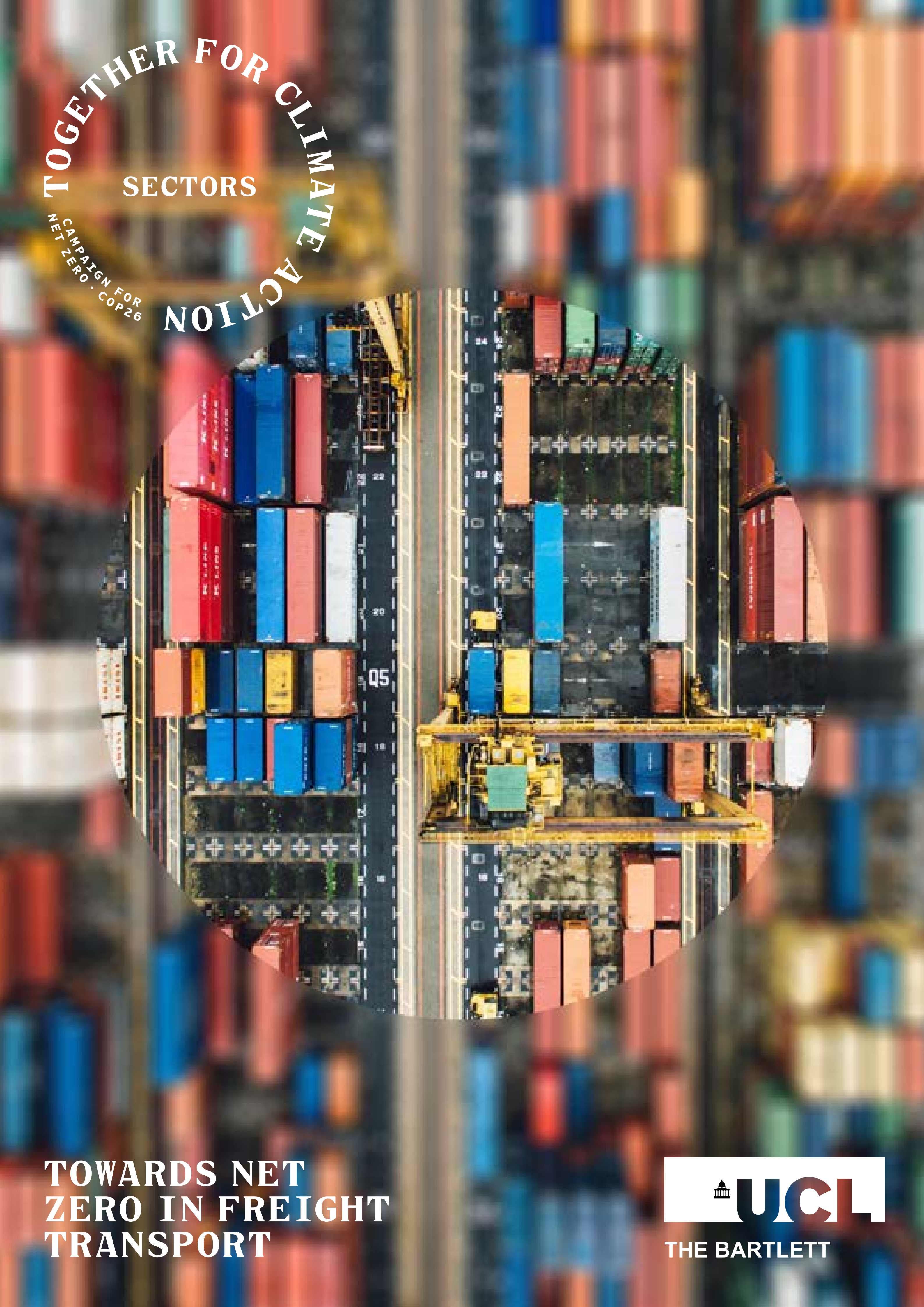

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TOWARDS NET ZERO IN FREIGHT TRANSPORT

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Towards net zero in freight transport

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Overview

Transport underpins modern economies and ways of life, facilitating the national and international movement of goods and services, and community inter-connectedness. One of the consequences of the COVID-19 pandemic has been to reveal the extent to which we rely on complex supply chains, and to make clear the vital role which freight transport plays. Yet the environmental impact of transport is very significant. In light of the UK's aim to reach net-zero emissions by 2050, the freight sector must decarbonise rapidly. To do so will involve navigating interlinking issues that are technological, financial, political and commercial.

