the Aerospace Technology Institute (ATI) and its FlyZero project, a £15 million, government-funded study into the potential for commercial aircraft that do not emit carbon emissions by 2030.[156] The project includes conducting a detailed study of the design challenges, manufacturing demands,

147 Department for Business, Energy & Industrial Strategy, Final UK greenhouse gas emissions national statistics: 1990 to 2019 (June 2021)
148 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 23 February 2023
149 Climate Change Committee, The Sixth Carbon Budget (December 2020) p 176
150 Climate Change Committee, The Sixth Carbon Budget (December 2020) p 176
151 Sustainable Aviation, Decarbonisation Road-map: a path to Net Zero (February 2020) p 20
152 Lee, D. S. et al., "*Aviation and global climate change in the 21st century*" Atmospheric Environment Vol 43, (July 2009) p 3520–3537
153 Climate Change Committee, Net-zero and the approach to international aviation and shipping emissions: Letter from Lord Deben to Grant Shapps (September 2019) p 11
154 Department for Transport, Jet Zero Strategy (July 2022) p 8
155 Ministry of Defence, World record RAF flight powered by synthetic fuel, November 2021
156 Aerospace Technology Institute, 'Zero-carbon emission flights to anywhere in the world possible with just one stop' accessed 10 September 2022

operational requirements and market opportunity of potential zero-carbon emission aircraft concepts. The project mainly focuses on developing hydrogen-powered flight; its March 2022 report states that,

> FlyZero has concluded that green liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft utilising fuel cell, gas turbine and hybrid systems. This has guided the focus, conclusions and recommendations of the project.[157]

97. Hydrogen can be combusted as a liquid or compressed gas fuel to power aircraft engines directly, or it can be used in a fuel cell to produce electricity to power electric aircraft.[158] In both cases, hydrogen-powered aircraft are not expected to be available commercially until after 2050.[159] The only option for long-haul hydrogen flights would likely be a liquid fuel, because fuel cells require batteries, the weight of which currently prohibits their use across long distances.[160]

98. Combusting hydrogen does not emit CO_2, but releases roughly twice as much water vapour as jet fuel. Water vapour has an overall warming effect on the climate.[161] Infrastructure to produce and supply hydrogen to aircraft at scale is currently undeveloped and would be costly. Hydrogen has a much lower energy density than jet fuel and thus requires much more storage space. There are also safety and public perception considerations around the transport, handling and storage of hydrogen on aircraft, due to it being highly flammable.[162]

99. In evidence to our previous inquiry on reform of UK aviation, the Aviation Environment Federation (AEF) expressed scepticism about the potential for hydrogen to offer a near-term solution to decreasing carbon emissions. They told us that, while fuels made from captured CO_2 combined with green hydrogen could offer a net zero solution, they are "currently being made only in tiny quantities and will require large new infrastructure and surplus renewable energy to produce".[163] The AEF also told us that in the long term, hydrogen options may be able to operate on longer trips, but that this would require investment in new aircraft, in refuelling infrastructure and in the hydrogen industry itself.[164]

100. Electric aircraft is another option for zero emission aviation. Electric aircraft can use batteries or fuel cells to power electric motors. They can be hybrid (using a mix of electric motors and jet engines) or fully electric (using only electric motors). Fully electric aircraft present a particular challenge because flight requires extremely high levels of power and currently available batteries are too heavy.[165] There will need to be significant advances in battery technology in order to achieve full electrification, particularly for large aircraft

157 Aerospace Technology Institute, Zero-carbon emission aircraft concepts (March 2022) p 2
158 House of Commons Library, POSTnote: Low carbon aviation fuels (February 2020) p 2
159 Staffell, I. et al., "*The role of hydrogen and fuel cells in the global energy system*" Energy Environ. Sci., Vol 12, (2019) p 468
160 ICAO Secretariat, ICAO Environmental Report 2019 (2019) p 125
161 Staffell, I. et al., "*The role of hydrogen and fuel cells in the global energy system*" Energy Environ. Sci., Vol 12, (2019) p 468
162 House of Commons Library, POSTnote: Low carbon aviation fuels (February 2020) p 2
163 Aviation Environment Federation (AEF) (AAS0021) para 9
164 Aviation Environment Federation (AEF) (AAS0021) para 9
165 ICAO Secretariat, ICAO Environmental Report 2019 (2019) p 125

and flights longer than 300 to 500 km (190 to 310 miles).[166] According to the CCC's projections, hybrid-electric planes will make up less than 10 per cent of the distance flown in 2050 and there are "no full-electric aircraft in the [CCC net zero by 2050] scenario which, particularly for long haul flights, are unlikely to be feasible by 2050."[167]

101. We heard that both battery electric and hydrogen have a role to play in the decarbonisation of the aviation sector, but that both technologies are in their infancies and are currently only viable for short-range aircraft.[168] The AEF echoed the CCC's assertions; they told us that "battery-powered aircraft are likely to exist only for very short-haul regional routes until after 2050".[169] Sustainable Aviation, however, told us that "significant progress is […] being made in battery technology, which initially will be best applied to short range aircraft. Maturing these technologies will allow industry to scale up to longer ranges".[170] ZeroAvia, a hydrogen-electric aircraft company, meanwhile, told us that while "hydrogen-electric is the only true zero emission way forward for the sector […] the immediate thing we can do today to help reduce emissions is through alternative fuels like SAF."[171]

