The Future of UK Freight

Opportunities for Improving Sustainability in the Context of Brexit and COVID-19

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Key Terms and Abbreviations

BEIS = UK Department for Business, Energy and Industrial Strategy

CCC = UK Committee on Climate Change

Cycle freight = Freight transported by cargo bike including Electrically Assisted Pedal Cycles (EAPCs)

DFT = UK Department for Transport

Defra = UK Department for Environment, Food & Rural Affairs

Domestic freight transport = The movement of goods where the origin and the destination are within the United Kingdom (Government Office for Science, 2019)

ERS = Electric Road System

EU = European Union

EP = European Parliament, the law-making body of the European Union

Freight transport = The carriage of goods between an origin and a destination for commercial reasons because goods available at one geographical location are required at another location for processing, sorting or consumption (Government Office for Science, 2019)

GHG emissions = Greenhouse Gas emissions

HGV = Heavy goods vehicles, goods vehicles over 3.5 tonnes gross laden weight (Government Office for Science, 2019)

IPCC = Intergovernmental Panel on Climate Change

'Last mile' journeys = The final (approximately) 5 miles of a delivery process, often in urban or residential areas

NIC = National Infrastructure Commission

ONS = UK Office for National Statistics

RIA = Railway Industry Association

SDGs = Sustainable Development Goals

Sustainability = The SixDegrees organisation defines sustainability as the pursuit of the United Nations' Sustainable Development Goals, with a particular focus on the following goals: 'innovation and Infrastructure', 'Sustainable Cities and Communities', 'Responsible Consumption', 'Climate action', 'Life below water' and 'Life on Land' (SixDegrees, 2020). For the purposes of this project, our understanding of sustainability in the freight sector focuses on a reduction of the carbon intensity of the sector

UK = United Kingdom

UN = United Nations

UNFCCC = United Nations Framework Convention on Climate Change

Six Degrees Edinburgh is a branch of [Six Degrees], a student-run environmental think tank operating across multiple universities in the UK. The organisation's aim is to advocate new pathways to sustainability in various sectors through consultancy and research.

The Six Degrees organisation defines sustainability as the pursuit of the UN Sustainable Development Goals (SDGs), with a particular focus on the achievement of the following goals: 'Industry, Innovation and Infrastructure', 'Sustainable Cities and Communities', 'Responsible Consumption', 'Climate Action', 'Life Below Water', and 'Life on Land' (Six Degrees, 2020).

Executive Summary

This report **assesses the future of the freight sector in the United Kingdom** (UK) and recommends policies conducive to its greater sustainability. It focuses specifically on **domestic road and rail freight**, highlighting domestic policies which will help the UK achieve its ambition to be carbon neutral by 2050. This report comes at a critical time to assess the future of UK freight, as the UK stands at the intersection of three disruptive forces:

- **Climate crisis** - the year 2020 was one of the three warmest on record, with atmospheric concentrations of greenhouse gases (GHG) continuing to increase (WMO, 2020). The freight sector must reduce its emissions of GHGs as part of the global effort to slow this warming.
- **COVID-19** - the global pandemic has brought delays, inefficiencies and unpredictability to the freight sector and the wider UK economy.
- **Brexit** - the UK's departure from the EU has caused logistical hurdles for international freight, creating a new policy landscape that will affect British society and business for decades to come.

In these challenges lie opportunities. Our findings show that with the right approach, the UK can forge a path towards sustainable freight that enables it to reach its climate goals, deliver on the promises of Brexit and provide a rapid green recovery from COVID-19.

Drawing on current academic, government and grey literature, this report assesses the potential impact of policies aimed at reducing GHG emissions from freight. Each policy is assessed on its effectiveness, efficiency and equity in pursuit of three of the UN's SDGs: **Climate Action; Innovation and Infrastructure; and Sustainable Cities and Communities**. The result of our analysis is a set of three complementary solutions.

1. **Emissions data must be collected, analysed and shared**, allowing companies to cut out the inefficiencies in freight systems that Brexit and COVID-19 have highlighted. Efficiency improvements will save freight providers money, allowing for increased investment in sustainability, while publishing data will facilitate pressure from the consumer end of the industry.

2. **Modal shifts must occur**, creating a freight industry that requires less energy while also having a positive impact on human and environmental health. In cities, this means creating a network of ultra low emissions zones and urban consolidation centres, helping shift freight from vans to cargo bikes. For long distance freight, this means utilising the full capacity of the rail network to remove HGVs from the roads.

3. **Electric roads and railways must be constructed to remove fossil fuels from the freight system** and bring its carbon emissions to zero. In particular, overhead electric cables on motorways will provide the most sustainable and cost effective way to decarbonise HGVs, while creating jobs on a decadal timescale and aiding the UK's economic recovery after COVID-19.

The following table represents the main findings of our analysis. Using an impact assessment, this report analyses each of the policies below, generating key recommendations.

Policies Analysed	Main Recommendations for Implementation
Mandatory emissions reporting for freight companies	• **Require mandatory freight emissions data collection and reporting**, first following a loose framework, and after a set deadline to clear standards and with emissions calculated based on fuel/electricity consumption. • Use the data to **better inform policy decisions, accelerate the uptake of best practices and technology for emissions reductions in the industry, and facilitate precise consumer carbon labelling**
Implementation of **consumer carbon labelling**	• **Collaborate with consumer goods companies to create a system of carbon labelling, thus limiting the chances there is a negative reception to the policy** • Take a **sector-by-sector phased approach to implementing carbon labelling,** starting with the food and drink sector, to reduce the potential for unfair competition. • Employ a **standardised UK economy-wide carbon label** to ensure consumer understanding and engagement.
Modal shift from road freight to rail and cycle	• **Encourage the uptake of cycle freight** for urban 'last mile' journeys to promote decarbonisation and minimise the health impacts of the freight sector. • **Encourage a modal shift** from road to rail in order to reduce carbon intensity over longer distances.
Expansion of the size and number of **Ultra Low Emission Zones** across the UK.	• **Introduce Ultra Low Emission Zones** (ULEZ) to urban areas in the UK to further encourage the uptake of cycle freight and minimise the negative health impacts of carbon-based transportation.
Implementation of an **Electric Road System** to reduce HGV emissions and move forward the ban on diesel vehicles.	• Make a clear commitment by the end of 2021 to **adopt an Electric Road System** (ERS) to be implemented at scale by 2035 following a trial. • **Move forward the ban on new diesel HGVs sales to 2035** and publish a **strategy for making alternative fuels a cheaper option** for freight providers.

1

Introduction

It is now widely recognised that climate change is the greatest threat facing humanity (McGrath, 2018). Our species is altering the Earth's atmosphere, oceans, and land at a rate that is pushing ecosystems to the brink of collapse. Indeed, the consequences are already manifesting: devastating plagues of locusts, desertification, flooding, and an increase in extreme weather are just a few examples.

This is the lens through which every policy decision must now be viewed, in order to be successful in securing prosperity for future generations. This is the lens through which the UK's youngest generation already views the world and the choices of policymakers, and why even the most basic functions of our society - including the movement of goods from one place to another - need to be readdressed to place sustainability at their core.

The UK has made impressive progress in renewable energy, and it is a world leader when it comes to setting targets for decarbonisation, but there is still a long way to go. As put by Dr Mark Carney, former Governor of the Bank of England (Carney, 2020):

"net zero isn't a slogan, it's an imperative of climate physics."

The need to become net zero looms large over the freight sector. However, it has yet to determine a clear pathway towards decarbonisation, to enable a decrease in emissions[1]. Now is the time to act; the disruptive forces of both Brexit and COVID-19 emphasising the need for decisive policymaking and collective action to combat the crisis.

This report's research goal is to identify key steps towards achieving sustainability in the freight industry, making recommendations as to how each step can be achieved. The following five chapters outline the report's findings. The rest of this chapter provides an overview of the UK freight sector, highlighting areas in need of improvement and summarising the UK's climate change targets and current policies bringing the freight industry in line with these targets. Chapter 2 examines the **challenges and opportunities for freight in the context of Brexit and the COVID-19 pandemic**. A methodology chapter follows, showing how the **UN's Sustainable Development Goals are at the core of our impact assessments**, and dividing methods of achieving freight sustainability into three key areas: **data availability, modal shift, and electrification**. Analysis and impact assessments are found in Chapter 4, where the report identifies the most effective policies in each area. Finally, the findings and recommendations are summarised in Chapter 5.

1.1 Overview of UK Freight

The freight sector is a significant part of the UK economy. According to the National Infrastructure Commission (NIC, 2019), **the sector contributed over £120 billion Gross Value Added, employing 2.5 million people**. This labour and investment is responsible for the transport of 2 billion tonnes of goods annually, a figure which is expected to increase by almost half within the next three decades (NIC, 2019).

Low barriers to entry and large numbers of freight service clients and providers mean that this sub-sector is **one of the most competitive in the world**. This is especially true in the UK, where over 200,000 enterprises compete for a market share (NIC, 2019), resulting in very low prices for service recipients (NIC, 2019; Government Office for Science, 2019). Nevertheless, the primary objective of the freight industry is to **link the British Isles to an increasingly globalised world**. It facilitates trade, including the import of essential materials, fuel and goods; the COVID-19 pandemic highlighting the importance of freight as a regulator of trade

The UK domestic freight sector is dominated by road transport via Heavy Goods Vehicles (HGVs) and Light Goods Vehicles (LGVs) (vans/white vans), which together haul 78% of domestic goods (in tonne-kilometres) (NIC, 2019). The use of LGVs has increased in recent years, in part due to online commerce

1 This report has an information cut-off date of May 2021.

deliveries replacing car journeys by consumers (Government Office for Science, 2019). Nevertheless, HGVs continue to be the main carrier of freight on the UK's road network.

Rail freight - which is particularly suited to bulk transport over longer distances - has seen an overall reduction in recent years with the decline of coal extraction. Discounting coal, however, the **market share of rail has increased** (MDS Transmodal, 2019). It is also one of the safest, most energy-efficient freight vectors, having minimal environmental impacts.

There is no official data on freight transport by walking and cycling. This, however, does not mean cycle freight has not been encouraged - a £2 million government fund in 2018 granted companies and local authorities money to buy electric cargo bikes (DfT, 2018). Furthermore, following the surge in cycling during the COVID-19 pandemic (Burns, 2020), a £2 billion package dedicated to active travel was announced (DfT, 2020a). These initiatives suggest that active freight is growing rapidly, and may soon be competing with other modes for short hauls in UK cities.

1.2 The Hidden Cost of Freight

The UK freight sector may be an economic success, but it also incurs costs to society and the environment. As these costs are largely outside the control of freight operators, competitive forces alone will likely not suffice in addressing them unless the UK makes significant changes to its policy approach.

Heavy reliance on road freight brings about a number of sustainability concerns. Firstly, goods vehicles contribute to congestion on the UK road network. This reduces fuel efficiency, causes delays for other road users, and reduces quality of life, particularly for those living and driving in congested urban areas. Noise pollution from freight activity causes annoyance, disrupts wildlife (Osbrink, 2021), and is linked to adverse health outcomes (Stansfeld, 2000). Furthermore, LGVs and HGVs are the two most dangerous vehicle types to other road users (Webster, 2020), while also causing disproportionate damage to roads due to their weight.

If the freight sector is to be aligned with the United Nations SDGs (in particular SDG 13, Climate Action), then its most pressing issue is that of greenhouse gas emissions. Currently, r**oad and rail freight contribute around 6% of the UK's emissions** (DfT, 2017). Freight emissions are still about 30% higher than in 1990, and have markedly increased between 2013 and 2019 (ONS, 2020). High freight emissions are partly due to the use of road transport - which is more carbon intensive than any other mode apart from air - although UK rail freight is still relatively carbon intensive, with only 5% being powered by electricity (DfT, 2016).

This trajectory is not consistent with the internationally agreed target of 1.5°C of warming set by the Paris Agreement, nor with the UK's legally binding target to achieve net zero emissions by 2050. Considering the scale of the freight industry and this rapidly approaching deadline, **decarbonisation must be the primary goal of future freight policies.**

The COVID-19 pandemic and Brexit has introduced new social and legal norms on the movement of people and goods. It will therefore be imperative to take note of how these events have thus far shaped the freight industry in order to design effective policies for the future. Such an analysis will be presented in Chapter 2, following a review of the current strategies and policies the UK government has in place regarding the sustainability of freight.

1.3 Current Policies

In April 2021, the UK Government pledged to reduce carbon emissions by 78% by 2035 with respect to 1990 levels (Harrabin, 2021). This pledge, which is to become law, is only the latest of a number of commitments made by the UK encouraging climate change mitigation at the national and international level. The following section outlines all of the environmental obligations the UK has made, as well as the plans and policies in place ensuring the freight sector meets these targets .

1.3.1 Climate change targets

In 1997, the UK entered the Kyoto Protocol, which came into force in 2005 and established the United Nations Framework Convention on Climate Change (UNFCCC). The protocol requires signatories to report on their progress towards meeting agreed emissions reduction targets;developed nations legally bound to meet them (UNFCCC, 2021a).

The 2015 Paris Agreement has since taken precedent as the major instrument for international cooperation on climate change. Its terms are binding for all parties and aim to "limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels" (UNFCCC, 2021b, n.p.).

Under this agreement, parties submit self-set emissions reduction targets, called 'Nationally Determined Contributions' (NDCs), every five years. **The UK's latest NDC states it will be reducing net GHG emissions by 68% by 2030** (w.r.t. 1990 baseline) **and reach net zero by 2050** (BEIS, 2020). These two targets are also inscribed in the UK's own Climate Change Act (2008).

1.3.2 Current policies addressing the freight sector's role in meeting UK targets

HGVs and LGVs have been the focus of numerous policy measures due to their significant contribution to road vehicle emissions: HGVs generate 17% of emissions despite constituting 5% of road vehicles, and HGVs and LGVs together accounted for 32% of the country's road transport GHG emissions (Department for Transport, 2017).

The UK Government has legislated that **new HGVs must reduce carbon dioxide emissions by 15% and 30% by 2025 and 2030** relative to 2019 (DfT, 2020a); manufacturers who do not meet these standards are to be subject to fines. Additionally, freight operators are encouraged to meet a voluntary target of reducing emissions from their HGV fleet by 15% by 2025 with respect to 2015 emissions levels (DfT, 2020a; DfT, 2018a). Energy- and fuel-efficiency have been encouraged through portals made available by the Energy Saving Trust with the aim of reducing emissions in the short-term.

Furthermore, **£20 million has been allocated to zero-emission HGV trials** to meet the target of developing operational vehicles by 2025 (Gabbatiss, Tandon and McSweeny, 2020). However, as of yet, the UK Government has not committed itself to a particular technology for decarbonisation, namely hydrogen or electric HGVs, either of which would require considerable infrastructure investment.

Vans have also been subject to rigorous legislation. **All new vans must be zero-emission by 2040**, though this could be brought forward to 2035 (DfT, 2020a). The UK Government aims for 40% of vans sold to be ultra-low or zero emission by 2030. Similarly to their larger counterparts, new LGVs need to increase GHG efficiency by 15% and 31% by 2025 and 2030, 2021 serving as a baseline (DfT, 2020a, p.41).

The use of both HGVs and vans in city centres is being limited by **low emissions zones**, in which carbon emitting vehicles are heavily charged (Transport for London, 2018). This means that in the long run, a modal shift towards electric vans, cycling and journeys taken by foot will have to occur in city centres.

In addition, the UK Government aims to see the contribution of sustainable, low carbon fuels increase to 7% by 2032 (DfT, 2018a, p.2), as well as a reduction in non-tailpipe emissions from components such as brakes and tyres (DfT, 2019).

The Department for Transport has also laid out its intention to "continue to support shifting freight from road to rail" (2018a, p.63) through schemes such as the Modal Shift Revenue Support Scheme (DfT, 2020a), which subsidies rail transportation, making it more expensive than road. There have also been calls by the Department for Transport to **increase the proportion of rail that is electrified** (2020a). While a clear pathway for rail decarbonisation is yet to be published, the Prime Minister's 'Ten Point Plan' recently vowed to "electrify more railway lines" (BEIS, 2020b, p.16).

1.3.3 Current progress and trajectories

In the next 30 years freight volumes are expected to increase. Without appropriate action, carbon emissions will also rise (NIC, 2019). Despite the UK having met GHG emission targets so far (BEIS, 2019), the transportation sector's emissions have increased (ONS, 2020). Non-CO2 emission levels are in excess of EU recommended levels in many parts of the UK (Logistics Emissions Reduction Scheme, 2019).

The present planned policies for HGVs are forecasted to translate into an emission reduction of only 20% by 2050 (DfT, 2020a), and those from LGVs will only level off slightly, with vehicle kilometres continuing to rise (DfT, 2020a). This is far from consistent with the UK's net zero goal for 2050. The NIC (2019) notes that modal shift will not be capable of replacing HGV journeys in their totality, meaning modal shift only represents a partial mitigation strategy rather than a long term solution to decarbonising freight.

The Government expects the transition to zero-emission freight to be "industry and consumer led" (DfT, 2018a, p.2). However, the NIC (2019) emphasises that as things stand, **market competition alone is far from sufficient to address the environmental impact of freight**. This, along with other reports, emphasises the need for the government to provide the infrastructure and incentives to set freight on a sustainable trajectory.