What is the problem?

The transport sector is responsible for 57% of global oil demand, as the largest consumer of petroleum-derived fuels worldwide. With 92% of final transport energy demand consisting of oil products it is presently the least diversified of the major energy end-use sectors. The sector, including passengers and freight, represents about 23% of the world's final energy use and contributes to around 15% of global greenhouse gas (GHG) emissions (but 23% of energy-related CO2 emissions). Surface transport (including road transport) represents the biggest share, while international shipping and aviation are each responsible for just 2% of total GHG emissions, though their emissions are growing strongly. Mainly driven by economic growth, behavioural changes and population increase, transport sector emissions increased by 2.5% annually between 2010 and 2015.

Transport is the largest contributor to UK domestic GHG emissions, at 27% in 2019 (figure 1), with freight responsible for roughly half of this. The freight sector contributed to 5.2% UK GDP in 2019, with around 90% of goods transported by road. The remainder shared equally between rail and water freight.

To achieve the Paris Agreement long-term temperature goal, global emissions of greenhouse gas emissions must peak as soon as possible, before declining to achieve net-zero emissions by mid-century. For that reason, the UK in 2019 revised the target set in its 2008 Climate Change Act, enshrining in law the UK target of net-zero emissions by 2050 (replacing its previous goal of an 80% reduction from 1990 levels). As a consequence, emissions reductions within the transport sector are urgently needed.

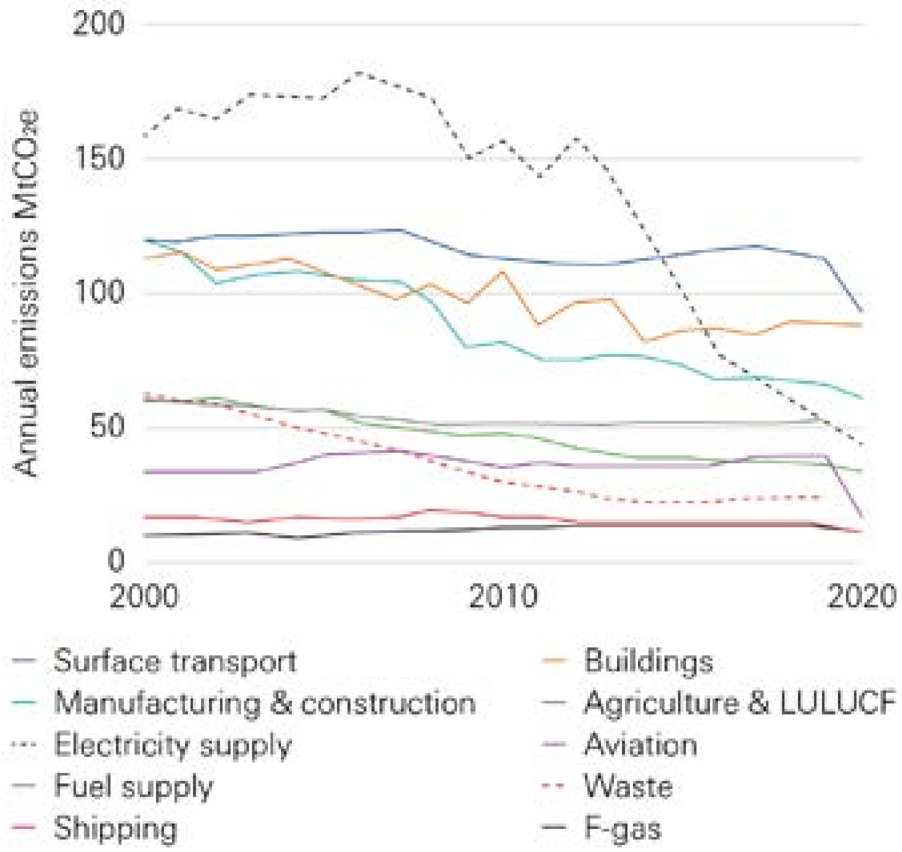

Figure 1. UK emissions by sector Source: BEIS (2021)

What are the key characteristics of the problem?