Sustainable Aviation Fuels

102. Sustainable aviation fuels (SAF) is the term given to alternatives to fossil fuel-derived kerosene. SAF are chemically identical to fossil fuel-derived kerosene but are made from different raw materials and processes.[172] SAF include biofuels and synthetic fuels (also called electrochemical fuels, that is, fuels that are produced through reactions between CO_2 and water).[173]

103. SAF provide a 'drop-in' solution within conventional aircraft, meaning they can be used with little or no change to engine technology or airport infrastructure. The costs associated with developing and modifying the infrastructure required to develop, produce, store and dispense SAF are therefore minimal when compared to the infrastructure requirements for the electrification of aircraft and airports, or developing new hydrogen fuel cell aircraft and hydrogen refuelling infrastructure.[174]

104. The UK Civil Aviation Authority estimates that currently SAF production capacity is around 0.1 per cent of global annual jet fuel consumption.[175] They state:

> The most optimistic estimates from the World Economic Forum, based on current trajectory, is that production in Europe could get to around seven per cent by 2030. Production would need to continue to grow by 15 per cent

166 House of Commons Library, POSTnote 615: Climate change and aviation (February 2020) p 3
167 Climate Change Committee, International aviation and shipping and net zero: Letter from Lord Deben to Grant Shapps (September 2019) p 9
168 Aviation Environment Federation (AEF) (AAS0021) ZeroAvia (FTF0055)
169 Aviation Environment Federation (AEF) (AAS0021)
170 Sustainable Aviation (FTF0035)
171 ZeroAvia (FTF0055)
172 House of Commons Library, Aviation, decarbonisation and climate change (September 2021) p 37
173 House of Commons Library, Aviation, decarbonisation and climate change (September 2021) p 37
174 Renewable Transport Fuel Association (FTF0017)
175 UK Civil Aviation Authority (FTF0013)

> compound to get to 100 per cent by 2050, assuming that other technology efficiencies are brought in to compensate for the growth in aviation over the same period.[176]

105. To increase SAF uptake, the Government announced in the Jet Zero Strategy that it was introducing a SAF mandate that will require at least 10 per cent of jet fuel to be made from sustainable sources by 2030.[177] Giving evidence before the Jet Zero Strategy was published, the then Minister told us, "The SAF mandate is something that has been called for to provide a level of certainty that investors can get behind, and industry can benefit from as well."[178]

Contracts for Difference: introducing a price support mechanism for SAF

106. A Contracts for Difference (CfD) model is a contract between an energy producer and the Government. The producer is paid the difference between the 'strike price'—which is a price that reflects the cost of investing in a particular low-carbon technology—and the 'reference price'—which is a measure of the average UK market price for electricity. The benefit of this model is that producers are provided with long-term price security, which should allow investment at a lower capital cost and therefore at a lower cost to consumers.[179]

107. The Government uses the CfD model as its "main mechanism" for supporting low-carbon electricity generation.[180] CfDs have the potential to incentivise investment in different energy sources by providing developers of projects with high upfront costs and long lifetimes with direct protection from volatile wholesale prices, and they protect consumers from paying increased support costs when electricity prices are high.

108. Although, they welcomed the SAF mandate, Velocys, a SAF producer, told us that:

> a mandate does not give any guarantee of SAF prices [and] finance experts have consistently delivered the message to the Government that investment in SAF plants in the UK will only occur when there is price certainty.[181]

Several witnesses suggested that a CfD model be introduced to support the commercialisation of SAF and create price certainty.[182] Velocys also told us that they believe the establishment of a price support mechanism for SAF such as CfDs is "the single most important action required to deliver SAF production here in the UK."[183] The Department for Transport reported in its SAF mandate consultation response summary that most respondents "identified CfDs or other price support mechanisms as being essential."[184]

176 UK Civil Aviation Authority (FTF0013)
177 Department for Transport, Jet Zero Strategy (July 2022) p 9
178 Q251
179 Q251
180 Department for Business, Energy & Industrial Strategy, 'Contracts for difference' accessed 10 September 2022
181 Velocys (FTF0071)
182 Velocys (FTF0071), Sustainable Aviation (FTF0035), Renewable Transport Fuel Association (RTFA) (FTF0017), Carbon Engineering (FTF0033)
183 Velocys (FTF0071)
184 Department for Transport, Sustainable aviation fuels mandate. Summary of consultation responses (March 2022) p 49

109. We asked the then Minister, Trudy Harrison MP, about the prospects of the Government implementing a CfD model for SAF. She told us it was being "considered".[185] She added, "It is not necessarily that we will definitely support that financial mechanism. It has worked across Government for many significant infrastructure projects."[186]

Technology neutrality

110. Most witnesses agreed that the Government has been technology agnostic in its approach in aviation.[187] Velocys agreed that the Government has been technology neutral thus far in its assessment and regulation of alternative fuels and associated policy development, and should continue to be open to multiple decarbonisation solutions such as hydrogen or battery electric. They also argued, however, that SAF should take priority. They told us that application of the technology neutrality principle

> needs to take into account the applicability of the technologies under consideration: it is abundantly clear, based on evidence from across industry, that SAF has a far greater scope to decarbonise aviation over the next three decades (possibly longer) than hydrogen or electric flight, for two main reasons: its greater energy density and the fact that it can be used in existing planes. We are not arguing against support for these other technologies, merely that the top priority is SAF because of its greater applicability.[188]