2

The impact of COVID-19 and Brexit on the future of freight

2.1 Brexit and EU Relations

The UK's withdrawal from the European Union (EU) has the potential to impact the UK freight industry greatly as the UK reconstructs their environmental policy. Furthermore, Brexit has already had a marked impact on the operation of the freight industry, just as COVID-19 has. This chapter will therefore firstly focus on the policy landscape that the UK is working within as a result of no longer being party to EU environmental policy commitments. An analysis of the EU-UK Trade and Cooperation Agreement is then necessary to determine what future EU-UK relations could mean for UK freight. The chapter will end with a discussion about the practical concerns that the industry is facing as a result of Brexit, and the potential for continued connectivity as a driver for sustainable trade between the UK and EU.

2.1.1 Post-Brexit Environmental standards and policy

UK and EU environmental policy has developed in tandem, and UK membership with the EU has been beneficial for UK standards, as considered within Chapter 3. Membership of the EU meant that the UK was part of a legal regime that provides unprecedented means of setting and achieving environmental goals. Addressing the transnational challenge of environmental issues within the similarly transnational structure of the EU is a significant contributing factor to this success. However, the UK has also shown itself to have higher standards than the EU on some occasions; impacts have therefore not been uniformly positive or negative, but rather a mix of both (Hilson, 2017). The relationship between the EU and the UK is therefore a complex one, particularly because the area of environmental law and policy has been so intertwined. There are subsequently valid concerns that the UK leaving the EU will result in negative impacts to the development of environmental policy.

The UK has not yet published its transport policy after departing from EU transport and environmental policy, therefore it would be misguided to give a definitive assessment of how the UK will proceed within this sphere. What is possible is to look at the wider political and legal landscape that the UK has cultivated for itself thus far in the lead up to and short period following Brexit. This will give a broader picture of the UK's economic and political priorities as it leaves the EU, which will impact the development of environmental policy within the freight sector. This analysis focuses entirely on the UK Government's legislative and policy action, and does not consider the actions of devolved governments, which are beyond the scope of this report.

2.1.2 Policy commitments thus far

The UK has previously been party to EU environmental policy, and now has the opportunity to construct ambitious and effective policy to achieve the net zero goal (among other environmental targets), separate from EU harmonisation and authority. **The UK Government has framed Brexit as an opportunity to enhance environmental standards**; a key example of this can be found within the'25 Year Environment Plan' published in 2018. In the report, it is stated that "Leaving the EU presents a unique opportunity to set in motion the behavioural and institutional changes necessary to build sustainable, enduring growth as well as an improvement in our wellbeing" (HM Government, 2018, p. 11).

The Government has committed to be a 'world leader' in shaping the future of mobility, "including the low carbon transport of the future" (HM Government, 2018, p. 98). In the 'Ten Point Plan for A Green Industrial Revolution', the Government makes several relevant commitments to driving the growth of low carbon hydrogen, accelerating the shift to zero emission vehicles, and renews commitments to both a green recovery after COVID-19, and to achieving net zero by 2050 (HM Government, 2020, p. 30). It is notable that these long-term policy agendas that set out the roadmap for the UK after Brexit are intrinsically linked to industrial innovation and economic benefit. The Government is willing to prioritise a move to a zero carbon and sustainable future in the transport sector – if it concurrently promotes economic activity and development. This is a clear priority of the Government that this report seeks to address in its analysis.

Another relevant report that has come from the Government is the 'Decarbonising Transport: Setting the Challenge' policy paper, which makes reference to EU environmental standards. First of all, it is claimed that the future approach to **vehicle emissions regulations will be 'at least as ambitious' as the current EU arrangements** (DfT, 2020b; p. 41). Secondly, it reiterates that the UK has committed to be 'at least as ambitious' as the EU Emissions Trading System (DfT, 2020b, p. 31). These commitments to resist dilution of environmental policy standards within the sector post-Brexit are strong, however not legally binding, and the final policy plan is yet to be published. The final Transport Decarbonisation Plan (TDP) will be published later in 2021 (DfT, 2020b).

To conclude, although some strong policy commitments have been made towards an innovative and sustainable future in the transport sector, it is still to be observed how the Government plans to implement the much needed move to zero carbon through the TDP. This chapter will now look at the Environment Bill as a key piece of proposed legislation that can show, in a more general manner, how the Government plans to approach environmental standards and policy in the post-Brexit era.

2.1.3 The Environment Bill

The Environment Bill was first introduced into parliament in 2019, reintroduced in 2020, and has now been delayed until the next parliamentary sitting (Defra, 2021) . The Government's rhetoric around the Environment Bill is that it is powerful and ambitious, indeed Theresa Villiers stated that 'we have set out our pitch to be a world leader on the environment as we leave the EU and the Environment Bill is a crucial part of achieving that aim' (Defra, 2020). Considering the delay of this landmark legislation, and some key criticisms, concerns arise around whether this Bill can achieve its purpose with the urgency that is required.

a) Lack of legal commitment to post-Brexit environmental standards and principles

The UK Government has made a number of non-legally binding written and verbal commitments to maintaining environmental standards post-Brexit. The Environment Bill, being the primary instrument that sets out the roadmap for environmental policy, protections and standards post-Brexit, would be a pertinent place to contain a robust legal commitment to the preservation of environmental standards to at least EU level. The UK government has not taken this opportunity.

Furthermore, Article 191(2) of the Treaty of the Functioning of the European Union (TFEU) requires that key environmental principles, such as the precautionary principle and the polluter pays principle, are applied in Union policy at all levels. The Environment Bill currently requires that Government Ministers have 'due regard' to these principles. This means that not all public bodies will need to give consideration to these principles, and 'due regard' is arguably significantly weaker than the duty to definitively apply the principles in law and policy making.

b) Key functions of the Environment Bill

A vital change that the Environment Bill will make is that it creates a new enforcement body: the Office for Environmental Protection (OEP), which will replace the EU Commission and the European Court of Justice as the enforcement body for environmental standards in the UK. These institutions have played a key role in driving improvements to the UK's environment during membership of the EU (House of Lords: EU Committee, 2021, p. 31). The delay of this Bill has resulted in the OEP failing to be established in time for Brexit.

The UK is therefore currently without an official environmental watchdog. Concerns have also been raised by critics that the OEP will not be fully independent and unable to hold the Government to account effectively. There are two primary reasons for this; first of all, the funding for this body will largely be controlled by the Secretary of State (Harper, 2020), and second of all, there is currently a clause within the Bill that would allow the Secretary of State to give guidance to the OEP – amendments have been proposed that would delete this clause (HoC, 2021, p. Column 223).

Another significant function of the Environment Bill is to create a new environmental target setting function. The Environment Bill will be followed by a plethora of statutory instruments that will operationalise the key goals of the bill. The Bill requires that statutory instruments setting out environmental targets are laid before parliament by 31 October 2022. This is valuable in terms of reaching net zero by 2050 as the UK needs legally-binding, interim targets to further the net zero agenda.

In conclusion, the Bill includes positive developments such as the target setting function, and the creation of the OEP, however there are some valid criticisms surrounding the Bill. The UK is showing a desire to become a world-leader in environmental standards after leaving the EU, yet within the primary legal instrument that could enhance environmental policy and law post-Brexit, commitments made are less robust and ambitious than they could have been. This arguably foreshadows that where the Government has made informal assurances, they may not follow through to the extent promised.

2.1.4 The EU-UK Trade and Co-operation Agreement

The EU-UK Trade and Co-operation Agreement (TCA) has some welcome environmental provisions in Part Two: Trade, Transport, Fisheries and Other Arrangements, particularly within Title XI which concerns the 'level playing field for open and fair competition and sustainable development'. For example, Article 1.1(3) reaffirms the ambition of achieving economy-wide climate neutrality by 2050 for both parties. There are, however, some concerns around the enforcement and accountability mechanisms within the TCA.

The first notable provision is the non-regression provision, at Title XI Article 7.2.2, which seeks to uphold environment and climate standards, but only limited to situations where such weakening would impact on trade or investment between the parties. The inclusion of this test has been described by stakeholders as 'disappointing', mainly due to the fact that it would be difficult to obtain proof of damaging economic impacts (Greener UK, 2021). Secondly, Article 9.4 sets out a 'rebalancing process' to allow both parties to implement measures on the significant divergence in environmental standards which are, again, shown to materially impact on trade or investment. The ultimate concern here is therefore that these mechanisms will not be effective or accessible as a means to genuinely further the environmental agenda between the two parties.

The EU being a growth-oriented trading block means that although it has coherent and stringent environmental standards, trade and economic benefit will always be primary concerns in any future relations with the UK. Indeed, it is clear that both the EU and the UK have a desire to continue a strong relationship that is conducive to open and sustainable trade. Both parties recognise that **transport is an essential driver of economic benefits in EU-UK relations** (European Commission, 2020). With these concerns considered, the pursuit of sustainable trade and economic benefit through transport must be compatible with the ultimate goal of net zero in 2050 for both parties.

In conclusion, the UK Government is placing itself as a world-leader in environmental standards, and is emphasising the role of Brexit to take it there. However, in terms of commitments in legislation, policy and the trade agreement, **the UK has taken an arguably reserved approach, with a common theme of a lack of accountability.** This may not be enough for the UK to reach net zero by 2050, as it has legally committed to do. This report therefore aims to encompass UK government and industry concerns, such as sustainable and economically beneficial trade and industrial innovation while ultimately pursuing the goal of a truly sustainable freight industry.

2.1.5 Short-term impacts: how is Brexit disrupting the freight industry?

The UK's departure from the EU brings many legal and political opportunities and challenges within the transport sphere, and Brexit has also impacted the freight sector in a very material way. Although the Government has claimed that exports to the EU are not down (Daily Business Group, 2021), data from the Office of National Statistics (ONS) and reports from the industry suggest a marked dip at the beginning of the year (ONS, 2021b; RailFreight, 2021). Increased costs and Brexit 'red tape' are reported to have caused major disruption within the industry (Woodcock, 2021). Increased documentation requirements have also interfered with normal business within the freight sector; country of origin documentation and incorrect paperwork at customs are impacting the day-to-day operations in the sector, as the industry adjusts to these onerous barriers to trade.

In 2019, the EU accounted for 46% of the UK's trade in goods (Ward, 2020). To use the term employed by the EU, 'continued connectivity' is a goal that both the EU and the UK are aiming for (European Commission, 2020). However, as a mixture of EU and COVID-19 impacts have elucidated, this may not be a smooth process. A survey conducted by DDC Freight Processing Operations (FPO) (2021), **shows that unease and disruption remain in the industry.** 95% of freight forwarders, and 100% of hauliers reported disruption to their operations related to Brexit impacts. Indeed, industry players, such as the chief executive of the Road Haulage Association (RHA), have claimed that concerns about a two-thirds drop in EU exports at the beginning of 2021 were largely ignored by the UK Government (Daily Business Group, 2021).

Concerns around delays and inefficiency are also being reported by rail freight operators, which have led to demand at ports in the UK moving away from the Channel, and instead to more inland rail distribution hubs (RailFreight, 2021). This change has positive implications for the rail freight industry, and represents an economic argument in favour of a **modal shift towards rail freight.**

Ultimately, the freight industry in the UK is having to conform to new and more rigorous trading conditions with the EU. It is too early to say whether trade will recover, and to what extent, but it is clear that it is in the UK and the EU's economic interests that continued connectivity and sustainable trade prevails. **These concerns can only be actioned by efficient, sustainable and innovative freight transport.**

2.2 The effects of COVID-19

The effects of the ongoing COVID-19 pandemic have been felt by the freight sector since it began in March 2020. While much of Asia and Oceania were able to suppress initial waves of the pandemic, other regions, including the UK, **have undergone multiple waves of rising infections and thus a cycle of decreasing and increasing restrictions** (UNCTAD, 2020). Varying levels of regional instability due to COVID-19 responses have had international consequences in regards to trade, **with inefficiency rising and subsequent costs skyrocketing.**

The added complexity of Brexit with ongoing pandemic-related effects has made the last few months the worst ever-recorded for the UK freight sector with the Office of National Statistics (ONS) recording the largest single drops in total imports/exports recorded in modern British history (ONS, 2021a).

Global recovery is estimated to vary across different freight sectors and regions, **but a proper return to pre-pandemic levels of demand and efficiency on a global scale are not expected until towards the end of 2023** (McKinsey & Co., 2020). By the spring of 2021, the UK has begun to shake off the worst of 2020 as its vaccination campaign progresses and firms adjust to Brexit-related measures but the country is still far off its pace from where it was in 2019 (ONS, 2021b).

2.2.1 Local delays, global consequences

Longer processing times across British ports but also at facilities across the rest of Europe and North America have led to a global shortage in shipping containers (Drewry, 2021). Demand for containers has remained relatively constant in Asian markets, where, because of an earlier exit from the strictest forms of lockdowns and coronavirus preventative measures, delays at ports and processing centres have been less problematic (Hillebrand, 2021).

However, within the UK context, which has since returned to full lockdown measures twice since lifting the first in the summer of 2020, **processing times have nearly quadrupled**. In pre-pandemic times, a shipping container would spend around 2-3 days in processing before being loaded to an outgoing ship. Coronavirus related shutdowns as well as distancing measures and closures within freight processing centres have extended this period to up to two or even three weeks (Bloomberg, 2021).

This, in addition to Brexit related delays as the UK adjusts to its post-EU reality (Bloomberg, 2021) has led to an increased percentage of ships returning empty with containers still backlogged on the UK mainland. **The result is a massive increase in costs, with the price of a 40 square foot container rising from just over $1000 (USD)** before the start of the pandemic to over $5000 by January. The World Container Index began to rise in the early months of the pandemic before rising steeply in November 2020 when second and third waves of COVID-19 swept through much of Europe and the Americas. By March 2021, the price had begun to taper off but still sits at above $5000 on average per 40-square-foot container (Drewry, 2021). Prices on the Shanghai-Europe route had begun to dip back below $4000 per 40-square-foot container but shot back up in April 2021 due to rising infection rates through much of continental Europe and the temporary blockage of the Suez Canal by the Ever Given cargo vessel (UNCTAD, 2021).

This 400% increase in the price of containers is having a particularly significant impact on domestic retailers in the UK. Increased international shipping costs and delays mean a lower volume of goods is making it through international freight points of entry and then onto domestic shipping routes and what does make it through is costing retailers substantially more (Financial Times, 2021).

Rail freight encountered a different reality, especially within the UK. Stay-at-home orders led to massive drops in passenger rail traffic, providing an opportunity to increase rail freight trips. This was especially beneficial at the start of the pandemic, with freight companies DB Cargo and Transfea Logistics taking advantage and operating 72-hour rotational trips between major Spanish ports such as Murcia and Valencia to transport pandemic-related supplies including medical protective equipment (Global Railway Review, 2020). The shift to more rail-based freight on China-European routes could be a permanent one, with rail volume on the Yiwu-London and Yiwu-Madrid lines estimated to have grown by close to 94% compared to 2019 levels (Global Railway Review, 2020).

Slowdowns related to road freight were most visible to the public, not least during the temporary shutdown of the Dover-Calais crossing towards the end of 2020. The decision to shut the border completely was a result of the continued and exponential spread of a new variant of coronavirus throughout the United Kingdom, known as the “Kent” variant (officially known as Lineage B.1.1.7 or Variant of Concern 202012/01). While international travel has been at almost a complete standstill since the early phases of the pandemic, freight had not faced restrictions nearly as stringent as the temporary French-UK shutdown. The border was initially cut off for a period of 48 hours and by the time freight was allowed to move again upwards of 3,000 trucks had been stranded on either side (Bloomberg, 2020).

The repercussions of the border shutdown reverberated into the new year, with French-UK cargo prices rising by 44.7% into February (Bloomberg, 2021). Rejection rates, that is the rate at which freight is being rejected by carriers before even commencing a trip, peaked at an increase of close to 300% (France-UK) and 200% (Germany-UK) at the time of France’s shutdown of the Dover-Calais crossing in December. Both have slowly begun to taper off but remain much higher than pre-pandemic times (Bloomberg, 2021).

Perhaps most telling of the state of British freight are the monthly reports from the ONS. In the ONS' January report, it is evident that the sector has yet to fully recover from the tumultuous nature of 2020 and the debacle at the Dover-Calais crossing. **By the end of January 2021, total exports of goods (excluding precious metals) to EU states fell by 40.7% while imports also fell by 28.8% in the same timeframe** (ONS, 2021a). Total imports of goods (excluding precious metals) from non-EU states also fell by 12.7% while exports still managed to grow by 1.7% (ONS A, 2021). Since the ONS started recording such statistics on import/export trends in the UK on a monthly basis in 1997, these are the largest drops ever recorded within the span of a single month. The ONS report primarily attributes this to the impacts of the coronavirus measures, especially highlighting the third national lockdown that began in January and lasted until March (ONS A, 2021).