In recent decades the transport sector has been one of the highest-emitting sectors of greenhouse gases in the UK. It was lower than electricity supply, but above emissions from business and residential buildings. Together these four sectors accounted for almost 80% of emissions in 2010. However, since 1990, the UK has achieved steep emissions reductions in its electricity supply sector, historically the highest emitter, particularly in the last eight years as a result of phasing out coal in power generation and the increasing the use of renewables, such as wind and solar. In other areas – such as transport – emissions remain largely unchanged.

Although transport demand in the UK has increased substantially since 1990 (particularly road transport), GHG emissions from the sector have only increased by 3%, as increased road traffic has been largely offset by improvements in vehicle fuel efficiency. However, just 2% of all licensed vehicles (including passengers and freight without distinction) in the UK in 2020 are low/ultra-low emission vehicles (although this is a substantial increase from just 2018, when it was 0.5%).

COVID-19 has had an unprecedented impact on travel demand and the transport sector as a whole. However, freight transport is now returning to pre-pandemic levels and it is accepted that future growth will revert to pre-pandemic forecasts. Indeed, one challenge in the freight sector is the substantial expected global growth in demand for the next three decades. According to pre-COVID-19 projections from the OECD (Organisation for Economic Co-operation and Development), the growth in global trade was expected to continue to outpace GDP growth, at around 3.5% annually within the next decade (although lower compared to the 6.9% experienced over the period 1990-2007). Still, global trade (in constant values) is projected to grow by a factor of 4 from 2010 to 2050 (Figure 2).