111. This sentiment was echoed by South West Hydrogen Ecosystem Partnership; they said that technology neutrality would mean equally supporting electric, hydrogen, and SAF for all aircraft sizes and routes, but that this "would be a poor use of resources and fail to take account of how the technologies can best be utilised."[189]

112. ***There is significant demand and potential for sustainable aviation fuels in the aviation sector: they are the most plausible option for significant decarbonisation of aviation in the short and medium terms. We welcome the SAF mandate in the Jet Zero strategy, but consider that further measures are needed to stimulate the progress required. The Government must introduce a Contracts for Difference model to stimulate uptake of SAF. The Government should also examine whether such a model could be used to incentivise the uptake of other sustainable aviation technologies such as hydrogen.***

185 Q274
186 Q274
187 Sustainable Aviation (FTF0035)
188 Velocys (FTF0071)
189 South West Hydrogen Ecosystem Partnership (SWHEP) (FTF0014)

6 Rail

113. Rail travel is a naturally low-carbon transport mode, making up only 1.4 per cent of UK total transport greenhouse gas emissions in 2019.[190] Official statistics are not available for the summed totals of all air pollutants, that is, not just greenhouse gas emissions.[191] However, trains in the UK still heavily rely on diesel traction for their power. Railway traction makes up the largest proportion of emissions within rail, with those emissions almost entirely coming from diesel train operation. In 2018, the Government committed to phasing out all diesel-only trains by 2040, including freight trains.[192]

Electrification

114. Rail, as a transport mode, is the furthest ahead in electrification. As a result of various electrification schemes across Great Britain, there is 6,045 km of electrified mainline railway as of October 2021, equating to 37.9 per cent of all route length.[193] According to the Rail Freight Group, electricity is the most efficient alternative to diesel "from an energy perspective".[194] It is a proven technology for network and locomotives and is reliable. Crucially, electrification is presently the only technology that can deliver a full range of requirements including high speed, long distance passenger travel and freight haulage.[195] In its final report to the Minister of Rail in 2019, the Rail Industry Decarbonisation Taskforce found that electric traction, where a line is sufficiently intensively used, "provides the lowest whole-life carbon impact, and delivers services that are faster, more reliable, quieter and less polluting than diesel".[196] However, "on less intensively used lines, the long-term benefits of electrification may not justify the investment cost and disruption caused by engineering works".[197]

115. The Traction Decarbonisation Network Strategy published by Network Rail stated that as of July 2020 there was 15,400 km of track yet to be electrified.[198] Over the course of 2020–21, only 179 km of railway was electrified, less than half the rate needed to decarbonise the network by 2050.[199] While giving evidence to us on Great British Railways, Network Rail Chief Executive Andrew Haines OBE told us that "everyone recognises that to get to 2040 we would have to ramp up from where we currently are."[200]

116. However, there are projects that appear to run counter to this plan to 'ramp up' electrification. East West Rail is a major project to establish a strategic railway connecting East Anglia with central, southern and western England. It is due to open between Oxford and Milton Keynes in 2024 with diesel trains. Then Parliamentary Under Secretary of State at the Department for Transport, Trudy Harrison MP, told us that the opening of the line unelectrified is an "interim solution which will allow the earliest possible start date

190 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 1 September 2022
191 Department for Transport, 'Transport and environment statistics: Autumn 2021' accessed 23 February 2023
192 Department for Transport, 'Let's raise our ambitions for a cleaner, greener railway' accessed 1 September 2022
193 Office of Rail and Road, Rail infrastructure and assets (October 2021) p 9
194 Rail Freight Group (FTF0003)
195 Siemens Mobility Limited (TFF0017)
196 Rail Industry Decarbonisation Taskforce, Final report to the Minister for Rail, (July 2019) p 34
197 Rail Industry Decarbonisation Taskforce, Final report to the Minister for Rail, (July 2019) p 34
198 Network Rail, Traction Decarbonisation Network Strategy: Interim Programme Business Case July 2020, p 6
199 Railway Industry Association, 'The UK is electrifying its railway at less than half the rate needed to decarbonise by 2050'accessed 1 September 2022
200 Oral evidence taken on 30 March 2022, HC (2021–22) 1076, Q144 [Mr Haines]

for services between Oxford and Milton Keynes from the end of 2024."[201] She added that the rationale behind this decision was to bring "wider transport benefits and [encourage] modal shift away from cars, while decisions can be taken over traction for the whole of East West Rail."[202]

Rail freight

117. Freight trains pose a particular challenge for decarbonisation. The average freight train carries a cargo load equivalent to 76 HGVs, meaning significantly more power is needed to move the trains compared to passenger trains.[203] The UK Petroleum Industries Association told us that they believe rail freight may pose the biggest challenge to the Government's rail decarbonisation aims, with only 16 per cent of the UK's freight locomotives currently electric, in part due to the lack of electrified lines.[204]

118. When asked whether she believes the rail freight industry can meet its net zero targets by 2050 solely through electrification, Maggie Simpson OBE, Director General of the Rail Freight Group, told us:

> In theory, there is no reason why we cannot meet 2050 through electrification. Practically, it is a different question, because not all of the network is electrified today, and even though the Government are committed to some new schemes they certainly will not give full network coverage, and even some of the schemes they are committing to have gaps in them where freight trains operate. If you take Midland Mainline, it is great that the completion of that has been announced, but some of the freight routes between Corby and Silsden are excluded from that. Realistically, we will not have enough of the network electrified by 2050 for all rail freight to be using electrification, so we will have to look at alternatives for those parts of the network where we cannot.[205]

119. Helen Simpson, Innovation and Projects Director at Porterbrook, reiterated this point when she told us that, in terms of the 2050 objective, "we do not yet have a solution for all freight lines […] We are going to have to look at something else or increase the amount of electrification to solve that issue."[206] Witnesses agreed that the decarbonisation of rail will mostly be achieved via electrification, but there will be individual lines on which electrification is not possible or does not make economic sense and in those cases decarbonisation could be achieved by hydrogen, battery or biofuels.[207]

Hydrogen

120. In a previous inquiry, 'Trains fit for the future?' we looked at both hydrogen and battery power as alternative decarbonisation technologies where electrification is not viable. We

201 Correspondence from Trudy Harrison MP, Minister of State, Department for Transport, relating to Great British Railways (29 March 2022)
202 Correspondence from Trudy Harrison MP, Minister of State, Department for Transport, relating to Great British Railways (29 March 2022)
203 Network Rail, 'Rail freight' accessed 1 September 2022
204 UK Petroleum Industries Association (FTF0018)
205 Q186
206 Q209
207 Q186, Q187

found that the main advantage of hydrogen fuel is that it is zero-emission at the point of use, given that hydrogen combines with oxygen to produce electricity, heat and water.[208] It is quiet and, unlike electrification, it does not require extensive trackside infrastructure.[209] The main challenge is that, presently, hydrogen is not capable of delivering the power required by freight and high-speed train services because of their high energy demand.[210] The UK would have to heavily invest in its own supporting infrastructure and supply chain, and hydrogen production can have a negative environmental impact ('green hydrogen' produced by electrolysis making up only around four per cent of hydrogen worldwide).[211]

Battery electric

121. We found that battery technology is zero emission at the point of use, it can travel on the network without a "contact system" and is quiet.[212] It is also a natural complement to electrification as batteries can be incorporated on electric trains and can charge from existing electricity infrastructure.[213] Batteries can also be used to reduce peak electricity load and can work during a power outage.[214] The main challenge is that, like hydrogen, battery technology is not currently able to deliver the required energy for freight and high-speed services.[215] Furthermore, battery manufacture produces a high amount of carbon, and current battery life is significantly shorter than the lifetime of a train, meaning a battery will need to be replaced multiple times.[216] Battery disposal is also a high energy process and recycling is complex.[217]

122. Since the publication of our 'Trains fit for the future?' report, the Government has published a UK Hydrogen Strategy, in which it states there will be "a role for new traction technologies, like battery and hydrogen trains, on some lines where they make economic and operational sense."[218]

Biofuels

123. Another option for rail is biofuels. UK Petroleum told us that low carbon fuels could replace the 1.7 billion litres of diesel currently used per year for rail, "with return-to-depot refuelling meaning rail is well suited to dedicated, high blend biofuel supply utilising existing infrastructure while overhead cabling is built".[219] They added that, due to other alternative decarbonisation technologies not yet having the capability to power freight, "low carbon fuels may prove the most viable short- and medium-term means of decarbonising rail freight."[220]

208 Fuel Cell & Hydrogen Energy Association, 'Fuel Cell Basics', accessed 2 September 2022
209 Angel Trains (TFF0028), Alstom UK (TFF0024), Rail Delivery Group (TFF0021), West Yorkshire Combined Authority (TFF0020)
210 Oral evidence taken on 9 December 2020, HC (2020–21) 876, Q88 [Helen McAllister], Q105 [Andrew Kluth]
211 Aldersgate Group (TFF0011), Alstom Transport UK Limited (TFF0024), Anglo American (TFF0025), Eversholt Rail Limited (TFF0014), Committee on Climate Change, Hydrogen in a low-carbon economy, (November 2018) p 19
212 Transport Committee, Sixth Report of Session 2019–21, Trains Fit for the Future? HC 876, para 72
213 Oral evidence taken on 11 November 2020, HC (2020–21) 876, Q11 [Leo Murray], Q14 [Leo Murray]
214 Network Rail, Traction Decarbonisation Network Strategy: Interim Programme Business Case (July 2020) p 70
215 Oral evidence taken on 11 November 2020, HC (2020–21) 876, Q11 [Leo Murray], Q14 [Leo Murray]
216 Network Rail, Traction Decarbonisation Network Strategy – Interim Programme Business Case (September 2020) p 180
217 Institute for Energy Research, 'The Afterlife of Electric Vehicles: Battery Recycling and Repurposing' accessed 1 September 2022
218 Department for Business, Energy & Industrial Strategy, UK Hydrogen Strategy (August 2021) p 66
219 UK Petroleum Industries Association (FTF0018)
220 UK Petroleum Industries Association (FTF0018)