2.3 Concluding remarks on the impact of COVID-19 and Brexit

Departure from EU environmental law and policy is being treated by the UK government as an opportunity to place the UK as a world-leader in environmental standards. It is also evident that there is political and economic aspiration for the UK and the EU to have continued transport connectivity, and work towards a common goal of sustainable trade. **However, political and legal action taken by the UK thus far has not necessarily supported the sustainability rhetoric that has been advanced**. Additionally, more material impacts to the operations of the sector are being reported, with uncertainty, extra costs, and Brexit 'red tape' being key complications plaguing the sector in the first few months of 2021.

The COVID-19 pandemic has also brought its own additional complications to the freight sector. Increased processing times, and shortages of key freight material have increased the pressure on the sector. **These burdens have culminated in economic losses and have exacerbated occasional border closures, and they have highlighted the already existing inefficiency within freight operations.**

The COVID-19 pandemic has also triggered a global macroeconomic shock, which has heavily impacted the UK economy. Implementing a green economic recovery after COVID-19 is therefore a key policy driver for the UK Government; the Prime Minister has made a commitment to 'build back greener' (Department for Business, Energy & Industrial Strategy, 2020c). Political momentum from these unprecedented challenges must be utilised to implement sustainable and economically sound solutions.

In conclusion, **the freight industry is reeling from the impacts of COVID-19 and Brexit, which are, at times, indistinguishable from each other**. What is certain is that any route to sustainability within this sector must also consider other industry and governmental concerns that have been elucidated because of these circumstances, such as increased efficiency, connectivity, sustainable trade, and industrial innovation. This report aims to assess policy options that will encompass these concerns, while providing actionable and robust recommendations that will contribute to the attainment of net zero in the future of freight.

3

Methodology

3.1 Impact Assessment

This report draws on current academic papers, government reports and grey literature, as well as journalistic writing to make recommendations for the creation of a more sustainable UK freight industry. While the report's insights are valuable for a range of stakeholders interested in exploring pathways to a net zero future, the primary motivation for writing the report is to serve as a guideline for government policy advisors – as well as other Six Degrees consultants – who should use it as a concise but rigorous summary of recent thinking and as a source of future policy ideas.

Central to this report is the concept of sustainability, which underpins both policy selection and analysis. Incorporating the SDGs into the methodology of this report grounds the policy recommendations in this broader, internationally recognised path towards sustainability. Furthermore, doing so aligns recommendations with humanitarian objectives, including improving wealth inequality and public health, whilst producing a concise Impact Assessment. Therefore, our suggested policies are analysed with reference to priority and secondary SDGs, as illustrated in **Figure 1.**

The priority SDGs are: **9. Industry, Innovation and Infrastructure, 11. Sustainable Cities and Communities, and 13. Climate Action**, due to their relevance to the research focus of this report. The secondary SDGs are 3. Good Health and Well-being, and 8. Decent Work and Economic Growth. By framing our analysis within the identified SDGs, the ex ante Impact Assessment (IA) stays focused in pursuing our definition of sustainability (see Figure 1 below). While not all among Six Degrees' focus SDGs, the SDGs highlighted in this report directly apply to the freight sector and research question.

This report employs an ex ante Impact Assessment (IA). This type of analysis focuses on the impact of a new policy or intervention in order to inform future policy making (OECD, no date). It divides the impacts into three categories: equity, effectiveness, and efficiency. An ex ante Impact Assessment is beneficial because quantitative, qualitative and comparative analyses can be examined within its framework. In the following chapter, each proposed policy is assessed according to the three criteria outlined below (equity, effectiveness and efficiency); however, **the order in which they appear depends on their relevance to the policy in question.**

There are multiple further benefits to conducting an ex ante Impact Assessment. As the authors of this report have varied skill sets and come from a range of academic disciplines, the use of an IA based on the three criteria outlined below allows for the incorporation of perspectives from each of these. **The breadth of focus facilitated by this methodology thus increases the value of the report by increasing the scope of the recommendations produced** (as they are not limited solely to economic, political or societal concerns). An ex ante approach to an IA assesses potential impacts prior to policy implementation ensuring that this report will be a valuable resource to policymakers.

In this approach, potential issues are highlighted in advance and can be addressed before they have any negative consequences, as opposed to simply conducting an IA *post hoc*. The foresight incorporated into this methodology thus ensures that the majority of stakeholders will face no negative repercussions should the policies be implemented. Furthermore, this methodology ensures that the beneficiaries of the policy recommendations range from local communities to the UK government. The purpose of this analytical tool is to include as many facets and perspectives as possible to allow for the most informed decision making.

For the purposes of this IA the authors have defined equity, effectiveness and efficiency in the following ways:

- **Equity** = A measure of the positive or negative impacts which could be felt by stakeholders after the implementation of a policy.

- **Effectiveness** = A measure of how much progress each policy will allow the UK to make towards the SDGs and net zero by 2050, given the contexts of Brexit and COVID-19.

- **Efficiency** = A measure of the cost vs benefits of each policy. Does this policy incur minimum costs for significant benefits?

This work represents an analysis of the best data available to the authors at the time of writing. During the research process, the authors encountered some key issues. Firstly, the continuously evolving nature of both the COVID-19 pandemic and negotiations of new trade deals and policies in light of Brexit made staying up to date with the latest information challenging. This led to some concerns regarding continued relevance of the Brexit and COVID-19 sections of this report. Where their impacts are more predictable, they are highlighted within the IAs. Secondly, despite reaching out to a number of industry experts, the authors encountered significant challenges gaining first-hand industry expertise to inform this report. The authors would, however, like to thank Jason Pesek of KeepTruckin for his time and input. This report would have been strengthened by further industry insight, which will likely be more available to future researchers after the COVID-19 pandemic ends and workplaces are no longer disrupted.

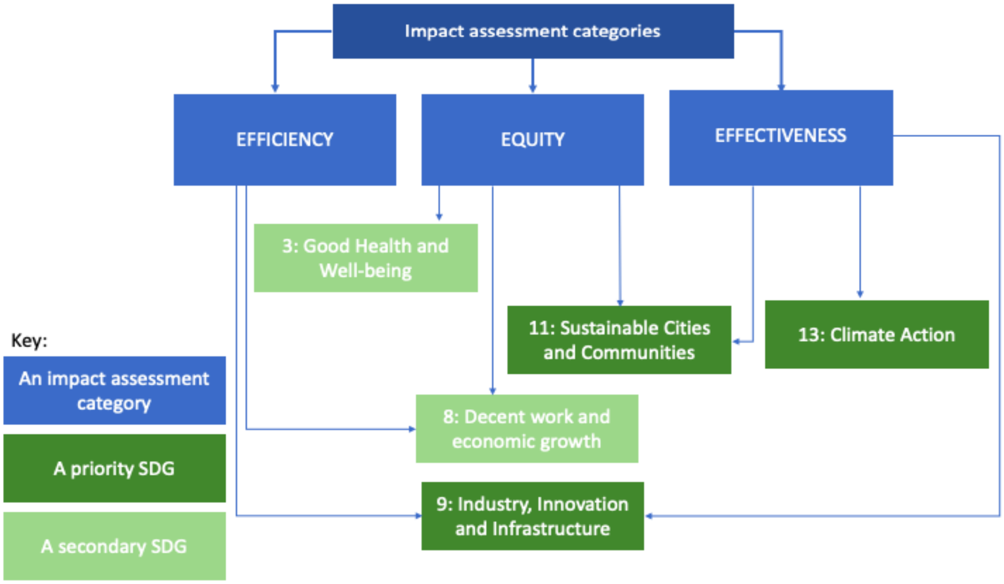

Figure 1: Flowchart illustrating how each impact assessment category is related to the SDGs

3.2 Framework for prioritisation

Of the SDGs considered, **Climate Action represents the most pressing sustainability issue for the freight sector** as part of the wider economy and existing net-zero commitments. Therefore, the authors selected policies based on their ability to align the freight industry with the UK's target of net zero emissions by 2050. Considering that many sectors such as agriculture and aviation will be much more challenging to decarbonise, this likely means the real target is a **complete elimination of freight emissions.**

In order to prioritise areas where impact will be maximal, the emissions from freight can be broken down into five main factors (McKinnon, 2007):

1. **Tonnes freight** - how much freight needs to be transported to and around the UK, measured in tonnes.

2. **Distance** - the distance freight is hauled from its source to destination, measured in km.

3. **Loading** - the amount (in tonnes) of freight hauled by each freight vehicle.

4. **Efficiency** - how much energy is consumed by each freight vehicle per kilometre travelled.

5. **CO2 intensity** - the carbon emissions per unit of energy consumed.

A first approximation of the total carbon emissions from UK freight could be made by combining the averages of these factors as follows.

CO2 emissions = tonnes freight x (distance / loading) x efficiency x CO2 intensity

It should be noted that this equation is a simplification. There are many interdependencies between the various factors, for example, how heavily an HGV is loaded will affect its energy efficiency. Additionally, this does not take into account any emissions associated with storage, construction and maintenance of vehicles and infrastructure. It is, however, a useful starting point to analyse the problem, as any policy that aims to reduce emissions must affect at least one of these factors in order to be successful.

The tonnes of freight transported to and around the UK is likely to remain stable, if not increase. As the movement of goods is essential to the majority of UK livelihoods and its economy, it is not feasible to suggest a policy on freight reduction.

The distance goods are moved is also difficult to constrain without putting limits on market freedom and international trade. Considering the UK's status as an island nation with a high population density, there is only a limited extent to which goods can be sourced locally. Within the UK, this factor has a particularly strong effect on vehicle load - taking the shortest possible route at all costs would decrease vehicle loads by requiring more use of smaller vehicles. Thus, this is not an appropriate target for policy either.

Efficiency measures include vehicle fuel efficiency, aerodynamics, efficient driving, and optimised logistics. These measures represent an opportunity for freight suppliers to reduce their costs in a competitive market, and therefore provide an ideal starting point to engage the industry in sustainability. Policy could help with this in two ways - by encouraging the uptake of technology to facilitate emissions data collection and by encouraging companies to communicate this data publicly, enabling consumers to apply pressure to reduce emissions. However, it has been estimated that efficiency improvements alone only have the potential to reduce carbon emissions by 20% by 2050 (Unterlohner, 2020). It is clear, therefore, that action is required elsewhere in the long term.

The loading of vehicles can be broken down further into two main components - vehicle size and loading factors. The loading factor is the average fraction of vehicle capacity that is utilised on each journey. As freight and logistics companies have a financial incentive to maximise their loading factor - thus limiting wasted journeys and increasing their efficiency - this is not an area where government intervention is likely to make a large impact. However, vehicle size depends on modal type, which in turn depends on national infrastructure such as the road and rail networks. This points to policies that make it possible to **shift freight from road to rail**, as this can decrease emissions in the medium term.

This leaves the final factor - the carbon emissions associated with fuel consumption. The majority of UK freight currently uses diesel as its main fuel, which has high carbon emissions. Diesel's popularity can be attributed to it being the most economic option, and the fuel source most commonly used in technology. To bring freight emissions to zero, a zero carbon energy such as renewable electricity must be adopted. This framework leads to three key policy areas. These areas range from policies with smaller impact but faster implementation times, to policies with higher impact that require longer implementation times:

- **Data availability** - using the latest technology and modern computing, the freight sector will make efficiency savings, which can be further driven through consumer pressure if emissions data is made available. This will contribute to emission savings in the short term while infrastructure projects are underway.

- **Modal shift** - changing the type of vehicles used will lead to substantial emissions reductions in the long term both by improving vehicle capacity for longer journeys (i.e. using railways) and by accelerating an energy transition (e.g. through cycle freight).

- **Electrification** - renewably sourced electricity will drive the freight sector's carbon footprint to zero by 2050 by eliminating the need to burn fossil fuels.

4

Impact Assessments and Analysis

4.1 Improve quality and availability of data on freight GHG emissions

The availability of complete and accurate information for goods traded is a fundamental prerequisite for the functioning of a market system. However, this is currently only available to a limited extent in the freight sector: the closest consumers can get to an evaluation of the freight GHG intensity of the products they buy is usually an origin label. More broadly, information in the public domain about emissions from the freight sector is confusing and ambiguous. Government departments have different ways of splitting up the economy into sectors and different definitions of what constitutes "UK emissions", which makes it arduous to find definitive and dependable data on the impact of the freight sector in isolation (ONS, 2020; BEIS, 2019; Brown et al., 2020; McKinnon and Piecyk, 2009). This lack of dependable and clear information may be contributing to a market that fails to properly represent the cost of excess GHG emissions, and it makes it more difficult for policymakers to identify where regulation is needed.

This policy proposal aims to address this problem. This report will first explore how freight GHG emissions data collection can be improved, and will then discuss how and to what extent this data can be made available to the public to better guide consumer and policy decisions.

4.1.1 Freight data collection

Current methods of data collection in freight

UK transport emissions data is generally obtained by taking some measure of activity (e.g. road or rail km, by vehicle and fuel type) and applying an appropriate emissions factor to that activity (Brown P. et al., 2020)[3]. For road traffic, the activity estimates are derived from surveys conducted by the Department for Transport (Brown et al., 2020). These surveys are conducted by counting traffic and, for HGVs, asking hauliers to provide details of trips made by a representative sample of HGVs (DfT, 2019a; DfT, 2019b; DfT, u.d.). For rail freight activity, data is obtained from the Office for Road and Rail (ORR), which monitors rail movements mainly through Network Rail's Track Access Billing System (Brown P. et al., 2020; ORR, 2021).

Insufficiencies of available data and possible improvements

The data collection method outlined above is meant to provide data for long-term monitoring of transport activity in the "big picture" and for submission under international agreements like the UNFCCC. But it lacks the resolution necessary to inform consumer decisions and policy specifically aimed at freight. The ONS only publishes emissions figures for all emissions by specialised transport and storage companies (that includes passenger traffic, but excludes some freight operations) (ONS, 2020), while BEIS also includes household car use in the 'transport' section of its UK GHG emissions releases (BEIS, 2019). DFT road traffic surveys are published at most quarterly, and emissions reports and inventories come out only annually. **To improve the resolution and usefulness of the data, it should be made mandatory for all freight companies to report their GHG emissions.**

For this, a phased approach is proposed:

- First, reporting should be implemented to relatively loose standards, letting operators choose how they calculate emissions

- After a set deadline and with government support for upgrading technology where necessary, emissions need to be calculated from fuel/electricity consumption and reported to a clear standard

3 This is, at least, the way emissions statistics are compiled for the legally binding (Climate Change Act, Kyoto Protocol, etc.) UK GHG inventory. It is assumed that publications by government departments like ONS or BEIS follow the methodology outlined here. Also note that this paragraph is a simplified depiction of the process.

- Reporting should require minimal effort and be possible by simply submitting a dataset to a web form

Impact Assessment - Freight GHG data collection

Effectiveness

Making freight companies report emissions does not lead to any emissions reductions in itself. Its effectiveness is indirect in multiple ways. Firstly, it will better inform government decisions regarding emissions reduction policies aimed specifically at freight. Having data for every single carrier would help in creating a "best practice", and create an accurate measure of the effectiveness of new technologies as they were implemented. Secondly, the data can act as an incentive to hauliers to decrease emissions: Companies with GHG emissions above the industry average are likely using more fuel (thus spending more money) than they need to. Lastly, if the data finds its way to consumers, their demand might help accelerate emissions reductions in the industry (this, however, is a complex issue - see proposal on consumer carbon labelling).

Necessary Technology

To improve on the current state of affairs and ensure the reporting is effective in driving emissions reductions, emissions should be calculated **based directly on fuel or electricity consumption** (not distance travelled) to avoid merely reproducing what is already known about the comparative efficiency of different modes.

The technology necessary for this is already in use. For the purpose of seeking out maximum cost efficiency, some freight companies are using fuel cards or telematics systems. Both fuel cards and telematics are capable of recording fuel consumption.

Fuel cards, in essence, are an agreement between a freight company and a particular petrol supplier that gives the haulier access to fuel at cheaper rates. Because all fuel costs are registered with the company using fuel cards, this automatically also works as a record of fuel consumption (FuelGenie, u.d.).

In the freight context, **'telematics' (telecommunications and informatics) is an umbrella term describing technology that allows various types of vehicle data to be collected and remotely monitored** (Austin-Beckett, 2018). This can include GPS for vehicle location monitoring and route planning, tachograph data required to comply with driving hours regulations, or data on engine use and fuel consumption for maintenance and cost saving purposes (Austin-Beckett, 2018; Driver and Vehicle Standards Agency, 2020).

The installation of fuel management systems will be necessary for reporting emissions based on fuel consumption, but its potential to enable fuel savings through a better understanding of fuel consumption would also offer a cost benefit to those hauliers that are not already using it.

Reporting Practice

To ensure that the reported data is useful and comparable between companies, **a clear standard on how reporting needs to be done is vital**. There are many standards and third party services available for emissions reporting - the GHG protocol, the Carbon Trust, or the Global Reporting Initiative (GRI) for example. These are all standards that freight companies can fall back on if they wish to report emissions globally as well as within the UK, for example with the Carbon Disclosure Project.