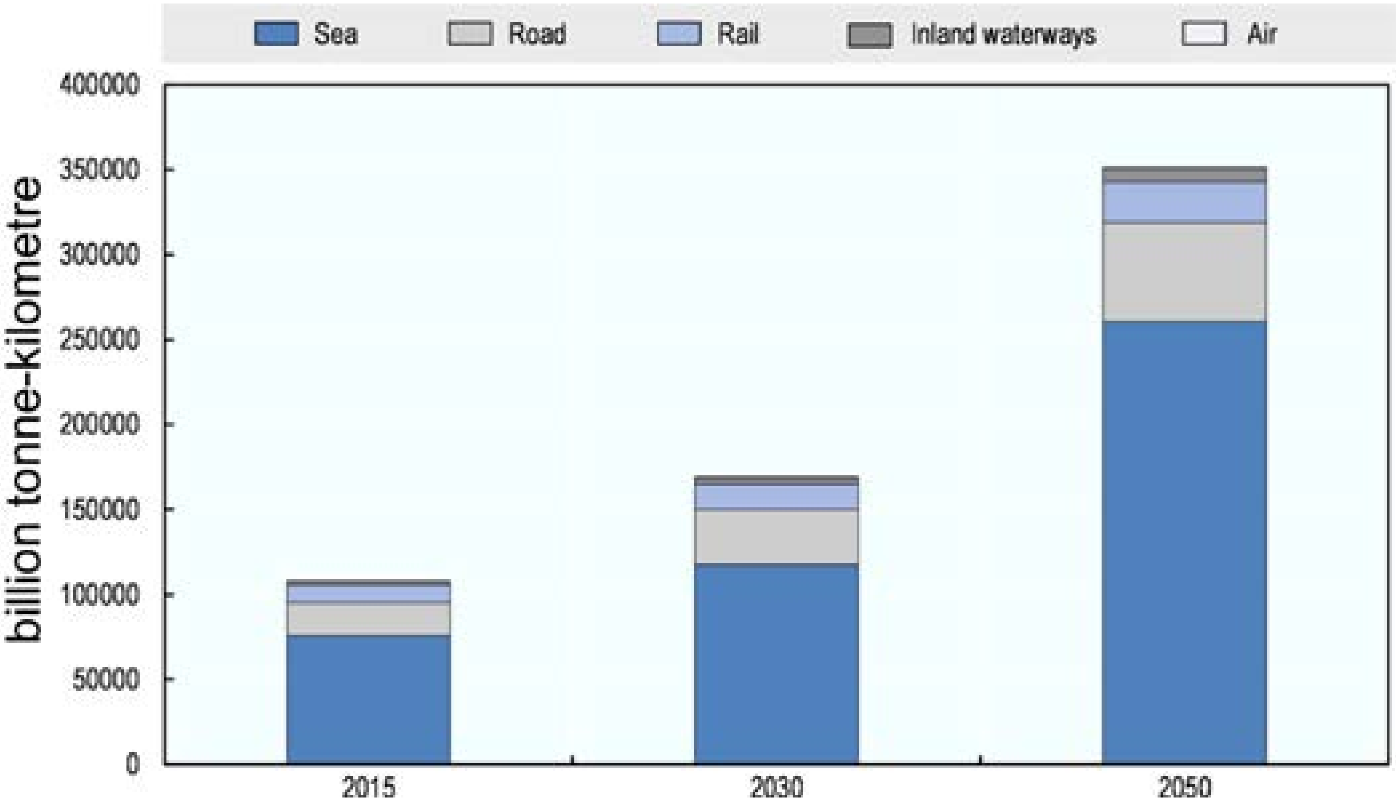

Figure 2. Projected global freight transport demand by mode. Current demand pathway, billion tonne-kilometres source OECD 2019

Barriers to decarbonisation in freight will differ by mode of transport. In some cases the lack of commercially available decarbonisation technologies or low-carbon operational practices are hurdles to strong emissions mitigation. While some parts of the freight sector already have a range of tested and scalable emission-reduction opportunities, for example delivery with electric vans, this is not the case in other parts of the sector, such as long-distance road haulage or aviation.

What is the solution?

Any improvement in efficiency of the total freight transport and logistic system, as well as in components of it, would make it easier and cheaper to reach the net-zero target.

Logistics operators aim to maximise efficiency and minimise costs estimated at 9-11% in the latest CCC report (CCC 2021). Further optimised logistics operations through, could reduce emissions from the sector by around 10% by 2030 as estimated for the UK freight system in the CCC analysis.

The improvements are driven by the following:

1. The increased availability and standardisation of data (vehicle telemetry) for route optimisation, and load pooling to reduce empty-running.
2. The creation of urban consolidation centres reducing the use of larger vehicles in town and allowing consolidated delivery.
3. The relaxing of delivery time to avoid congestion, and improving efficiency of the delivery by vehicle adaptation.
4. The modal shift of freight from road to rail.

Non-fuel-based solutions (demand management or operational efficiency) are important but will not achieve net-zero alone; fuel switching to non-carbon based fuels is needed.

The following table presents selected potential fuel alternatives for the transport sector:

Fuel	Advantages	Disadvantages
Biodiesel	• Domestically produced • Can be blended in most diesel engines • Reduced emissions of some criteria pollutants • Biodegradable, non-toxic	• Lower energy content than diesel • More expensive • B100 not suitable in low temperatures • Potential engine issues if not used properly
Renewable Diesel	• Drop-in fuel for all diesel vehicles at all blend levels up to 100% • Can be domestically produced from renewable resources • Reduced emissions	• Availability • Potential land use impacts, although currently most feed-stocks are waste products such as cooking oil or beef tallow
Ethanol	• Domestically produced from renewable resources • Fuel cost comparable to gasoline • Lower emissions of some air pollutants	• Flex-fuel vehicle required for higher blends above 15% for 2001 model years or later • Lower energy content • Land use impacts, over 90% of ethanol produced from corn
Natural Gas	• Domestically produced • Relatively cheap fuel • Fewer emissions of some criteria pollutants	• Non-renewable fuel • Potentially higher greenhouse gas emissions from leaked methane
Propane	• Domestically produced • Reduced emissions of some criteria pollutants	• Non-renewable fuel • Few commercially available vehicles
Electricity	• Fuel can be produced everywhere • The most energy efficient powertrain option available • Zero tailpipe emissions • Typically lowest fuel cost / mile	• Limited driving range • Battery recharge time
Hydrogen	• Can be produced with renewable resources • Zero tailpipe emissions	• Fuel cost • Lack of fuel availability • Vehicle cost

There are a number of different technology pathways within the sector for fuel switching:

1. For land transport (road and rail), electricity seems the first choice; hydrogen for range extension on vans or single fuel in trucks (pre-commercial testing) with potential biofuels use during a short transition period.
2. For shipping, ammonia seems to be the alternative (as hydrogen storage for fuel-cells or in ICE) with batteries restricted to short-range ferries.
3. Aviation is limited to synthetic or bio-kerosene; batteries may become available on short-range planes only after 2050.