124. Research from the University of Leeds has concluded that while utilising biodiesel in the rail sector has merit, there are challenges. The cost of producing biodiesel is higher than for fossil fuels, with the price of feedstock an important constituent. Maintenance costs for biodiesel usage on rail are currently under-investigated and potentially could be higher than diesel due to materials in older rolling stock, such as metals, degrading more quickly if biodiesel were to be used. The longer life of rail locomotives compared with road vehicles may also be a barrier to rapid adoption of higher blends of biodiesel.[221]

Synthetic fuels

125. Paddy Lowe of Zero Petroleum said about the rail sector:

> If you start with freight, that is the easiest case in which you can say that you cannot fully electrify freight until you have fully electrified all the railways. That is the last application and it will take a long time. In freight, you are going to need mixed mode almost indefinitely. You then come back to whether it is going to be hydrogen, electric battery or liquid fuel. That may be dependent on a case-by-case basis, but battery and hydrogen all consume payload. In the operation there is a commercial cost to that if you are consuming payload with your energy store relative to liquid fuel. Then you have to look at the wider economics around those three possibilities. In some of the cases we have looked at there is a very strong commercial case for making synthetic liquid fuel when you look at the investment in the round.[222]

Technology neutrality

126. Despite there being a range of alternative decarbonisation technology options, there has yet to be significant investment in any one technology by the rail freight sector. Maggie Simpson told us that it is difficult for the private sector to know which of these alternative decarbonisation technologies to invest in due to a lack of guidance from the Government as to which technologies will be available for rail freight. She said:

> We do not yet really know how much of the network will be electrified. […] We do not really know whether hydrogen will be available at scale. […] Will it be green even if it does, and is it investable even if it is not green? In battery technology you need a huge amount of battery to move a heavy freight train. The technology is not really there yet but, even if it were, will the batteries be committed to those modes?[223]

127. ***Freight transport and high-speed rail are the most significant decarbonisation challenges in the rail sector. To meet its objective to phase out all diesel-powered trains by 2040, the Government must increase the current pace of electrification set out in Network Rail's traction decarbonisation plan. The lifespan of rolling stock alone means that any rail projects currently being developed that are not wholly electrified—such as East West Rail—place in doubt the achievability of the 2040 target.***

221 Stead C. et al, "*Introduction of Biodiesel to Rail Transport: Lessons from the Road Sector*" Sustainability, vol 11 no 3 (2019) p 16
222 Q59
223 Q191

128. ***As stated in our 'Trains fit for the future?' report, we recommend that the Department for Transport publish a long-term strategy for decarbonising the rail network as a matter of priority. This should include a vision for what proportion of the future network will use electrification, battery and hydrogen. That strategy should be supported by appropriate costings, a credible delivery plan, and enabling targets and milestones. These targets and milestones should clarify how the 2040 and 2050 targets will fit together.***

7 Conclusion

129. Witnesses agreed that the Government has broadly been neutral in its approach to choosing which alternative decarbonisation technology is the best solution for each transport sector.[224] However, we also heard that this approach in practice has resulted in a lack of guidance from the Government as to which technologies the private sector should be investing in, effectively slowing down the take-up of decarbonisation technologies and innovation in the sector.[225] The Grantham Institute told us,

> Technology neutrality is not a viable approach because different technologies used in different sectors have different emissions impacts, and their infrastructure needs have to be supported differently. […] Government should apply comparable metrics across the different technologies in the different sectors to determine which is the most likely candidate to succeed and then back it to ensure the required investment, research development and production can occur.[226]

130. There are challenges with increasing uptake of alternative fuels in the transport sector. Financial investment in zero and near-zero emission technologies, adequate production facilities and the introduction of market incentives to improve uptake will all be necessary for the UK transport industry to transition to alternative fuel power. Prioritising investment towards alternative fuels that are proven to have the greatest effect on emission reductions while providing value for money will be the optimal way for the Government to distribute its finite resources.

131. **The Government may not always be able to adhere to its technology agnostic policy as it seeks to achieve the target of net zero emissions by 2050. If that aspiration is to be fulfilled, it must introduce policies that enable a functioning market which encourages alternative fuel uptake. That will sometimes mean 'picking winners'. A technology agnostic approach from the Government should not be used as an excuse for doing nothing to lead.**

132. **The technology agnostic approach has led to a lack of investment in alternative decarbonisation technologies by the private sector. A more nuanced approach to increasing the uptake of alternative fuels is required.**

133. ***The Government must shift its 'technology agnostic' policy to a 'targeted technology investment' policy. Such a policy will provide the Government with the flexibility to make strategic investments in new technologies that offer evidenced solutions to lowering emissions, while allowing the Government to maintain a level of neutrality on the emission reduction approach in transport sectors which are currently difficult to decarbonise.***

224 Road Haulage Association (FTF0041), Mineral Products Association (FTF0029), Logistics UK (FTF0010),UK Civil Aviation Authority (FTF0013),Sustainable Aviation (FTF0035)

225 Q109, Grantham Institute (FTF0042), South West Hydrogen Ecosystem Partnership (FTF0014), Renewable Transport Fuel Association (FTF0017)

226 Grantham Institute (FTF0042)

Conclusions and recommendations

Sustainable and synthetic fuels

1. It is our view that the case for full electrification in private cars is 'the received wisdom', and therefore needs further scrutiny and investigation. (Paragraph 25)

2. Given the existing private cars that will remain on the road for some time, drop-in replacement fuels from renewable sources could be a no-risk, very sensible and economically sound approach. (Paragraph 28)