Most notable for UK emissions reporting however is the guidance that the UK government itself, along with private sector representatives, has already published for emissions reporting in the freight industry. The Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations offers concrete and actionable advice for companies wishing to report emissions and takes into account the fact that access to information (e.g. on fuel consumption) varies. **In the long term, the reporting standard should make it possible for freight companies to provide emissions figures for every order they fulfil so that information can be communicated to consumers without incurring large costs.**

Some larger freight and logistics companies like DHL and Kuehne + Nagel have already produced sustainability reports including information on GHG emissions from their operations. However, the transparency of these reports varies - DHL for example doesn't produce any 'hard numbers' on their emissions, just qualitative figures. Kuehne + Nagel followed GRI reporting standards and provided figures on carbon emissions multiple years back. Interestingly, Kuehne+Nagel also seems to offer disclosure of carbon emissions to customers on an order-basis, meaning that this is possible with current technology (Deutsche Post DHL, 2020; Kuehne and Nagel, 2020).

While some of these large companies may already be required to report emissions by virtue of being "quoted" companies (i.e. listed at an international stock exchange), these reports demonstrate that emissions reporting is feasible and may also be of use for company PR. However, they also highlight the need to have consistent standards if this were to become mandatory: different approaches to reporting make it impossible to compare DHL's emissions to Kuehne + Nagel's. In addition, the freight sector is largely made up of many small companies, meaning that a more 'blanket' reporting policy would still vastly increase the coverage of GHG reporting.

Efficiency

As identified earlier, the current circumstances of COVID and Brexit already make freight operations difficult, meaning that any such **policy needs to be designed such that it places a minimal additional burden on freight companies.**

Therefore, it is important to stress again that the fuel management systems necessary for this policy to work are already in use - however, not all companies have adopted them yet. Hale et al. (2018) found that while almost all hauliers surveyed use some form of digital data collection (almost all used tachograph software for compliance with driving hours regulations), only 5 of the 23 representatives surveyed reported using fuel management systems.

According to Jason Pesek, a product manager at KeepTruckin (a provider of fleet management solutions to freight companies), most large companies already have fuel management systems, since their larger consumption usually means that it is easier for them to get large discounts on fuel. They also typically seem to place greater importance on using marginal gains to be more competitive, while smaller hauliers tend to rely more on experience and what has worked well for them in the past. This can result in resistance to change from smaller companies, meaning that there would likely be pushback if this policy proposal were to be put into action. However, it can also be thought of as levelling out the playing field: companies that do not keep a close eye on their fuel consumption are at a disadvantage over the big players that do seek out maximum efficiency already (personal communication, April 23, 2021). Telematics systems can result in fuel cost savings of between 5 and 15%, particularly if paired with driver training (Energy Savings Trust, DfT, Fleetnews u.d.).

To minimise the time hauliers need to spend compiling reports, it is important that submission of data amounts to not much more than uploading a dataset formatted in a particular way (to be outlined by the reporting standard) to the website of the relevant authority in regular time intervals (e.g. monthly).

There will also be concerns from freight companies about disclosing data that is sensitive to their business. **This means that the reporting standard needs to strike a balance between providing good resolution (i.e. data available for each haulier, vehicle type, and in reasonably small time steps) without putting too specific information about orders into the public domain.**

To ensure that companies receive some benefit in exchange for their compliance, perhaps the website could provide statistics on the companies' performance against the industry average and a specific breakdown of where there is room for improvement (if and where the data allows pinning down which technologies and practices have led to improvements for others) every time a submission is made.

Equity

The previous sections have shown that collecting data can be beneficial to the companies themselves as well as better informing government and (potentially) consumer decisions. However, given that it will be predominantly the smaller companies that need to upgrade their infrastructure to comply, combined with the fact that those smaller companies are also less likely to have the administrative capacities necessary to deal with compiling reports, this policy bears the risk of threatening the operation of small hauliers. Therefore, it is important that the process is as simple as it can be (using information about the companies and their fleets that authorities already have). In addition, the exact requirements made by the reporting standard must be laid out well before their implementation to give companies ample time to prepare, and support on how to go about reporting and upgrading systems must be available.

In comparison to price-based efforts to address market failures (such as a carbon tax), this policy has the advantage of only pushing for adoption of technologies that are readily available instead of pricing the industry out of international competition, and it avoids issues such as double taxation where hauliers operate outside the UK as well.

In conclusion, **mandatory GHG emissions reporting can be a very useful tool to accelerate the adoption of already available emissions reduction practices and technologies**, provided a clear framework for reporting exists and emissions calculations are based on fuel consumption. **It is also an important prerequisite for functioning consumer carbon labelling**. Given the current situation, care must be taken to avoid overburdening freight companies, especially small hauliers.

Given that many freight operators don't have the necessary fuel management technology in place yet and many freight operators are under high pressure, this report proposes a **phased approach** to bringing in mandatory emissions reporting.

First, the framework for reporting emissions should be relatively loose and allow reporting to be done with basic methods such as reading distance travelled off the tachometer. This would not yet offer the precision required, but would force companies to put procedures for reporting into place without immediately creating pressure to upgrade to (potentially expensive) fuel management systems.

A deadline should be set by which all reporting needs to be based on fuel consumption. After this deadline, there should be clear standards for reporting. These standards need to be published well before the deadline in order to ensure that operators can prepare. A lot of the work necessary for such a standard is already done in The Chartered Institute of Logistics and Transport (UK) et al., u.d. Ideally, it would align with established standards such as the GHG Protocol or GRI such that companies can report internationally, e.g. to CDP. Before the deadline, government agencies should offer support to companies that need to upgrade their systems.

The reporting should be done using a simple, web-based solution requiring minimal time and effort. In the long term, this should also include a tool that allows hauliers to easily and effortlessly calculate the GHG impact of each order they fulfill to align this with effective carbon labelling.

This proposal is most closely related to SDGs 9 (Industry, Innovation, and Infrastructure) and 12 (Responsible Consumption and Production).

4.1.2 Carbon Labelling – a Consumer-Driven Instrument for a Low-Carbon Economy

Carbon labelling, as described by Upham et al. (2011), **is the practice of publicly communicating the greenhouse gas emissions associated with the life cycle of a product or service via a label**. The same study also identifies another form of carbon label that may communicate a more broad claim of emissions reduction. From an information economics perspective, the benefit of this practice is that, by enabling the consumer to make more informed purchasing decisions, labels can correct market failure and encourage increased sustainability in supply chains (Upham et al., 2011). Indeed, **consumer purchasing power is largely underutilised as a mechanism to drive decarbonisation of the economy, and the freight sector.**

Carbon labelling is already utilised within the UK; The Carbon Trust, an organisation established by the UK Government in 2001, is the leading label for product carbon foot-printing (Carbon Trust, n.d), and their 'Carbon Reduction Label' has also experienced global uptake (Langley et al., 2012).

Interest and investment in carbon labelling is growing generally as well; multinational consumer goods company Unilever has announced at the beginning of 2021 that they plan to communicate, via a label, the carbon footprint of every product that they sell (Unilever, 2021). Furthermore, the largest meat substitute company in the world, Quorn, started labelling their products with carbon footprint data in 2020 in partnership with the Carbon Trust (Montague, 2020). These developments show a trend of increased uptake of carbon labelling, yet carbon labelling still remains relatively limited.

Data availability and accessibility has been identified as an integral barrier to the implementation of carbon labelling in practice. A key example of this is the failed carbon labelling initiative of UK supermarket Tesco PLC that ran from 2007 to 2012 (Wired, 2020). Tesco's cited reasons for ending this initiative included that calculating carbon footprints for consumer products was too complicated, and that asking for the data for even one product's footprint was a 'huge task' (Franklin-Wallis, 2020).

The efficacy of a carbon labelling scheme also depends on the level of consumer engagement. A 2011 UK study found that environmental objectives are only a high priority for a small minority of consumers and consumer behaviour can therefore not be relied upon to achieve the level of change required (Upham et al., 2011). Since that study, consumer behaviour and intention has evolved to encompass sustainability as a more significant concern, which has been expedited because of the impacts of the COVID-19 pandemic. Research conducted by the Ethical Consumer Research Association and the Co-op in 2020 found that the COVID-19 pandemic has indeed impacted consumer spending; consumers reported that they intend to shop even more ethically post-pandemic (Ethical Consumer, 2020).

This impact assessment finds that although the efficacy of carbon labelling schemes has been frequently debated (Liu et al., 2016) due to implementation barriers and complexities, **it is undeniably a legitimate economic instrument that has the potential to harness consumer power and utilise innovative technologies**. A carbon labelling scheme could indeed facilitate the UK's move towards a zero-carbon economy, and influence the freight sector to become more sustainable. This change can be driven by consumer interest in consuming sustainably and ethically, which has increased over recent years and been bolstered by the COVID-19 pandemic. The IA conducted below results in the following key recommendations.

Recommendations

- **Data collection** is the first step. Requiring mandatory freight emissions is a primary concern considering that freight transport will contribute heavily to the end value on a carbon label. Facilitating this will also help to support consumer goods companies in keeping prices stable, as the financial investment required from these companies will be lower.

- The UK Government should ensure **collaboration with consumer goods companies** to avoid a negative reception of the policy.

- **A sector-by-sector phased approach is recommended, starting with the food and drink sector**. Doing so lessens the potential of unfair competition practices within the economy.

- Finally, the UK Government should employ **a standardised and UK economy-wide carbon label** to ensure consumer understanding and engagement.

Impact Assessment - Carbon Labelling

Efficiency

Carbon labelling is an extremely complex exercise that requires cooperation and collaboration between many actors. A carbon label on a consumer product typically contains a value that relates to the entire life cycle of that product. This is known as 'Cradle-to-Grave' or 'Business-to-Consumer' (Carbon Trust, no date; p. 7).

Figure 2: The Carbon Trust 'Cradle-to-Grave' graphic (Carbon Trust, no date; p. 7)

Due to the data collection, interpretation and communication that must happen to produce a carbon label for a consumer product, there are significant costs that are associated with carbon labelling schemes. They hold significant financial risks for companies, and the timeline necessary can lead to competition issues, as well as inefficient roll-out.

Financial risks for industry

For a carbon labelling scheme to be successful, consumer goods companies, and their supply chains (including freight companies), need to be willing to invest financial resources into conducting complex life cycle analysis. They also take on the risk of their products' carbon footprints causing a decrease in sales (François-Lecompte et al., 2017, p. 690). The potential benefits available to the supply side of the market may not outweigh the risks attached for more carbon intensive companies. Some companies would suffer financially from a carbon labelling scheme, and thus the scheme should be expected to be faced with some initial push back from less sustainable companies.

This is however a necessary intervention, so that companies are incentivised to change their processes and promote sustainability within their supply chains. The French Government attempted to roll-out mandatory 'Generalised Environmental Labelling' in 2016, but public authorities decided instead on a supervised, voluntary rollout because of the negative reactions of established stakeholders (François-Lecompte et al., 2017, p.688). The UK Government must learn from this experience and collaborate with consumer goods companies and their supply chains to ensure that a carbon labelling scheme is well-received and that companies are financially invested. **Clear communication and cooperation with stakeholders is integral to the efficiency of a carbon labelling scheme**. If the support is lost from industry itself, the costs incurred by the UK Government would likely be high.

Time and competition issues

The time frame for an economy-wide carbon labelling scheme to be rolled out is difficult to estimate. Data collection is ultimately the first step, and as elucidated in the previous section, data quality and availability is still lacking. To understand and interpret data to produce a carbon label is another operation in itself. These processes take long periods of time for individual companies. Oatly, a plant-based milk brand, began analysing the life cycle of its products in 2013 yet were unable to include carbon footprint information on labels until 2018 (Kateman, 2020). Similarly, Quorn has worked with the Carbon Trust since 2012 to analyse the emissions of its operations (Kateman, 2020), yet carbon labels were not published until 2020.

The potentially very extended timeline for an economy-wide carbon labelling scheme is therefore a concern, especially given that companies have different resources and vary in their pre-existing commitment to sustainability. Disjointed implementation of carbon labelling schemes may put some retailers in the situation that sales of labelled products are boosted at the expense of non-labelled products (Gadema et al., 2011, p. 821). Genuine emissions comparisons could therefore not take place if widespread adoption of carbon labelling within different sectors happened on different time scales. An implementation period within any sector would be necessary. While a sudden and complete switch by all competitors to ensure an entirely level playing field would be unlikely, the impacts of a long implementation period could be minimised if the roll-out of a carbon labelling scheme was conducted sector-by-sector.

The UK Government should therefore employ a phased roll-out. This roll-out should start with the food and beverage industry in order to have the greatest efficiency and thus greatest impact on the reduction of GHG emissions. This sector would be appropriate for first intervention, as research shows that consumer engagement is necessary to change the environmental impacts of the food sector (Poore et al., 2018).

Effectiveness

Consumer uptake for maximum reduction of emissions

The critical issue with carbon labelling is that the level of consumer engagement needs to be high enough for the scheme to have the intended effect of incentivising a move to low-carbon supply chains. Previously, it has been found that consumers desire to be able to make choices around the carbon credentials of products, but do not feel empowered to do so (Gadema et al., 2011). A carbon label is confusing to consumers for two primary reasons. First of all, individuals find difficulty in conceiving a gas in terms of its mass; and numerical values are difficult to engage with meaningfully (Upham et al., 2011). Secondly, consumers find it difficult to contextualise the information if they are unable to compare the value to something else (Upham et al., 2011). A carbon label is most effective when it is simple to understand, and should include reference values that permit comparisons and put information into context.

The form that a carbon label takes is therefore integral to consumer acceptance and use. A 2011 study showed that UK consumers were more receptive to a claim from a company that they are actively reducing emissions, rather than values of emissions attached to a singular product (Upham et al., 2011). The issue with such promises is that they negate the ability of a consumer to actively pick a product that is lower in GHG emissions and influence the market. To improve consumer comprehension, the UK Government should design a label that could be used on every consumer product to communicate carbon information, and allows consumers to contextualise the numerical values given.

A 'reducing emissions' label could perhaps be an interim measure for sectors that have not yet engaged with mandatory carbon labelling. The Carbon Trust's 'reducing emissions' label is awarded to products that have a carbon footprint that is reducing year-on-year, and the company has committed to ongoing footprint reductions (Carbon Trust, n.d).

Equity

Consumers – food prices

A way in which consumers could be negatively affected by carbon labelling is through the increase of end point consumer prices, particularly food prices. As previously explained, for a carbon labelling scheme to have the desired effect, consumer uptake needs to be high enough to lead to an influence on supply chains. Purchasing patterns can be influenced by carbon labels (Vanclay et al., 2011), but ultimately price and carbon concerns need to coincide. Some research suggests that only 'highly educated, well-paid' people would engage with these schemes purposefully and regularly, when in reality most people consider cost, convenience, and accessibility before they consider environmental impacts (Shuai et al., 2014). Thus, if food prices rise as a result of carbon labelling, the level of engagement required for the desired efficacy of a carbon labelling scheme would not be reached.

Shuai et al (2014) concludes that retail prices of low-carbon products with carbon labels are higher than conventional products due to the 'additional costs of low-carbon certification and technologies'. In contrast to this, research conducted in 2012 concludes that end point consumer price on products with carbon labels would not be significantly affected (Kortelainen et al., 2012). Requiring mandatory reporting from actors within the supply chain would ensure that companies are not investing large amounts of money acquiring data from supply chains and subsidising this within their end-point consumer price.

In conclusion, if the UK Government intends for decarbonisation in the freight industry to be industry and consumer led, carbon labelling should be implemented. Indeed, this report finds that a carbon labelling scheme can serve as a market intervention that facilitates the shift to a net zero economy in the UK. In the roll-out of a carbon labelling scheme, the UK Government must ensure that the concerns of stakeholders are addressed throughout implementation, so that the ultimate goal of sustainability in the freight industry is achieved. Furthermore, effectuating a carbon labelling scheme would help the UK Government to adhere to their commitments to SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption), due to this policy being innovative in its nature as it harnesses the previously underutilised power of ethical consumer choice.

4.2 Modal Shift

The term 'modal shift' refers to the process of "reducing the amount of transport carried out by carbon-intensive modes, especially road, and substituting the movements with transport by less carbon-intensive methods, typically inland waterway, coastal shipping or rail" (Sanchez Rodrigues et al., 2015, p.42).

HGVs produce 17% of road GHG emissions, despite constituting just 5% of road-based vehicles (Department for Transport, 2017). While the eventual electrification of the freight industry (see Chapter 4.3) will reduce and potentially eliminate the resultant carbon emissions, this report suggests the short and medium term solution of a road to rail or cycle freight modal shift. This shift would be supported by expanding Ultra Low Emission Zones (ULEZs) in urban areas such as the pre-existing ULEZ in London, which implements a daily charge on vehicles that do not meet the emissions standards (Transport for London, 2021).

Recommendations

- The UK government should subsidise the purchase of cargo bikes to encourage the uptake of cycle freight for urban 'last mile' journeys.
- The UK government/local authorities should introduce ULEZs to urban areas in the UK to further encourage the uptake of cycle freight and minimise the negative health impacts of carbon-based transportation.

- The UK government should encourage a modal shift from road to rail in order to reduce carbon intensity, which could be facilitated through increased taxation of HGVs or banning the use of road freight where there are viable rail alternatives.