What is stopping the solution being implemented?

Shifting to a low-carbon development pathway requires substantial and rapid changes for the freight transport sector.

Here are the main perceived barriers to the switch toward non-carbon based fuels:

1. Significant initial capital requirement for a non-emitting fleet. The investment barrier is still the most prevalent obstacle to the widespread market penetration of alternative-fuel vehicles.
2. Significant infrastructure investment to support fuel switching. An extensive network of charging and refuelling infrastructure is needed. The upgrade or creation of systems for the production and distribution of electricity, hydrogen or ammonia.
3. Limited battery range of electric freight vehicles and slow charging.
4. The size of the necessary hydrogen reservoir in the vehicle.
5. Currently limited choice in alternative technologies for HGV or aviation.

How can these barriers be removed?

Benefits need to be clearly highlighted through awareness and changes in mindset. Transport-related climate change mitigation actions can yield substantial economic as well as health benefits:

1. Businesses need to forge new partnerships with other sectors to create potential new opportunities for economic development. For example, BEV charging behaviour can be integrated in an electricity network with large variable renewable generation.
2. The initial cost barrier should be assessed against available information on the relevant payback periods. EVs have lower life-time ownership costs than internal combustion engine (ICE) vehicles.
3. Economically, a transition to zero emissions in the sector will accelerate technical innovation, job creation and skill development in the green economy ('Green Growth').
4. The parallel cost reduction and increased market share of new technologies. For example, the recent increased diffusion of BEVs for cars, or the growth of wind and solar generation in the electricity system over the last decade.
5. Improvement in air quality should be taken into consideration as a co-benefit of GHG emissions mitigation in the transport sector.

Governments and international bodies are producing policies to put the technological options, infrastructure and institutions in place to support transport decarbonisation. The UK "Transport Decarbonisation Plan" was published by the Department for Transport in July 2021 and it sets out the principles to deliver a path to net-zero transport in the UK:

1. For the road sector, the phase-out dates for new non-zero emission LCVs and HGVs are 2035 and 2045 respectively (under consultation for HGV).
2. For the rail sector, the ambition is to remove all diesel-only trains from the network by 2040, setting a rail freight growth target in parallel (under consultation).
3. For the maritime sector, indicative targets from 2030 will be introduced and consultation on the potential for a planned phase-out date for the sale of new non-zero emission domestic vessels will be conducted.
4. For aviation, consultations will start through "The Jet Zero Council" to reach net-zero in 2050 with a net-zero target for domestic aviation in 2040, and in the interim to introduce a UK mandate for sustainable aviation fuels.

Conclusion

Decarbonising the transport sector implies changes such as curbing demand, a shift to cleaner transport modes and a shift to new energy sources. Demand reduction can reduce emissions by a certain amount, but net-zero emissions will require that vehicles, from cars to airplanes, will need to run more efficiently and on zero-emission energy in the future. The evidence shows that bringing transport close to full decarbonisation is possible for surface transport (land and sea), but very challenging for aviation.

Achieving decarbonised transport will require comprehensive strategies involving policy decisions, technology choices, infrastructure developments and logistic improvements to achieve the net-zero goal within the next three decades. An integrated portfolio of these strategies can bring the achievement of a zero-carbon freight system. This will require strong partnerships between freight businesses, governments, equipment manufacturers and energy suppliers to overcome the barriers toward net-zero in transport.

Abbreviations

BEV Battery Electric Vehicle
CCC Climate Change Committee
EV Electric Vehicle
GDP Growth Domestic Produce
GHG Green House Gas
HGV Heavy Goods Vehicle.
ICE Internal Combustion Engine
LCV Light Commercial Vehicle

Key references for further information

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