3. While maintaining an official line on technology neutrality with respect to achieving zero emissions in private cars, the Government is in fact 'putting all its eggs in one basket': battery EVs. The reality is that not everyone in the UK can afford a new or second-hand electric vehicle, and if they could, cannot easily charge one at home. The infrastructure is not adequate to deliver sufficient electricity to homes, and there are insufficient raw materials to produce the battery banks needed for all vehicles to be EVs. We therefore caution against the promotion of electric vehicles as being the only solution to reducing carbon emissions from private vehicles; as the cliff edge of 2030 (2035, 2040 and 2050) approaches and minds are concentrated, reality will bite. (Paragraph 48)

4. *We reiterate the message of our July 2021 report on zero emission vehicles that Government needs to take account of legacy petrol and diesel-powered motoring and continue to explore the potential of alternative fuels where possible. This includes the huge potential for sustainable fuels to provide a low-carbon option for conventional engines. A reality check is needed. High-end premium and supercar manufacturers and smaller bespoke and specialised manufacturers—which have a much smaller construction carbon and other energy and pollutant footprint compared to EV manufacturers—need direction, clear guidance, and regulation from the Department for Transport, sooner rather than later.* (Paragraph 49)

5. *Furthermore, while long-haul aviation and international shipping are often identified as the most likely users of sustainable fuels, we believe that the Government must open-mindedly consider all alternative fuels for all modes of powered transport, including private cars.* (Paragraph 50)

6. All the propulsion alternatives have a significant role to play so the Government needs to stop demonising specific technologies that could really help. Addressing the existing fleet will be decisive in achieving the UK's climate goals. Reducing greenhouse gas emissions right now by the use of increasing quantities of drop-in sustainable fuels enables us to address the existing fleet and minimise cost (and carbon emissions) through the use of existing infrastructure. It would also enable more socially equitable access to carbon reduction technologies for everyday transport as it would not be necessary to buy a new electric car and have access to charging infrastructure. However, sustainable fuels still produce emissions at point of use so offer no 'apparent' benefit in the current, misleading, legislative framework.

We need a mechanism to enable the carbon savings associated with sustainable fuels to count, which would incentivise investment, drive down costs and offer a better-managed and complementary set of solutions. (Paragraph 51)

7. The continued focus on battery electric vehicles alone risks failing to meet the UK's climate goals. Demand for more and more range from electric vehicles makes them very heavy and very expensive, tying up precious resources in an energy store that might rarely be used. Distributing those resources across more plug-in hybrid vehicles with smaller battery packs that enable 80 per cent of our journeys to be completed electrically yet retaining extended range using an ICE running on a sustainable fuel might be a better compromise. (Paragraph 52)

8. The ideal solution may be to allow automotive companies to fix the problem and provide the solution by applying the right mix of technologies. Plugin hybrids (petrol and diesel) offer the best options when in urban areas they can make a switch to electric propulsion on entry (such as at low emission zones) or pay the charge and revert back to ICE (on sustainable/synthetic fuels) propulsion if required. They can also utilise such ICE propulsion outside of urban environments where they are very efficient and 'cleaner' over long distances and/or at higher average speeds, and hence 'range anxiety' becomes a thing of the past. (Paragraph 53)

Road

9. *We recommended in our July 2021 report on zero emission vehicles that some of the £950 million rapid charging fund be used to provide fully future-proofed grid capacity, and that the Government work with National Grid to map the electricity network to assess potential weak areas. In October 2021 a proof-of-concept version of a National Energy Systems Map was published. We reiterate our previous recommendation that this kind of information be used to develop a plan to prevent 'not-spots' in grid capacity from emerging.* (Paragraph 61)

10. We believe there is a case for many people right across the country in all areas, but particularly in rural and isolated communities, to continue to drive wholly diesel or petrol-powered cars, or hybrids (or EVs if they wish). Over time they will very likely account for a negligible proportion of transport emissions. The cost of introducing EV charging infrastructure everywhere is completely unrealistic and will require massive amounts of taxpayers' money through government subsidy for electricity generation, infrastructure provision and storage, and basic raw materials for battery production in order to be anywhere near acceptable as an alternative to ICE or hybrid personal vehicles, delivery, farming or construction vehicles. (Paragraph 64)

11. *We recommend that the Government publish its future of rural transport strategy as a matter of priority. The strategy should include the Government's plan to ensure people living in rural areas have adequate access to charging infrastructure.* (Paragraph 65)

12. *The Government should examine the roll-out of public charging networks in other European countries and in Scotland, to see how best to harness government expenditure on chargepoints—particularly in rural and more economically marginal locations—to help increase the pace of the rollout and increase coverage and EV-to-charger ratios.* (Paragraph 66)

13. *There is not yet a solution for the decarbonisation of HGVs in heavier weight categories that travel long distances. We recommend that the Government publish a long-term HGV decarbonisation strategy as a matter of priority.* (Paragraph 73)

Maritime

14. *The UK Government should support the International Maritime Organization's work to develop global standards for vessel construction that enable ships to utilise alternative fuels such as ammonia, synthetic fuels and hydrogen. The UK should use its influence at the IMO to ensure that, globally, the path forward for investors in alternative maritime fuels becomes more secure.* (Paragraph 91)