4.2.1 Modal Shift to Cycle Freight

Cycle freight is an efficient and sustainable alternative to LGVs in urban areas. The health benefits of this form of modal shift include a reduction in emissions and improved air quality in already heavily-polluted urban areas, an increase in active travel, a reduction in noise pollution and reduced road congestion. Furthermore, commercial benefits include **more reliable freight journey times and reduced costs for companies** (Element Energy/Transport for London, 2018). For the purposes of this report "cycle freight" is defined as "the use of human-powered or electrically-assisted standard bicycles, cargo bikes and cargo tricycles for the transport of goods between A and B, primarily in urban areas" (Schliwa et al., 2015, p.52). Cycle freight is only practicable in urban environments and for last mile journeys, therefore the following analysis will exclusively assess cycle freight in an urban context.

Impact Assessment - Modal Shift to Cycle Freight

Equity

1. Local Community

This report defines the local community as those who live in the geographical area where policies will be introduced and will therefore be affected by their impacts. A salient issue for local community members is the health impacts arising from congestion in urban centres. Cycle freight provides an effective solution to address the equity concerns of urban neighbourhoods by removing HGVs and LGVs from the road and reducing congestion as well as air and noise pollution levels.

Despite marked improvements since 2016, in London "tens of thousands still live in areas with illegally polluted air and 99% of London still exceeds WHO limits" (Mayor of London, 2020). Due to the severity of the issue, it was highlighted by the Mayor of London, Sadiq Khan, as a central focus of his successful campaign for re-election (Khan, 2021). Air pollution also gained media attention with the landmark decision by the Southwark Coroner's Court ruling, in December 2020, that the death of nine-year-old Ella Adoo-Kissi-Debrah in 2013 was directly related to the level of air pollution near her home in Lewisham, London. Here, levels of NOx exceeded WHO and EU safety guidelines (BBC, 2020).

Adoo-Kissi-Debrah's death highlights that the issue of health impacts related to congestion is socially differentiated: socio-economically disadvantaged people are statistically more likely to live near busy roads and thus suffer the negative health consequences of congestion (Transport for London, 2014). In the wake of campaigning, Londoners are increasingly aware of the negative impacts of congestion on their health, with **54% of a London sample group agreeing that pollution from congestion has affected their health** (London Assembly, 2017; p.18).

The adoption of cycle freight is part of the solution to improving air quality. According to Element Energy/Transport for London (2018), for every LGV in London replaced by cycle freight over 3 kilograms of NOx per year is saved (Element Energy/Transport for London, 2018). Long term exposure to atmospheric NOx is associated "with respiratory and cardiovascular mortality, children's respiratory symptoms and [poor] lung function" (COMEAP, 2015: 4). Therefore, a policy that encourages cycle freight will address local community equity concerns and improve health outcomes for many of the UK's poorest urban communities.

Local community members are also concerned with how congestion impacts upon their lives beyond air pollution. According to a poll conducted by the London Assembly Transport Committee, 80% of Londoners feel frustrated by levels of congestion (London Assembly, 2017). In the same year, **London motorists spent an average of 74 hours waiting in traffic due to congestion** (BBC, 2018). Reducing congestion reduces noise pollution in urban environments, which is linked to cardiovascular disease and sleep disruption (Transport for London, 2014). Furthermore, congestion has a significant economic impact. Schliwa et al. (2015) states that "[e]very year the European economy loses approximately 1% of Gross Domestic Product (GDP) due to congestion" (p.50). A report commissioned by Transport for London suggests that cycle freight is able to effectively address these concerns:

"Replacing vans with cycles reduces the number of vans and HGVs on London's streets and can help to address congestion; particularly where cycles can use alternative routes such as cycle lanes and restricted access roads." (Element Energy, 2018; p.5)

Therefore, the issue of congestion is multifaceted and affects multiple stakeholders, including local government, as the concerns of local politicians as a stakeholder in this policy should reflect those of the local communities which they represent. This broad appeal should make the policy of increasing cycle freight attractive to local politicians as it has the potential to benefit diverse groups.

2. Employees of private companies

While with regards to pollution levels cycle freight represents a positive solution to equity concerns in urban UK environments, there are significant equity concerns surrounding the employees of private cycle freight companies and the gig economy as a whole,such as Uber Eats and Deliveroo. Such companies have been accused of "abusive practices" by the EU due to unreliable salaries and 0-hour contracts (BBC, 2019, n.p.). On the other hand, cycle freight employees report higher life satisfaction since moving from driving roles to cycling roles (Element Energy/Transport for London, 2018). Safety of cycle freight employees is a further equity concern, however the consensus in academic literature is that the health benefits of cycling far outweigh the dangers of traffic (Pucher et al., 2012).

Efficiency

In order for cycle freight to be a viable alternative to HGV and LGV last mile deliveries, infrastructural development is required. To ensure efficiency, it is essential that freight can be collected from accessible central depots in urban areas (Schliwa et al., 2015). Central depots or "Urban Consolidation Centres" have the potential to "both improve supply chain performance and reduce environmental and social impacts of freight transport activity" (Allen et al., 2012, p. 486). However, the financial burdens of developing and running such centres may fall disproportionately on local authorities and make them less viable. To avoid this, there needs to be a consolidated effort stemming from the higher levels of government so that more local levels are not left with an unmanageable level of responsibilities.

To achieve an efficient cycle freight system, journeys must attain a high level of route efficiency. This can be facilitated by the development of cycling infrastructure such as cycle lanes and restricted access routes, which allow cycle freight vehicles to navigate urban centres more efficiently by avoiding congestion (Element Energy/Transport for London, 2018). The result of this cycling infrastructure is that **journey time can be reduced by between 25 and 50% compared to journeys made by LGVs** (Element Energy/Transport for London, 2018).

The potential for these gains in time efficiency is increasing with the expansion of the UK cycle network, an example of which is the expansion of the Mini-Hollands Scheme in London. Representing a financial investment of approximately £100 million, this scheme is intended to facilitate the transition of three outer London boroughs into "cycling hubs" by making junctions safer for cyclists, increasing the number of cycle lanes and by implementing traffic calming measures (Greater London Authority, 2021). Rather than viewing traffic calming measures as obstacles to an efficient freight system, the freight industry should capitalise on these government investments in cycling infrastructure to deliver a time efficient cycle freight system for last mile deliveries, particularly in urban areas such as London where cycling is expanding.

	Cargo bike		Cargo trike	Van
	non-EAPC[a]	EAPC	EAPC	Small van
Vehicle load capacity	100 kg		300 kg	600 kg
Vehicle cost	£1,900	£4,100	£7,500	£2,600 p.a.[b]
Annual running costs	£295	£305	£328	£5,930
Fuel cost[c]	£0	£11	£33	£680
Vehicle excise duty	£0	£0	£0	£150
Insurance	£135	£135	£135	£800
Servicing	£160	£160	£160	£270
Congestion charge	£0	£0	£0	£2,530
Parking penalty charges	£0	£0	£0	£1,500[d]

Figure 3 (Element Energy/Transport for London, 2018; p.16)

Finally, the cost to private companies of operating a cycle freight fleet is significantly lower than operating a traditional motorised vehicle fleet. In their review of cycle freight, Element Energy/Transport for London (2018) produced a comparison of costs and capacities between diesel vans and cargo cycles, including Electrically Assisted Pedal Cycles (EAPCs) (see Fig.3). From this comparison, it is clear that, despite relatively steep upfront investments in cycles, the annual running cost of any cargo bike or cargo trike is less than 10% of that of a diesel powered van. Therefore, it can be concluded that cycle freight displays a great level of potential to be cost-efficient for private freight companies compared to current road freight options.

Dynamic Parcel Distribution (DPD) delivers 375 million parcels annually and has recently investigated the adoption of cycle freight due to its pledge to deliver "every parcel for all shippers in a carbon-neutral manner - at no additional cost to customers" (Zeh, 2019, n.p.). During a 2011 trial in Hamburg, Germany, DPD introduced cargo tricycles into their delivery fleet. They concluded that where there was a high spatial drop-off density, cycling was more cost effective. They also noted wide acceptance of the modal shift from customers and delivery drivers alike (Hülsbusch, 2012). This case study proves that cycle freight can be financially efficient in practice.

Effectiveness

The effectiveness of cycle freight in addressing public health (as outlined in the equity analysis) is of great significance as it represents further progress towards achieving SDGs 3 and 11. Cycle freight offers a clear and meaningful reduction of carbon emissions with minimal electric energy required to charge EAPCs. A freight company in London, Gnewt Cargo, found that by incorporating cargo cycle and electric delivery vans into their delivery fleet, they reduced carbon emissions by 62% and decreased average mileage by 52% through increased route efficiency (Lenz and Rhiele, 2013). Furthermore, examples show that each LGV that is replaced by a cargo bike saves over 1 tonne of $CO2$ annually (Element Energy/Transport for London, 2018). Modal shift to cycle freight therefore represents a significant step towards a zero carbon freight system.

As previously stated, cycle freight is especially viable for last leg journeys and urban freight. The increased time efficiency which is possible through cycle freight is restricted to journeys of less than 10km (Lenz and Rhiele, 2013). **Across Europe, over 30% of freight journeys are under 5km** (Ibid, 2013): ultimately these are the journeys where cycle freight can be substituted.

There is a further psychological barrier to implementing cycle freight on a greater scale: there is a "lack of perception of cargo cycles as a suitable mode of transport and the consequent lack of acceptance by potential customers." (Lenz and Rhiele, 2013, p.44). Private freight companies, governmental bodies and urban planners need to shift their perception on cargo freight as a viable modal shift. Therefore, this report further **suggests a publicity campaign in order to exhibit the viability of cycle freight** by circulating this report to the private sector. There has been previous subsidisation of cargo bikes at a small scale (Department for London, 2018b) however, this policy recommendation suggests an increase in subsidies to make cycle feight a financially viable option for private freight companies.

In conclusion, the paramount criteria for cycle freight, due to the impact of air pollution on the lives of urban residents, is equity. This Impact Assessment also shows that cycle freight can be effective and efficient relating to SDGs 3 (Good Health and Wellbeing) and 11 (Sustainable Cities and Communities). Therefore, cycle freight represents a promising example of modal shift for urban areas.

4.2.2 Expansion of the ULEZ

The Ultra Low Emission Zone is an area in London in which any vehicle emitting particulate matter or NOx is charged a high fee on a daily basis (£12.50 for LGVs and £100 for HGVs) (Transport for London, 2021). The ULEZ boundary (figure 3) is due to expand in October 2021. This policy was implemented in 2019 as a response to poor air quality: it is estimated that in 2010, 9,400 premature deaths occurred due to the high concentrations of atmospheric PM and NOx (London Councils, 2018) and 2 million people live in areas where NOx concentrations exceeded legal levels (Brown, 2016). The scheme has reduced NOx concentrations within the ULEZ. On this evidence, similar schemes should therefore be introduced to other urban areas of the UK. This will encourage the uptake of modal shift to cycle freight and zero-emission vehicles whilst improving air quality.

Figure 4: Current boundary of the ULEZ in London (Transport for London, 2021)

Impact Assessment - Expansion of ULEZ

1. Local community

As discussed with regards to cycle freight, the health implications of air quality as a consequence of congestion are socially differentiated, with disadvantaged people more likely to be exposed to poor air quality. It would benefit all community members to reduce levels of atmospheric NOx and PM. Equally, congestion within the ULEZ would be greatly reduced which is a major source of frustration as outlined in section 5.2.2, in line with SDG 3. While concerns regarding the injustice of limiting motorised access to urban centres to those with newer – and thus more expensive – vehicles have been debated in the press (Lydall, 2019; Mason, 2019), it is clear that the improvements in air quality generated thus far by the ULEZ provide a significant benefit for the population.

2. Urban Planners

The implementation of ULEZs across the country would encourage urban planners to cater for active transport (cycling, walking etc.). Therefore, cycle freight can be more readily introduced as it has been proven that cycle friendly environments are a fundamental requirement for it to be effective (Element Energy/Transport for London, 2018).

Furthermore, local communities can benefit from infrastructural changes that cater to active transport due to increased safety and shortened travel times. For example, Transport for London has pledged to invest £5 million annually to the Health Street Activation Programme (2018), which aims to create a healthier and more sustainable city (Transport for London, 2018a). Furthermore, this has secondary positive impacts on the economy as it is estimated that £9.3 billion is lost to congestion in London annually (London Assembly, 2020).

3. Private Freight Companies

The financial implications of the ULEZ mean that last mile delivery services by carbon emitting LGVs are not financially viable. Therefore, such companies will have to invest in modal shifts to cycle, EAPCs or electrically-powered vehicles.

Efficiency

The implementation of this policy is part of a positive cycle: the money generated from the scheme gets reinvested into infrastructure which functions to improve air quality (Transport for London, 2021). Equally, journey time is minimised due to reduced congestion. Such a policy ultimately benefits the local community and residents' health. The primary costs of the ULEZ policy fall upon the private freight sector thus causing them to invest in sustainable modal shift. Private freight companies will then have to make an initial investment into modal shifts. However in the long-term, such companies will experience a reduction in running costs (see 4.2.1).

Effectiveness

It is important to identify where ULEZs would be most effective. The following UK cities all have PM concentrations that exceed the safe limit: Port Talbot, Stanford-le-Hope, Glasgow, London, Scrunthorpe, Leeds, Eastbourne, Nottingham, Southampton, Oxford, Stoke-on-Trent and Middlesbrough (Griffiths, 2017). These are the urban hubs where the implementation of the ULEZ would be most effective in regard to public health. The effectiveness of the policy is also dependent on there being sufficient, sustainable alternative transport methods such as public transport or bike rental schemes.

The ULEZ in London has reduced NOx concentration by 44% indicating the success of the policy (Transport for London, 2021). Equally, compliance rates have reached 80% suggesting an acceptance of the policy in London (ibid, 2021). However, individual areas in London still exceed legal levels of NOx, (Brown, 2016), suggesting that the results could be even better with stricter enforcement and an expansion of the ULEZ regulations.

Furthermore, most major cycle freight startups are located in London and are growing in size such as the 'Greenwich: Recharge Cycle Freight Project' and the 'City of London: Cargo Cycle Delivery Scheme' (Element Energy/Transport for London, 2018). Although causality can not yet be proven between the ULEZ and increased cycle freight, the Cycle Freight Study suggests that the ULEZ encourages such startups to prosper (Element Energy/Transport for London, 2018).

4.2.3 Modal Shift to Rail

Multiple studies carried out by various freight stakeholders have concluded that a transition from road freight to rail freight would have a significant impact on the carbon intensity of the UK freight sector. This impact is derived from the fact that **carbon emissions from rail freight are only 10% of the carbon emissions from road freight** on a tonnes per kilometre basis (Allan et al., 2016).

A government policy promoting the modal shift from road freight to rail freight has the potential to significantly reduce the carbon emissions of the UK freight sector. Addressing the present market paradigm, in which **environmental externalities are largely uncosted,** will be central to incentivising this shift in freight from the carbon-intensive road network to more sustainable rail infrastructure. An example of this type of incentivisation comes from a study, commissioned by the European Federation for Transport and Environment, of modal shift from passenger air travel to rail travel (Bleijenberg, 2020). One of Bleijenberg's (2020) key recommendations is the introduction of increased taxation of aviation to account for negative externalities arising from the air travel industry. This strategy for incentivisation could be adapted by the UK government to promote the transition towards rail freight, with a secondary benefit of incentivising the further reduction of carbon intensity within the road freight industry.

A more extreme example of a proposed policy to facilitate model shift is Executive Vice-President of the European Commision Frans Timmermans' call for a total ban on short haul flights (Noack, 2019). While such a bold policy would undoubtedly generate a backlash among the industry affected, this strategy could be adapted to the UK freight context so that, **where a rail alternative is available**, road freight journeys are banned. In the context of a post-Brexit Europe, a bold policy move such as this would allow the UK government **an opportunity to live up to its goal of using Brexit as an opportunity to create more progressive environmental regulations than those of the EU** (see Chapter 2).

These two pathways represent only two of the many legislative possibilities for promoting road to rail modal shift within UK freight. It is the responsibility of the UK government to determine which will be the most effective and realistic method for incentivising the greatly-needed shift from road to rail freight, which constitutes the main proposal of this subsection and the focus on the following ex ante Impact Assessment.

Impact Assessment - Modal Shift to Rail

Effectiveness

The emissions intensity of rail freight is markedly less than that of road freight, **hence a modal shift to rail freight can reduce carbon emissions "by an estimated 76% as each freight train removes the equivalent of 25-76 HGVs from the roads"** (Allan et al., 2016, p.3). Therefore, from an emissions intensity perspective, a modal shift to rail freight will be highly effective in advancing the UK's progress towards its carbon neutral ambition.

A study conducted in Finland shows the potential for carbon emissions savings which accompany a road to rail modal shift. In this example, the modal shift was facilitated through the construction of 'dry ports' (intermodal terminals which are connected to ports by railways) (Lättilä, Henttu and Hilmola, 2013). By connecting ports with dry ports via railway, the study concludes that per freight container, CO2 emissions can be reduced "by 32% to 45%" compared with road freight (Lättilä, Henttu and Hilmola, 2013, p.38). This success in carbon emissions reduction indicates the high level of success that pursuing a road to rail modal shift policy in the UK could have.

Finally, due to the private nature of the freight sector, the effectiveness of modal shift will only be ensured if private enterprises adopt these measures. The effectiveness of modal shift is, therefore, dependent on its attractiveness to private business. While adoption could be ensured through government policy, there is also an opportunity for freight companies to take a proactive approach to reducing the carbon intensity of freight and help them achieve non-financial business goals. **Modal shift to rail could become increasingly attractive to private business if the freight industry adopted a carbon labelling model,** as outlined in Chapter 4.1.2. Furthermore, a report by Allianz pro Schiene, Community of European Railway and Infrastructure Companies and The European Railway Industries (2008) found that companies which underwent a road to rail modal shift experienced significant benefits: not only was rail freight found to be cheaper than HGV freight and supportive of companies environmental aims, it was "easier to plan", "more reliable", and facilitated an "improved work flow [sic] in factories or depots when compared with other modes of freight" (p.6). These further benefits of modal shift will increase its uptake by private companies, thus increasing its effectiveness across the industry.

Efficiency

The **rail freight network in the UK is not currently operating at maximum capacity**, suggesting that there is **potential to increase the efficiency of rail freight without investing in the creation of new infrastructure** (Allan et al., 2016). This underutilisation is due in part to the closure of coal fired power stations in the UK, and the resulting rapid decline in demand for Electricity Supply Industry (ESI) coal haulage (Allan et al., 2016). Therefore, rail freight holds great potential for innovation to maximise the efficient use of this pre-existing network.

Rail freight is also extremely efficient in terms of fuel consumption as, "[o]n average a gallon of fuel will move a tonne of goods 246 miles on the railway, but only 88 miles by road" (Network Rail, 2013, p.2). Therefore, without any investment in new infrastructure or change in fuel, modal shift from road to rail can increase the overall fuel efficiency of the UK freight industry. The potential for an already fuel-efficient mode to become increasingly efficient through more extensive use of the pre-existing network bolsters the ability of a road to rail modal shift to achieve the aim of a net zero future.

To expand on this discussion of fuel efficiency, **higher oil prices do tend to disproportionately favour rail freight because fuel takes up a larger proportion of road costs** (Allen at al., 2016). Therefore, road freight is ultimately more sensitive to oil price fluctuations. Estimations range greatly, but it is predicted that our global oil reserve will have been fully depleted between 30-100 years (Bruckner et al., 2014). However, if all the world's oil supplies were to be burned, society would exceed the IPCC's carbon budget by 475 billion tonnes of carbon (Bruckner et al., 2014), which from an environmental perspective, is drastically unsustainable. Furthermore, relying on a mode of freight transport that is more sensitive to oil price fluctuations means that road freight is ultimately more vulnerable to geopolitical disruptions, such as the COVID-19 pandemic and Brexit. For example, Brent crude oil prices per barrel dropped from $70 in January 2020 to $9.12 on the 21st of April as a consequence of the COVID-19 pandemic (Hargreaves Lansdown, 2021). As this report shall explain in Chapter 4.3, electrification offers a long term solution to the inefficiencies of road freight. However, in the short and medium terms, relying on road freight – which remains heavily oil dependent and sensitive to price fluctuations – is environmentally and economically unsustainable. This, therefore, suggests a modal shift to rail freight will be more efficient from a financial and a carbon emissions perspective.

Equity

1. Geographic Limitations of Rail

The rail network is limited, especially in more rural settings within the UK where HGVs or smaller delivery vans are currently the only viable options for freight. The UK government has explored even using drones as a means to access hard to reach locations in the country, but use of this technology is still many years away (Campbell, 2020). **The goal here is not to limit the access to goods and freight to more rural regions within the UK, but to make use of the UK's extensive rail network to engage in a modal shift in regions where such a shift is possible**. Even in the event of a complete modal shift to rail, there would of course remain a necessary amount of HGVs or other smaller freight options in order to maintain the same amount of access across the country as today.

2. Reduced Congestion and Noise Pollution

One of the main benefits of a modal shift towards increased rail freight traffic for the general population would be reduced congestion on UK roads. On average, each train could potentially take up to 60 HGVs off the roads (RFG, 2021). **Because most railways are removed from residential areas, increased rail freight has the potential to reduce the number of HGVs from passing through suburbs and smaller urban areas,** further reducing noise pollution in those areas (Transport Scotland, 2017).

4.2.4 Impacts of COVID-19 and Brexit on Modal Shift

Through the ongoing impacts of the COVID-19 pandemic and the implementation of Brexit measures, all sectors have seen some form of major disruption or decrease in freight volume. **European rail freight saw a reported reduction of 20-30% in volume between March and June 2020** (IRJ, 2020).

However, rail still saw a slight resurgence during the pandemic in the European context, but especially in the UK. At the start of the pandemic, **decreased passenger traffic on domestic and European routes allowed for increased rail cargo traffic**, mostly used to transport medical equipment from the Spanish ports of Valencia and Murcia (Global Railway Review, 2021). By November, **rail freight had returned to 95% of its pre-COVID-19 capacity**, a much faster recovery than other means of freight transport in the UK (Network Rail, 2021). **Volume on rail freight routes from China to Europe increased by as much as 94% through 2020**, the reduction in human interaction compared to HGVs a welcomed benefit as COVID related restrictions have heavily impacted other freight sectors (Global Railway Review, 2021). Another example of this is the expanded use of rail freight routes between the ports of Felixstowe and Liverpool first put forward by the Mediterranean Shipping Company (MSC) in the summer of 2020 (Walton, 2020). Interest in rail freight has certainly increased: **MDS Transmodal pegs a 15.6% increase in capacity over the next seven years but a potential for an increase of up to 50%** (Network Rail, 2021).

However, as congestion from passenger traffic slowly returns to pre-pandemic levels with the easing of restrictions across the four nations, there is a level of uncertainty regarding what comes next. The public nature of railways but private nature of rail freight firms ultimately means that cooperation is needed to undergo any form of major expansion (Government Office for Science, 2019). **In a way, the pandemic has shone a light on the resilience of rail freight and it's potential to increase its capacity**, but if the UK were to fully undergo a shift towards increased rail freight, the interest and willingness of the private sector would need to be met with increased government attention and action.

4.3 Electrification of Road and Rail Freight

The bulk of carbon emissions from UK land freight originate from the burning of diesel by HGVs and trains. As diesel remains the only economic fuel for freight operators in a competitive market, this sector is currently seeing an increase in emissions while lighter vehicles are decarbonising. Without the urgent implementation of policies to address this issue, it will be impossible to achieve a zero emission freight sector.

There are technical difficulties in converting large, heavy vehicles to alternative fuels. Primarily, they require a high power output over long distances, which generally means their onboard energy supply must be large. **Storing a large amount of energy by battery is unfavourable because of their weight, while storing a large amount of energy by hydrogen is unfavourable due to its volume.**

The problem of energy storage, however, can be avoided almost entirely by **choosing a solution that continuously delivers energy to the vehicle**. While there are a variety of such mechanisms, the most technologically developed and cost efficient is an overhead electric cable. These are already commonplace in railways, trams and trolleybus systems around the world.

The UK government has so far been indecisive on this issue (Cebon, 2020c), partly due to debates over the use of hydrogen, which have been driven primarily by fossil fuel lobbyists - currently most hydrogen is extracted from natural gas (Heubl, 2021). While hydrogen is likely to play a role in powering future freight vehicles, this section will show that **large-scale electrification is the only policy that can reduce emissions fast enough to meet the UK's legal targets**. Additionally, **electrification will ensure that the UK continues to be technologically competitive with the EU and reduce the risk of additional trade barriers** with the continent.

Specifically, our research leads us to recommend the following actions:

- The UK Government **should publish a clear decarbonisation strategy for rail**, including plans for early contractor involvement in a ten year rolling program of electrification and the introduction of bimodal hydrogen trains. This will make it possible to meet the target of a decarbonised rail system by 2040 (2035 in Scotland).

- The UK Government **should make a clear commitment by the end of 2021 to adopting an Electric Road System** (ERS), to be implemented at scale by 2035 following a trial.

- The UK Government **should move the ban on new diesel HGVs sales forward to 2035 and publish a strategy for making alternative fuels a cheaper option** for freight providers by this point

4.3.1 The Electric Road System

An electric road system (ERS) - also termed *eHighway* or *electrified corridors* - refers to infrastructure which facilitates the **direct transmission of electric power to either the engine or onboard battery of a vehicle**. While this can be achieved through rails or induction through coils installed beneath the asphalt surface of a road, the simplest implementation is a *catenary system*.

A catenary system consists of overhead powerlines - meaning that no addition or alteration of the road itself is required. . To extract power, an electric vehicle is equipped with a *pantograph*, i.e. an antenna that automatically raises when overhead cables are detected.

ERS would make it possible for a vehicle with zero tailpipe emissions to travel the length of the UK without the need to refuel, recharge or swap batteries. It is also the most energy efficient solution to bulk road transport that has yet been proposed. The technology is already available, having been trialed in Germany and Sweden.

In May 2021, the UK government is closing a £10m competition for feasibility studies on zero emission road freight. While entries have been invited for multiple power-sources - including hydrogen powered HGVs -

this money should be allocated primarily on establishing a trial of ERS in the UK.

4.3.2 UK Rail Electrification

The UK is currently lagging behind the EU with respect to rail electrification. Around 60% of European track is electrified, whereas in Britain it is closer to 40% (RIA, 2019). This is despite the clear benefits of electric rail including zero tailpipe emissions, better energy efficiency, reduced noise pollution and reduced wear to rail infrastructure.

Reluctance to electrify can be attributed to poorly managed efforts in the past. For example, the Great Western Electrification Project (GWEP) set a poor example by massively exceeding both time and spending budgets (RIA, 2019). However, clear lessons have been learnt from this experience - an analysis by the Railway Industry Association has shown that setting up a long term rolling programme of electrification (as opposed to the current "feast and famine" approach), provides considerably better value for money (RIA, 2019).

However, some railways may be almost impossible to fit with electric power lines for practical reasons. Additionally, the long time scale for cost effective electrification will leave many lines untouched for a decade or more. It is thus recommended that the government invests in the development of hydrogen powered trains which can alternate between electrified track sections and self-powered sections.

4.3.3 The Importance of Renewable Electricity

It is vital to keep in mind that electricity must come from renewable sources in order for road freight to be truly zero emission. This issue has been considered in our recommendations in two ways. Firstly, this report acknowledges that the UK electricity mix is currently reliant on fossil fuels and will take some time to become 100% renewable. Secondly, it takes into consideration the additional demand for energy that will be placed on electricity generation by the decarbonisation of transport - the more energy that is required, the more difficult it will be to decarbonise the grid. Both of these reasons lead to a strong imperative for an energy efficient solution. Whichever route the UK takes to decarbonise freight, **it must be accompanied by accelerated efforts to create a green national grid**, in order to progress towards SDGs 11, 14, and 15.

In the following impact assessment it will be demonstrated that large scale electrification projects are more effective at reducing freight emissions than other proposed energy pathways; an efficient approach in economic terms; and can be implemented without great risk to equity.

Impact Assessment - Electrification

Effectiveness

Technological-neutrality on the part of the UK Government (NIC, 2019) has allowed space for a healthy debate on which fuel will power the UK to its net zero goals. Four main options for road freight decarbonisation have emerged:

- biofuel-powered vehicles;
- hydrogen-powered vehicles;
- battery electric vehicles (BEVs);
- and electric road systems (ERS).

Biofuels, combustible oils derived from crops - are considered a more sustainable alternative to diesel and are highly compatible with existing diesel infrastructure. The UK Government and EU both have goals in place to increase their use. However, **biofuel will not be scalable fast enough** to power the road freight industry due to the huge areas of land required to grow the fuel (ITF, 2018). Furthermore, it has been found that **converting to a biofuel economy would not get the UK to the Paris Agreement Goals** (ITF, 2018).

Hydrogen, unlike diesel and biofuel, produces no tailpipe emissions when it is burned. By contrast, hydrogen fuel-cells generate electricity by combining hydrogen with oxygen from the air, producing only water. Hydrogen can be produced via 'green' or 'blue' methods. In a green hydrogen scenario, electricity is used to separate hydrogen from water - essentially the reverse process of a hydrogen fuel cell. The alternative is blue hydrogen, which forms hydrogen from methane (natural gas) and steam; for this to be carbon neutral, the carbon dioxide generated in the process would need to be stored using Carbon Capture and Storage technology (CCS).

Research clearly shows that both methods are less energy efficient than electric powered vehicles. The production of hydrogen, its compression, and its storage all cause a portion of the raw energy to be wasted before it powers a vehicle. For comparison, 10 Gigajoules of grid electricity could drive a green hydrogen powered HGV 475 km, whereas an electric HGV could travel 1080 km using the same amount of energy (Haugen et al., 2021).

The result would be that significantly **more electricity would need to be generated if green hydrogen were chosen over electric vehicles.** This is infeasible using any known renewable technology - it would take 7.4% of the UK's land area covered in wind turbines to produce enough hydrogen to power HGVs alone (Cebon, 2020a), which would adversely impact on SDG 15, 'Life on Land', due to the destruction of natural ecosystems.

As for blue hydrogen, CCS is currently expensive and inefficient, meaning it cannot be expected to be carbon neutral if it were scaled up in the short term. In fact, projections show that a rapid conversion to hydrogen powered vehicles - considering the UK's current electricity production - would in fact increase carbon emissions compared to diesel (Johrens, 2020). Furthermore, the UK would risk its energy security by relying on natural gas imported from Russia (Ainalis, Thorne and Cebon, 2020).

This brings us to the final two options: BEVs and ERS. While BEVs cause no tailpipe emissions, they are limited primarily to smaller vehicles and shorter journeys due to other sustainability issues. Firstly, the weight of batteries required to power HGVs would cause excess road damage per tonne-km. Even more importantly, the batteries themselves require rare metals, and the requirements to power HGVs would exceed all known reserves (Low, 2020), as well as raising concerns about whether their production is in line with SDG 12, 'Responsible Consumption and Production'. By contrst, an ERS would reduce the fuel storage requirements of HGVs, instead using long-lasting infrastructure to deliver energy directly and efficiently from the national grid. Thus, it is clear that this proposal is highly related to SDG 9, 'Industry, Innovation, and Infrastructure'.

However, ERS will not cover 100% of the UK road system, meaning that all of the technologies discussed above will have their place in the future of British freight. Batteries, biofuels, and hydrogen will be required for HGVs to complete their journeys on smaller roads. The same is true for rail electrification, especially in the time-period when electrification is being rolled out, as only segments of networks would be electrified. Hybrid trains which will run on multiple power sources will therefore be required.

In summary, although a mixture of alternative fuels will be required for the UK freight sector to reach net zero, rail electrification and ERS deployment are the most effective solutions to deploy at scale, and should be prioritised in government policy.

Efficiency

An ERS could be implemented over a short enough time period to help avert the climate crisis, by covering 65% HGV-kms within 10 years (Ainalis, Thorne and Cebon, 2020). This is practical because of the UK's strategic road network. Most HGV mileage occurs on motorways, meaning the above figure could be achieved with only 6,500 lane-km of ERS construction. However, ERS installation will require temporary closures on major routes (Hill et al., 2020). While inconveniences may arise from road closures during trial and implementation stages, the government should not be put off making the necessary structural upgrades which will allow it to meet its climate change commitments in the long term, for fear of public annoyance. A best practice community engagement strategy should be followed to educate those living near to trial sites about why this work is so essential in combating climate change.

An ERS trial will inform the Government regarding legislation on HGV sizes and weights, in order to allow the industry to optimise vehicle characteristics to adapt to the new power mix as it comes into effect. Additionally, in order to ensure that the ERS is fully utilised and represents good value, it must be accompanied by legislation to ban the sale of diesel HGVs as soon as it is operational. Allowing time for a trial, this date can reasonably be expected to be by 2035.

Rail electrification must also be well planned in order to be time and skills efficient. The government should implement a rolling programme approach to rail electrification, as recommended by the Railway Industry Association, which evidence from Scotland and mainland Europe has shown to be more efficient (RIA, 2019). Furthermore, models to integrate contractors and service providers earlier in the planning and development process (Early Contractor Involvement) should be explored, simultaneously approaching electrification as a system-wide change embedded within the broader freight and energy infrastructure.

In terms of monetary cost, the deployment of an ERS is the "lowest cost zero-carbon option for all periods when considering both infrastructure and fuel costs" (Hill et al., 2020). Given that the technology employed is well-understood and ready for deployment, installing an ERS on 65% of UK highways would cost less than £20 billion (Ainalis, Thorne and Cebon, 2020). Estimates indicate that companies will recoup the cost of upgrading their fleet to ERS requirements within 15 years due to the continued saving from lower fuel costs, and the Government would be able to supplement its balance sheets via an electricity excise tax to partially replace lost fossil fuel tax incomes (Ainalis, Thorne and Cebon, 2020).

Rail electrification also boasts savings for operators and infrastructure managers. Electric trains are lighter, decreasing damage to the vehicles and infrastructure, whilst reportedly having lower operational costs than diesel counterparts (RIA, 2019).

Equity

Efficient electrification ensures that the transition to sustainable freight is equitable by minimising additional land use. In this respect there are serious issues with biofuel competing with human nutritional requirements. In a context where almost one billion people across the globe are hungry (FAO 2020) and SDG 2 (Zero Hunger) is far from being reached, this is an unjust use of diminishing productive land.