Aviation

15. *There is significant demand and potential for sustainable aviation fuels in the aviation sector: they are the most plausible option for significant decarbonisation of aviation in the short and medium terms. We welcome the SAF mandate in the Jet Zero strategy, but consider that further measures are needed to stimulate the progress required. The Government must introduce a Contracts for Difference model to stimulate uptake of SAF. The Government should also examine whether such a model could be used to incentivise the uptake of other sustainable aviation technologies such as hydrogen.* (Paragraph 112)

Rail

16. *Freight transport and high-speed rail are the most significant decarbonisation challenges in the rail sector. To meet its objective to phase out all diesel-powered trains by 2040, the Government must increase the current pace of electrification set out in Network Rail's traction decarbonisation plan. The lifespan of rolling stock alone means that any rail projects currently being developed that are not wholly electrified—such as East West Rail—place in doubt the achievability of the 2040 target.* (Paragraph 127)

17. *As stated in our 'Trains fit for the future?' report, we recommend that the Department for Transport publish a long-term strategy for decarbonising the rail network as a matter of priority. This should include a vision for what proportion of the future network will use electrification, battery and hydrogen. That strategy should be supported by appropriate costings, a credible delivery plan, and enabling targets and milestones. These targets and milestones should clarify how the 2040 and 2050 targets will fit together.* (Paragraph 128)

Conclusion

18. The Government may not always be able to adhere to its technology agnostic policy as it seeks to achieve the target of net zero emissions by 2050. If that aspiration is to be fulfilled, it must introduce policies that enable a functioning market which encourages alternative fuel uptake. That will sometimes mean 'picking winners'. A technology agnostic approach from the Government should not be used as an excuse for doing nothing to lead. (Paragraph 131)

19. The technology agnostic approach has led to a lack of investment in alternative decarbonisation technologies by the private sector. A more nuanced approach to increasing the uptake of alternative fuels is required. (Paragraph 132)

20. *The Government must shift its 'technology agnostic' policy to a 'targeted technology investment' policy. Such a policy will provide the Government with the flexibility to make strategic investments in new technologies that offer evidenced solutions to lowering emissions, while allowing the Government to maintain a level of neutrality on the emission reduction approach in transport sectors which are currently difficult to decarbonise.* (Paragraph 133)

Formal minutes

Tuesday 21 February 2023

Members present:

Iain Stewart, in the Chair

Mike Amesbury

Jack Brereton

Chris Loder

Karl McCartney

Gavin Newlands

Greg Smith

Draft Report (*Fuelling the future*), proposed by the Chair, brought up and read.
Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 50 read and agreed to.

Paragraph 51 read, as follows:

While maintaining an official line on technology neutrality with respect to achieving zero emissions in private cars, the Government is in fact 'putting all its eggs in one basket': battery EVs. The reality is that not everyone in the UK can afford a new or second-hand electric vehicle, and if they could, cannot easily charge one at home. The infrastructure is not adequate to deliver sufficient electricity to homes, and there are insufficient raw materials to produce the battery banks needed for all vehicles to be EVs. Promotion of EVs as the sole solution is an unrealistic, 'emperor's new clothes' scenario which bears the hallmarks of groupthink; as the cliff edge of 2030 (2035, 2040 and 2050) approaches and minds are concentrated, reality will bite.

Amendment proposed, delete from "Promotion" in line 7 to "groupthink" in line 8 and insert: "We therefore caution against the promotion of electric vehicles as being the only solution to reducing carbon emissions from private vehicles". —(Chair.)

Question put, That the Amendment be made.

The Committee divided.

Ayes, 3	Noes, 3
Mike Amesbury	Chris Loder
Jack Brereton	Karl McCartney
Gavin Newlands	Greg Smith

Whereupon the Chair declared himself with the Ayes.

Question accordingly agreed to.

Paragraph 51, as amended, agreed to.

Paragraphs 52 to 133 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Third Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

Adjournment

[Adjourned till tomorrow at 9.30 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Wednesday 09 February 2022

Paddy Lowe, Chief Executive Officer and Founder, ZERO PETROLEUM LIMITED; **Dr Neville Hargreaves**, Vice President for Waste to Fuels, Velocys; **Dr Andy Roberts**, Director of Downstream Policy, UK Petroleum Industries Association; **Louise Kingham**, Head of Country (UK) and SVP for Europe at BP Q1–63

Dr Nina Skorupska CBE, Chief Executive, The Association for Renewable Energy and Clean Technology; **Ed Birkett**, Head of Energy and Environment, Policy Exchange Q64–108

Wednesday 02 March 2022

Rhona Macdonald, Sustainability Advisor, British Ports Association; **Anna Ziou**, Policy Director (Safety and Environment), The UK Chamber of Shipping Q109–140

James McMicking, Vice-President, Strategy, ZeroAvia; **Rob Bishton**, Group Director for Safety and Airspace Regulation, The UK Civil Aviation Authority Q141–167

Guy Lachlan, Director, Historic and Classic Vehicles Alliance; **Greg Archer**, Member, Electromobility UK Q168–183

Maggie Simpson OBE, Director General, Rail Freight Group; **Helen Simpson**, Innovation and Projects Director, Porterbrook Q184–224

Wednesday 16 March 2022

Trudy Harrison MP, Parliamentary Under-Secretary of State, Department for Transport; **Caroline Low CBE**, Director, Energy, Technology and Innovation, Department for Transport Q225–309

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website

FTF numbers are generated by the evidence processing system and so may not be complete.