The benefits which local communities receive from a reduction in carbon and tailpipe emissions associated with electrification is discussed in other chapters. Any temporary discomfort of road or rail works or visual impacts of overhead cables on motorways will be cancelled by quieter vehicles (Cebon, 2020c). Trials will be valuable in understanding the impact of installation works and operation of ERS on road-users: congestion from road closures may offset emissions saved from the ERS system, whilst increasing time wasted in traffic and slowing the UK's progress towards SDG 11, 'Sustainable Cities and Communities'.

It is also clear that these large scale projects will generate employment opportunities which require skills relevant to the international push to implement SDGs, particularly SDGs 9 and 11, and may attract labour from the ailing fossil fuel industry. A ten-year rolling programme, as proposed here, will ensure that workers develop relevant skills to a high degree, and that this skill labour is retained in the UK market (RIA, 2019).

The UK Government need not be apprehensive of the loss of revenue from fossil fuel taxes, as the economic stimulus of such investment and the introduction of an electricity excise will outweigh the monetary costs of the projects. Furthermore, these policies allow the UK to situate itself as a leader in climate change response, whilst providing an opportunity to work with the EU on zero-emission technologies by engaging in necessary discussions on standardising freight technology and infrastructure across the two economic zones (Hill et al., 2020).

The short pay-back period for fleet adaptation to ERS infrastructure means that operators are unlikely to be negatively impacted in the short-, medium- or long-term, as an ERS system also provides an added benefit over battery powered vehicles as stops for recharging are not required, extending vehicle range.

However, one of the main challenges in terms of rail is the model which has dominated the industry for recent decades, whereby infrastructure overseers such as Network Rail must shoulder the costs of network upgrades, whilst the benefits are enjoyed by the operators. The relevant Government authorities should-consider alternatives to this which would allow the costs and benefits of electrification to be distributed more equitably between operators and infrastructure managers in order to ensure sustained progress towards SDG 11 (RIA, 2019).

To conclude, it has been demonstrated that of all the available options for the decarbonisation of long distance freight in the UK, **large scale electrification is the most viable because it is energy efficient, effective at reaching carbon neutrality, cost effective and the technology is currently available**. By continuing a program of rail electrification, the UK will ensure it keeps pace with continental Europe, decreasing the risk of trade barriers with the EU as it fulfils its own electrification plan. This scheme, along with the implementation of an ERS to power electric HGVs, **will create jobs that will be part of the country's post-COVID recovery.**

5

Conclusion and Recommendations

This report has taken a multidisciplinary approach to the study of the freight industry. Its aim has been to identify key policies which will allow the industry to make progress towards achieving net zero carbon by 2050 in the challenging contexts of Brexit and COVID-19.

Through the process of conducting an ex ante Impact Assessment for three broad policy suggestions (increasing data availability, modal shift, and electrification), this report has shown that there are multiple possible methods by which stakeholders in the sector can reduce the carbon intensity of freight. The authors assessed each policy recommendation against the criteria of efficiency, effectiveness and equity, in order to capture the needs of a wide range of stakeholders, whilst also aligning the recommendations with the UN SDGs (see Chapter 3.1).

The following recommendations are not intended to function as stand-alone solutions. Rather, in order for significant progress to be achieved, the recommendations suggested here should be taken as a mutually supportive suite of policies, rather than mutually exclusive individual recommendations.

Implications of COVID-19 and Brexit

In light of the ongoing effects of both the COVID-19 pandemic and the enforcement of post-Brexit trade regulations across the UK, it is important to recognise the unpredictable nature of freight as a whole, even as the industry slowly recovers.While instability will likely remain for the time being, COVID-19 and Brexit have shone a light on longstanding inefficiencies in the UK freight industry . In recognising this, the authors feel the recommendations proposed are capable of increasing efficiency across the freight sector whilst aiding in the UK's recovery from COVID-19 and Brexit.

Recommendations

The recommendations included at the end of each impact assessment are re-asserted here. While this research approach and these results take into account the needs of multiple different stakeholders, the majority of our recommendations are actions to be taken by the UK central government. **The authors hope this report and its recommendations are of value and relevance to researchers, policymakers, students, and other stakeholders at this turning point in climate policy.**

Policies Analysed	**Recommendations for Implementation**	**SDGs Addressed***
Mandatory **emissions reporting** for freight companies	• **Require mandatory freight emissions data collection and reporting**, first to a loose framework, and after a set deadline to clear standards and with emissions calculated based on fuel/electricity consumption. • Use the **data to better inform policy decisions, accelerate the uptake of best practices and technology for emissions reductions in the industry, and to facilitate precise consumer carbon labelling.**	**9**, **12**
Implementation of **consumer carbon labelling**	• **Collaborate with consumer goods companies in the implementation of carbon labelling** to ensure positive uptake of the scheme by producers and consumers. • Take a **sector-by-sector phased approach to implementing carbon labelling**, starting with the food and drink sector, to reduce the potential for unfair competition. • A **standardised and UK economy-wide carbon label** should be implemented to ensure consumer understanding and engagement.	9, **12**
Modal shift from road freight to rail and cycle.	• **Encourage the uptake of cycle freight** for urban 'last mile' journeys to encourage decarbonisation and improve public health. • **Encourage a modal shift** from road to rail in order to reduce carbon intensity over longer distances.	**3**, 8, **9**, **11**, 15
Expansion of the size and number of **Ultra Low Emission Zones** across the UK.	• **Introduce Ultra Low Emission Zones** (ULEZ) to urban areas in the UK to further encourage the uptake of cycle freight and minimise the negative health impacts of carbon-based transportation.	**3**, **9**, **11**
Implementation of an **Electric Road System** and move forward the ban on diesel vehicles.	• Make a clear commitment by the end of 2021 to **adopt an Electric Road System** (ERS) to be implemented at scale by 2035 following a trial. • **Move forward the ban on new diesel HGVs sales to 2035** and **publish a strategy for making alternative fuels a cheaper option** for freight providers.	2, 3, 8, **9**, 12, 15
Railway electrification	• **Publish a clear decarbonisation strategy for rail**, including plans for early contractor involvement in a ten year rolling program of electrification and the introduction of bimodal hydrogen trains.	8, **9**, 11

*SDGs 13, Climate Action, and 17, Partnership for the Goals, are central to all the policies treated here.
SDGs in bold are those which we consider central to each policy.

Ainalis, D. T., Thorne, C. and Cebon, D. (2020) White Paper Decarbonising the UK's Long-Haul Road Freight at Minimum Economic Cost. Centre for Sustainable Road Freight.

Allan, C. et al. (2016) Future Potential for Modal Shift in the UK Freight Market. Available at: https://www.arup.com/perspectives/publications/research/section/future-potential-for-modal-shift-in-the-uk-rail-freight-market (Accessed: 13 May 2021).

Allen, J. et al. (2012) 'The Role of Urban Consolidation Centres in Sustainable Freight Transport', Transport Reviews, 32(4), pp. 473–490.

Allianz pro Schiene, Community of European Railway and Infrastructure Companies, and The European Railway Industries (2008) From Truck to Train: Thirteen examples of successful modal shift in European freight transport. Available at: http://www.cer.be/sites/default/files/publication/080617_cer_pos-bsp_engl.pdf (Accessed 13 May 2021).

Austin-Beckett, S. (2018). 'What is Telematics?' Verizon Connect Available at: https://www.verizonconnect.com/uk/resources/article/what-is-telematics/ (Accessed: 17.04.2021)

BBC (2020) 'Ella Adoo-Kissi-Debrah: Air pollution a factor in girl's death, inquest finds', BBC News, 16 December. Available at: https://www.bbc.com/news/uk-england-london-55330945 (Accessed: 13 May 2021).

BBC (2019) 'EU law fixes minimum rights for "gig economy" workers', BBC News, 16 April. Available at: https://www.bbc.com/news/world-europe-47947220 (Accessed: 10 May 2021).

BBC (2018) UK rush hour drivers spend more than a day in traffic, BBC News. Available at: https://www.bbc.co.uk/news/uk-england-42917201 (Accessed: 13 May 2021).

Bleijenberg, A. (2020) Air2Rail: Reducing CO2 from intra-European aviation by a modal shift from air to rail. Available at: https://www.transportenvironment.org/sites/te/files/publications/2020_03_Air2Rail_Koios_strategy_rev.pdf (Accessed 13 May 2021).

Bloomberg; Burden, L. and Pogkas, D. (2021) 'U.K. Goods Trade Partially Rebounds From Initial Brexit Shock', Bloomberg.com. Available at: https://www.bloomberg.com/graphics/uk-trade-post-brexit-deal-eu/

Brown P et al. (2020). UK Greenhouse Gas Inventory, 1990 to 2018. Annual Report for Submission under the Framework Convention on Climate Change. Department for Business, Energy & Industrial Strategy. Available at:
https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2004231028_ukghgi-90-18_Main_v02-00.pdf (Accessed: 21.02.21)

Brown, Y. (2015) Impacts of London's ULEZ. Transport for London City Planning, p. 1-15.

Bruckner T., et al (2014) Energy Systems. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Burns, T. (2020) Transport in the UK will never be the same, it must be better. Available at: https://www.sustrans.org.uk/policy/life-after-lockdown/2020/briefing-paper/transport-in-the-uk-will-never-be-the-same-it-must-be-better/ (Accessed: 11 May 2021).

Campbell, P. (2020) Drone deliveries to rural areas on UK government's radar. Available at: https://www.ft.com/content/45563192-a388-4e67-825e-2b3d4009ef11 (Accessed: 30 April 2021).

Carbon Trust (no date). Product carbon footprint label. Available at: https://www.carbontrust.com/what-we-do/assurance-and-certification/product-carbon-footprint-label. (Accessed: 7 May 2021)

Carbon Trust (no date) Product Carbon Footprint Protocol. Available at: https://prod-drupal-files.storage.googleapis.com/documents/resource/public/product-carbon-footprint-certification-part-1.pdf. (Accessed: 13 May 2021)

Carney, M. (2020) The Reith Lectures 2020: How We Get What We Value. [Podcast]. 23 December 2020. Available at: https://www.bbc.co.uk/programmes/m000qkms (Accessed: 11 May 2021).

Cebon, D. (2018) 'Blog: Should lorries be powered by Hydrogen?', The Centre For Sustainable Road Freight, 25 June. Available at: http://www.csrf.ac.uk/2018/06/should-lorries-be-powered-by-hydrogen/ (Accessed: 28 April 2021).

Cebon, D. (2020a) 'Blog: Long-Haul Lorries Powered by Hydrogen or Electricity?', The Centre For Sustainable Road Freight, 9 February. Available at: http://www.csrf.ac.uk/2020/02/blog-long-haul-lorries-powered-by-hydrogen-or-electricity/ (Accessed: 28 April 2021).

Cebon, D. (2020b) 'Blog: Technologies for Large-Scale Electricity Storage', The Centre For Sustainable Road Freight, 8 November. Available at: http://www.csrf.ac.uk/2020/11/electricity-storage/ (Accessed: 28 April 2021).

Cebon, D. (2020c) 'Blog: Hydrogen or Electron Economy?', The Centre For Sustainable Road Freight, 31 December. Available at: http://www.csrf.ac.uk/2020/12/electricity-or-hydrogen-economy/
(Accessed: 28 April 2021).

Climate Change Act (2008). Parliament: House of Commons. Bill no. 27. London.

COMEAP (2015) Statement On The Evidence For The Effects of Nitrogen Dioxide on Health. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/411756/COMEAP_The_evidence_for_the_effects_of_nitrogen_dioxide.pdf (Accessed: 13 May 2021).

Daily Business Group (2021) Gove's office insists EU freight 'near normal'. Available at https://dailybusinessgroup.co.uk/2021/02/goves-office-insists-eu-freight-near-normal/. (Accessed: 12 May 2021)

DDC Freight Processing Operations (2021) Brand New Britain: What Post-Brexit Really Means for Businesses. Available at: https://www.ddcfpo.com/brexit-impact-report. (Accessed: 12 May 2021)

Department for Business, Energy, and Industrial Strategy (2019) 2018 UK greenhouse gas emissions, final figures (statistical release) Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf (Accessed: 19 February 2021)

Department for Business, Energy and Industrial Strategy (2020a). United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution. Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943618/uk-2030-ndc.pdf (Accessed: 15 February 2021)

Department for Business, Energy and Industrial Strategy (2020b). The Ten Point Plan for a Green Industrial Revolution. Building back better, supporting green jobs, and accelerating our path to net zero. Available at:
https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution (Accessed: 15 February 2021)

Department for Business, Energy & Industrial Strategy (2020c) New plans to make UK world leader in green energy. Available at: https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy. (Accessed: 13 May 2021)

Department for Environment, Food & Rural Affairs (2020) Environment Bill sets out vision for a greener future. Available at https://www.gov.uk/government/news/environment-bill-sets-out-vision-for-a-greener-future. (Accessed: 12 May 2021)

Department for Environment, Food & Rural Affairs (2021) Environment Bill – next steps. Available at https://deframedia.blog.gov.uk/2021/01/26/environment-bills-next-steps/. (Accessed: 12 May 2021)

Department for Transport (2016) Rail Freight Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/552492/rail-freight-strategy.pdf (Accessed 11th May 2021)

Department for Transport (2017) Freight Carbon Review. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/590922/freight-carbon-review-2017.pdf (Accessed 11th May 2021)

Department for Transport (2018a) The Road to Zero - Next steps towards cleaner road transport and delivering our Industrial Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf (Accessed: 5 April 2021)

Department for Transport (2018b) Funding boost for green last mile delivery bikes. Available at: https://www.gov.uk/government/news/funding-boost-for-green-last-mile-delivery-bikes (Accessed: 11 May 2021).

Department for Transport (2019a). TSGB 2019 Notes and Definitions: Freight. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/852327/freight-notes.pdf (Accessed: 21.04.2021)

Department for Transport (2019b). Road freight statistics - notes and definitions

Department for Transport (2020a) Decarbonising Transport. Setting the challenge. Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932122/decarbonising-transport-setting-the-challenge.pdf (Accessed: 15 February 2021)

Department for Transport (2020b) £2 billion package to create new era for cycling and walking. Available at: https://www.gov.uk/government/news/2-billion-package-to-create-new-era-for-cycling-and-walking (Accessed: 8 May 2021).

Department for Transport (unknown date) Road Traffic Estimates - Notes and Definitions. Available at: - Notes and Definitions. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/527807/road-traffic-notes-definitions.pdf (Accessed: 21.04.2021)

Deutsche Post DHL Group (2020). 2019 Sustainability Report

Discover DHL (2021): Introducing 5G and what it means for Logistics. Available at: https://www.dhl.com/discover/business/productivity/5g-and-logistics (Accessed: 17.04.2021)

Drewry (2020) 'Drewry highlights transformation of rate conditions in transpacific container shipping'. Drewry. Available at: https://www.

drewry.co.uk/news/news/drewry-highlights-transformation-of-rate-conditions--in-transpacific-container-shipping

Driver and Vehicle Standards Agency (DVSA) (2020). Drivers' hours and tachographs: Goods vehicles. Available at: https://www.gov.uk/guidance/drivers-hours-goods-vehicles (Accessed: 17.04.2021)

Element Energy/Transport for London (2018) Cycle Freight Study. Element Energy, p. 36. Available at: http://content.tfl.gov.uk/cycle-freight-study.pdf.

Energy Savings Trust, Department for Transport and Fleetnews (unknown date). A Guide to Telematics. Available at: https://www.fleetmaxxsolutions.co.uk/wp-content/uploads/2020/10/Telematics.pdf (Accessed: 17.04.2021)

Ethical Consumer (2020) Ethical Consumerism in the Pandemic, UK: Ethical Consumer, Co-op.

European Commission (2020) EU-UK Trade and Cooperation Agreement: A new relationship with big changes. Publications Office of the European Union

European Union Publications Office (2016). Enforcing EU Environmental Law. Benefits and Achievements. Available at: https://ec.europa.eu/environment/pubs/pdf/enforcing_EU_environmental_law_factsheet.pdf (Accessed: 17 March 2021)

FAO, IFAD, UNICEF, WFP and WHO (2020). The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome, FAO.

François-Lecompte et al. (2017) The Environmental Labelling rollout of consumers goods by public authorities: Analysis of and lessons learned from the French case. Journal of Cleaner Production 161, pp. 688-697.

Franklin-Wallis (2020) 'Can carbon labels on food help save the planet? It's complicated', Wired, 4th February. Available at https://www.wired.co.uk/article/carbon-labelling-quorn. (Accessed: 13 May 2021).

FuelGenie (unknown date). Fuel Cards. A Complete Guide. Available at: https://www.fuelgenie.co.uk/fuel-cards/ (Accessed: 13.05.2021)

Gabbatiss, J., Tandon, A. and McSweeny, R. (2020) CCC: UK must cut emissions '78% by 2035' to be on course for net-zero goal, Carbon Brief. Available at: https://www.carbonbrief.org/ccc-uk-must-cut-emissions-78-by-2035-to-be-on-course-for-net-zero-goal (Accessed: 6 May 2021).