1 ADS Group Ltd (FTF0025)

2 ASLEF (FTF0008)

3 Airport Operators Association (FTF0047)

4 Alstom UK and Ireland (FTF0005)

5 American Express Global Business Travel (FTF0030)

6 Angel Trains (FTF0019)

7 Bennamann Ltd (FTF0023)

8 British Airline Pilots' Association (FTF0032)

9 Calor (FTF0011)

10 Campaign for Better Transport (FTF0038)

11 Carbon Engineering (FTF0033)

12 Chargepoint (FTF0007)

13 Department for Transport (FTF0051)

14 Electromobility UK (FTF0062)

15 eFuel Alliance (FTF0059)

16 FirstGroup plc (FTF0045)

17 GKN Aerospace (FTF0020)

18 Gas Vehicle Network (FTF0048)

19 Gasrec Limited (FTF0006)

20 Gatwick Airport Ltd. (FTF0040)

21 Go-Ahead Group (FTF0024)

22 Grantham Institute - Climate Change and Environment at Imperial College London (FTF0042)

23 Greenergy (FTF0036)

24 Historic and Classic Vehicles Alliance (FTF0021)

25 HyPoint (FTF0015)

26 INEOS Group Ltd (FTF0063)

27 ITM Power (FTF0009)

28 JouleVert Limited (FTF0004)

29 Living Bio Power (FTF0064)

30 Logistics UK (FTF0010)

31 Manchester Airports Group (FTF0037)

32 Midlands Connect (FTF0028)

33 Mineral Products Association (FTF0029)

34 Mundy, Mr Tim (Technical and Classic Motoring Journalist, Freelance) (FTF0012)
35 National Express (FTF0031)
36 Port of Dover (FTF0026)
37 Porterbrook (FTF0054)
38 Prodrive (FTF0067)
39 Rail Delivery Group (FTF0061)
40 Rail Freight Group (FTF0003)
41 Ralph Hosier Engineering Ltd (FTF0065)
42 Renewable Transport Fuel Association (FTF0017)
43 Road Haulage Association (FTF0041)
44 Rolls-Royce plc (FTF0016)
45 Sizewell C (FTF0043)
46 South West Hydrogen Ecosystem Partnership (FTF0014)
47 SulNOx Fuel Fusions Ltd (FTF0058)
48 Sustainable Aviation (FTF0035)
49 Sustrans (FTF0001)
50 The Royal Automobile Club (FTF0066)
51 Transport East (FTF0060)
52 Transport and Environment (FTF0053)
53 TravelWatch NorthWest (FTF0027)
54 UK Chamber of Shipping (FTF0070)
55 UK Chamber of Shipping (FTF0057)
56 UK Civil Aviation Authority (FTF0013)
57 UK H2Mobility (FTF0056)
58 UK Petroleum Industries Association (FTF0018)
59 Valero Energy Ltd (FTF0022)
60 Velocys (FTF0071)
61 Velocys (FTF0034)
62 Virgin Atlantic Limited (FTF0050)
63 Wrightbus, Ryze and HyGen (FTF0052)
64 ZERO PETROLEUM LIMITED (FTF0039)
65 Zemo Partnership (FTF0068)
66 ZeroAvia (FTF0055)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

Session 2022–23

Number	Title	Reference
1st	Road freight supply chain	HC 162
2nd	The Integrated Rail Plan for the North and Midlands	HC 292
1st Special	UK aviation: reform for take-off: Government response to the Committee's Fifth Report of Session 2021–22	HC 542
2nd Special	Road freight supply chain: Government response to the Committee's First Report	HC 701

Session 2021–22

Number	Title	Reference
1st	Zero emission vehicles	HC 27
2nd	Major transport infrastructure projects	HC 24
3rd	Rollout and safety of smart motorways	HC 26
4th	Road pricing	HC 789
5th	UK aviation: reform for take-off	HC 683
1st Special	The impact of the coronavirus pandemic on the aviation sector: Interim report: Government Response to the Committee's Fifth Report of Session 2019–21	HC 28
2nd Special	Road safety: young and novice drivers: Government Response to Committee's Fourth Report of Session 2019–21	HC 29
3rd Special	Trains Fit for the Future? Government Response to the Committee's Sixth Report of Session 2019–21	HC 249
4th Special	Safe return of international travel? Government Response to the Committee's Seventh Report of Session 2019–21	HC 489
5th Special	Zero emission vehicles: Government Response to the Committee's First Report	HC 759
6th Special	Rollout and safety of smart motorways: Government Response to the Committee's Third Report	HC 1020
7th Special	Major transport infrastructure projects: Government Response to the Committee's Second Report	HC 938

Session 2019–21

Number	Title	Reference
1st	Appointment of the Chair of the Civil Aviation Authority	HC 354
2nd	The impact of the coronavirus pandemic on the aviation sector	HC 268
3rd	E-scooters: pavement nuisance or transport innovation?	HC 255
4th	Road safety: young and novice drivers	HC 169
5th	The impact of the coronavirus pandemic on the aviation sector: Interim report	HC 1257
6th	Trains fit for the future?	HC 876
7th	Safe return of international travel?	HC 1341