Gadema et al. (2011) The use and usefulness of carbon labelling food: A policy perspective from a survey of UK supermarket shoppers. Food Policy, 36(6), pp. 815-822.

Government Office for Science (2019) Understanding the UK Freight Transport System Future of Mobility: Evidence Review Understanding the UK Freight Transport System. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/777781/fom_understanding_freight_transport_system.pdf (Accessed: 11 May 2021).

Global Railway Review, McLernon, Z. (2020) UK rail freight demonstrates its true potential in the face of the pandemic, Global Railway Review. Available at: https://www.globalrailwayreview.com/article/117293/uk-rail-freight-covid-pandemic/

Greater London Authority (2021) The London Plan. London: Mayor of London, pp. 1–542. Available at: https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf (Accessed: 13 May 2021).

Greener UK (2021) Written Evidence (EEH0030). Available at https://committees.parliament.uk/writtenevidence/22443/html/. (Accessed: 12 May 2021)

Griffith, H. (2017) 44 UK towns and cities breaching air pollution limits, Auto Express. Available at: https://www.autoexpress.co.uk/car-news/101564/44-uk-towns-and-cities-breaching-air-pollution-limits (Accessed: 13 May 2021).

Hale, S., Taylor, H., Oates, C., King, L., Gribbin, J. (2019). Road Freight electronic data - discovery. Lagom Strategy for the Department for Transport. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/953883/road-freight-electronic-data-discovery-report.pdf (Accessed: 06.04.2021)

Hargreaves Lansdown (no date) Brent Crude Oil: Latest price and chart, Hargreaves Lansdown. Available at: https://www.hl.co.uk/shares/trading-commodities/brent-crude-oil (Accessed: 13 May 2021).

Harper (2020) A critique of the Westminster Environment Bill. Available at https://community.rspb.org.uk/ourwork/b/martinharper/posts/a-critique-of-the-westminster-environment-bill. (Accessed: 12 May 2021)

Harrabin, R. (2021) 'Climate change: UK to speed up target to cut carbon emissions', BBC News 20 April

Haugen, M. J. et al. (2021) 'A fork in the road: Which energy pathway offers the greatest energy efficiency and CO2 reduction potential for low-carbon vehicles?', Applied Energy, 283, p. 116295. doi: 10.1016/j.apenergy.2020.116295.

Heubl, B. (2021) How hydrogen hype puts the EU's climate goals at risk. Available at: https://eandt.theiet.org/content/articles/2021/04/how-hydrogen-hype-risks-eu-s-climate-goals/ (Accessed: 29 April 2021).

Hill, N. et al. (2020) Zero Emission HGV Infrastructure Requirements. Ricardo Energy & Environment.
ITF (2018) "Towards Road Freight Decarbonisation Trends Measures and Policies", ITF Policy Papers, OECD Publishing, Paris.

Hillebrand (2020) Where are all the containers? The global shortage explained. Hillebrand. Available at: https://www.hillebrand.com/media/publication/where-are-all-the-containers-the-global-shortage-explained

Hillsdon, M. (2019): 5G Smart Roads: Why they are the future of transport. Raconteur. Available at: https://www.raconteur.net/technology/5g/5g-smart-roads/ (Accessed: 17.04.2021)

Hilson, C. (2018) 'The Impact of Brexit on the Environment: Exploring the Dynamics of a Complex Relationship', Transnational Environmental Law, 7(1), pp. 89–113. doi: 10.1017/S2047102517000279.

HM Government (2018) A Green Future: Our 25 Year Plan to Improve the Environment. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf. (Accessed: 12 May 2021)

HM Government (2020) The Ten Point Plan for a Green Industrial Revolution. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf. (Accessed: 12 May 2021)

House of Lords: European Union Committee (2021) Beyond Brexit: food, environment, energy and health. Available at https://publications.parliament.uk/pa/ld5801/ldselect/ldeucom/247/247.pdf. (Accessed: 12 May 2021)

Hülsbusch, H. P. von L. (2012) Diploma Thesis. Berlin: Technical University.

International Railway Journal (IRJ) (2020) European operators urge policymakers to prioritise rail freight in Covid-19 recovery. International Railway Journal. Available at: https://www.railjournal.com/in_depth/european-operators-policymakers-prioritise-rail-freight-covid-19-recovery/

ITF (2018) "Towards Road Freight Decarbonisation Trends Measures and Policies", ITF Policy Papers, OECD Publishing, Paris

Jöhrens, J. (2020) 'Climate-friendly road freight transport – putting catenary trucking in context', Institute for Energy and Environmental Research p. 19. Available at: http://www.csrf.ac.uk/wp-content/uploads/2020/10/2.-2020-09-10-ifeu-Putting-ERS-into-context-V2-clean.pdf (Accessed 11 May 2021)

Kateman (2020) 'Carbon Labels are Finally Coming to the Food and Beverage Industry, Forbes, 20th July. Available at: https://www.forbes.com/sites/briankateman/2020/07/20/carbon-labels-are-finally-coming-to-the-food-and-beverage-industry/?sh=56544d377c03. (Accessed: 13 May 2021)

Khan, S. (2021) Sadiq for London Manifesto. Available at: https://sadiq.london/wp-content/uploads/2021/04/Sadiq-for-London-Manifesto-.pdf (Accessed: 31 May 2021).

Kortelainen et al. (2012) Price Impacts of Carbon Reduction Labels: Evidence from Scanner Data. Available at: https://www.tse-fr.eu/sites/default/files/medias/stories/sem_12_13/afio/roussillon.pdf (Accessed: 7 May 2021)

Kuehne+Nagel (2020). Sustainability Report 2019. Available at: https://home.kuehne-nagel.com/documents/20124/72221/Company-Sustainability-Report-2019.pdf/3a5dc74a-8564-06a9-45aa-175547825b1a?t=1592580269457 (Accessed: 10.04.2021)

Langley et al. (2012) Research on EU product label options. Ipsos MORI, London Economics and AEA for the European Commission.

Lättilä, L., Henttu, V., and Hilmola, O. (2013) 'Hinterland operations of sea ports do matter: Dry port usage effects on transportation costs and CO2 emissions', Transportation Research. 55 (Part E: Logistics and Transportation Review), pp. 23–42. DOI: 10.1016/j.tre.2013.03.007.

Lenz, B. and Riehle, E. (2013) 'Bikes for Urban Freight? Experience in Europe', Transportation Research Record: Journal of the Transportation Research Board, 2379, pp. 39–45.

Liu et al. (2016) A review of carbon labeling: Standards, implementation, and impact. Renewable and Sustainable Energy Reviews 53, pp. 68-79.

Logistics Emissions Reduction Scheme (2019) Logistics Emissions Review 2019. Available at: http://lers.org.uk/wp-content/uploads/2019/12/000195-LERS-Report-2019-WEB.pdf (Accessed: 11 March 2021)

London Assembly (2020) Mayor to lead drive to boost diversity and inclusion in infrastructure, London City Hall. Available at: https://www.london.gov.uk//press-releases/mayoral/mayor-to-boost-diversity-in-infrastructure (Accessed: 13 May 2021).

London Assembly (2017) London stalling- Reducing traffic congestion in London. London: Transport Committee. Available at: https://www.london.gov.uk/sites/default/files/london_stalling_-_reducing_traffic_congestion_in_london.pdf (Accessed: 13 May 2021).

London Councils (2018) Demystifying Air Pollution in London, London Councils. Available at: https://www.londoncouncils.gov.uk/node/33224 (Accessed: 16 May 2021).

Low, J., Haszeldine, S. and Mouli-Castillo, J., (2020). Comparative evaluation of battery electric and hydrogen fuel cell electric vehicles for zero carbon emissions road vehicle fuel in Scotland.

Lydall, R. (2019) Labour hopeful Dr Faiza Shaheen says Sadiq Khan's Ulez scheme is 'unfair' on poor, Evening Standard. Available at: https://www.standard.co.uk/news/london/labour-hopeful-calls-sadiq-khans-ulez-scheme-unfair-on-poor-londoners-a4069721.html (Accessed: 13 May 2021).

Mason, C. (2019) Thousands of appeals against fines for entering London's ultra low emission zone upheld, Money Saving Expert. Available at: https://www.moneysavingexpert.com/news/2019/11/half-of-completed-appeals-for-london-ulez-fines-successful---her/ (Accessed: 13 May 2021).

Mayor of London (2020) New data shows dramatic improvement in London's air quality since 2016, London City Hall. Available at: https://www.london.gov.uk//press-releases/mayoral/dramatic-improvement-in-londons-air-quality (Accessed: 13 May 2021).

McGrath, M. (2018) 'Sir David Attenborough: Climate change "our greatest threat"', BBC News, 3 December. Available at: https://www.bbc.com/news/science-environment-46398057 (Accessed: 8 May 2021).

McKinnon, A., (2007) CO2 Emissions from Freight Transport in the UK. Report prepared for the Climate Change Working Group of the Commission for Integrated Transport, 57.

McKinnon, A.C., Piecyk, M.I. (2009). Measurement of CO2 emissions from road freight transport: A review of UK experience. Energy Policy, Volume 37, Issue 10, Pages 3733-3742

MDS Transmodal (2019) Future of Freight Demand. Available at: https://nic.org.uk/studies-reports/uk-freight/future-of-freight-demand/ (Accessed: 11 May 2021).

Montague (2020) 'Quorn carbon footprint labelling', The Ecologist, 13th January. Available at: https://theecologist.org/2020/jan/13/quorn-carbon-footprint-labelling. (Accessed: 13 May 2021)

National Infrastructure Commission, (2019). Better delivery: The challenge for freight. Freight study final report. Available at: https://nic.org.uk/app/uploads/Better-Delivery-April-2019.pdf , p.36. (Accessed 11 May 2021)
Network Rail (2013) Value and importance of rail freight. Available at: http://planning.northwarks.gov.uk/portal/servlets/AttachmentShowServlet?ImageName=306738 (Accessed: 13 May 2021).

Network Rail (2021) Governance Framework. Network Rail, Network Services. Available at" https://www.networkrail.co.uk/wp-content/uploads/2021/02/Freight-Governance-Framework.pdf
Noack, R. (2019) 'Should short-haul flights be banned? Climate change is a major issue in elections in Europe and Australia.' The

Washington Post, 17 May. Available at: https://www.washingtonpost.com/world/2019/05/17/europe-discusses-banning-short-haul-flights-climate-change-is-suddenly-top-campaign-agendas-worldwide/ (Accessed: 13 May 2021).

OECD (no date) What is Impact Assessment?. Available at: https://www.oecd.org/sti/inno/What-is-impact-assessment-OECDImpact.pdf (Accessed: 13 May 2021).

Office for National Statistics (2020) UK Environmental Accounts: 2020. Measuring the contribution of the environment to the economy, the impact of economic activity on the environment, and society's response to environmental issues. Satellite accounts to the main UK National Accounts. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/ukenvironmentalaccounts/2020 (Accessed 12 February 2021)

Office for National Statistics (2021a) UK trade: January 2021. Available at: https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/uktrade/january2021

Office for National Statistics (2021b) UK trade: February 2021. Available at https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/uktrade/february2021. (Accessed: 13 May 2021)

Office for Rail and Road (2021): Freight rail usage and performance - Quality and Methodology Report. Available at: https://dataportal.orr.gov.uk/media/1233/freight-quality-report.pdf (Accessed: 21.04.2021)

Osbrink, A., Meatte, M.A., Tran, A., Herranen, K.K., Meek, L., Murakami-Smith, M., Ito, J., Nunnenkamp, C. and Templeton, C.N., (2021). Traffic noise inhibits cognitive performance in a songbird. Proceedings of the Royal Society B, 288(1944), p.20202851.

Poore et al. (2018) Reducing food's environmental impacts through producers and consumers. Science, 360(6392), pp. 987-992.

Pucher, J. et al. (2012) City Cycling. Cambridge, United States: MIT

Press. Available at: http://ebookcentral.proquest.com/lib/ed/detail.action?docID=3339528 (Accessed: 13 May 2021).

RailFreight (2021) New Brexit beating routes could benefit rail freight. Available at https://www.railfreight.com/business/2021/03/01/new-brexit-beating-routes-could-benefit-rail-freight/?gdpr=accept&gdpr=accept. (Accessed: 12 May 2021)

Rail Freight Group (2021) Why use rail freight? Rail Freight Group. Available at: http://www.rfg.org.uk/rail-freight/why-use-rail-freight/

Railway Industry Association (2019) RIA Electrification Cost Challenge. Available at: https://www.riagb.org.uk/RIA/Newsroom/Stories/Electrification_Cost_Challenge_Report.aspx (Accessed 11 May 2021)

Sanchez Rodrigues, V. et al. (2015) 'UK supply chain carbon mitigation strategies using alternative ports and multimodal freight transport operations', Transport Research Part E, 78, pp. 40–56. doi: 10.1016/j.tre.2014.12.013.

Schliwa, G. et al. (2015) 'Sustainable city logistics — Making cargo cycles viable for urban freight transport', Research in Transportation Business & Management, 15, pp. 50–57. doi: 10.1016/j.rtbm.2015.02.001.
Shuai et al. (2014). How consumers are willing to pay for low-carbon products? - Results from a carbon-labeling scenario experiment in China. Journal of Cleaner Production 83, pp. 366-373.

Six Degrees (2020) About Us. Available at: https://www.sixdegreesoxford.com/about (Accessed: 11 May 2021).

Stansfeld, S., Haines, M. and Brown, B., (2000). Noise and health in the urban environment. Reviews on environmental health, 15(1-2), pp.43-82.

The Chartered Institute of Logistics and Transport (UK) et al., u.d. Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/218574/ghg-freight-guide.pdf (Accessed: 08.04.2021)

Transporeon (2021) Trust the Network The Way Forward in Achieving Transportation Desired Outcomes: Transportation Pulse Report 2021. Transporeon.

Transport for London (2021) Ultra Low Emission Zone, Transport for London. Available at: https://www.tfl.gov.uk/modes/driving/ultra-low-emission-zone (Accessed: 13 May 2021).

Transport for London (2018) Programmes and Investment Committee: Healthy Streets Programme. Transport for London, pp. 1–27.

Transport for London (2014) Improving the health of Londoners - Transport action plan, p. 88. Available at: http://content.tfl.gov.uk/improving-the-health-of-londoners-transport-action-plan.pdf (Accessed: 13 May 2021).

Transport Scotland (2017) Delivering Your Goods: Benefits of using Rail Freight. Transport Scotland. Available at: https://www.transport.gov.scot/media/33630/transport-scotland-rail-freight-guide-web.pdf

Unilever (2021) Carbon footprints - now it's personal. Available at: https://www.unilever.com/news/news-and-features/Feature-article/2021/carbon-footprints-now-its-personal.html. (Accessed: 7 May 2021)

United Nations Conference on Trade and Development (2020) COVID-19: A 10-point action plan to strengthen international trade and transport facilitation in times of pandemic. UNCTAD. Available at: https://unctad.org/webflyer/covid-19-10-point-action-plan-strengthen-international-trade-and-transport-facilitation

United Nations Framework Convention on Climate Change (2021a) What is the Kyoto Protocol? [online]. Available at: https://unfccc.int/kyoto_protocol (Accessed: 16 March 2021)

United Nations Framework Convention on Climate Change (2021b) The Paris Agreement [online]. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (Accessed: 16 March 2021)

Unterlohner, F., (2020). How to Decarbonise the UKs Freight Sector by 2050. Available at: https://www.transportenvironment.org/sites/te/files/publications/Study_How%20to%20decarbonise%20the%20UKs%20freight%20sector%20by%202050.pdf (Accessed 11th May 2021)

Upham et al. (2011) 'Carbon Labelling of grocery products: public perceptions and potential emissions reductions'. Journal of Cleaner Production, 19, pp. 348-355.

Vanclay et al. (2011) Customer Response to Carbon Labelling of Groceries. J Consum Policy, 34, pp. 153-160.

Walton, S. (2020) Intermodal trains forced to leave UK ports light loaded'. RailFreight.com, RailFreight.com. News about rail freight. Available at: https://www.railfreight.com/railfreight/2020/12/14/intermodal-trains-forced-to-leave-uk-ports-light-loaded/

Ward (2020) Statistics on UK-EU trade. Available at https://commonslibrary.parliament.uk/research-briefings/cbp-7851/. (Accessed: 12 May 2021)

Webster, E. and Davies, D., Parliamentary Advisory Council for Transport Safety. "What Kills Most on the Roads?." (2020). Available at: https://www.pacts.org.uk/wp-content/uploads/PACTS-What-kills-most-on-the-roads-Report-15.0.pdf (Accessed 17 March 2020)

Woodcock (2021) 'Brexit trade barriers to cost UK e-commerce firms £5bn a year, report warns', The Independent, 9 March. Available at: https://www.independent.co.uk/news/uk/politics/brexit-barriers-trade-uk-ecommerce-imports-b1814495.html. (Accessed 12 May 2021)

Zeh, S. (2019) Parcel deliveries free from local emissions: DPD Germany now using cargo bikes in Leipzig, DPDgroup. Available at: https://www.dpd.com/group/en/2019/08/22/parcel-deliveries-free-from-local-emissions-dpd-germany-now-using-cargo-bikes-in-leipzig/ (Accessed: 13 May 2021).

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