



SCOTTISH PARLIAMENT CROSS PARTY
GROUP ON SUSTAINABLE TRANSPORT

FOSSIL-FREE FUTURE: ACCELERATING SCOTLAND TO ZERO-CARBON PUBLIC TRANSPORT

FOREWORD



The Cross Party Group on Sustainable Transport was formed two years ago with the clear intention of adding to the debate on making transport less-polluting.

We produced our first report, looking at the Scottish Government's plans for cutting emissions from public transport a year ago.

It contained five recommendations, including the call for fares to be cut on rail and bus.

While we still await the Fair Fares Review, we have seen the introduction of a peak time fares removal on ScotRail, which is to be welcomed.

This report builds on that work and considers how we can decarbonise public transport.

We looked at trains, buses and ferries.

Given the cross-party nature of the group, we will not all agree on everything all the time.

However, we have come up with a set of recommendations for the Government that are clear and challenging.

These include the need for further funding to buy zero-emission buses, prioritising electrification of the rail network so there are as few gaps as possible and, on ferries ensuring that, where possible, all new ferries should be plug-in electric.

Scotland is not doing well enough to decarbonise transport, though progress is being made and we recognise that.

But patting ourselves on the back is not going to get the job done.

Can I thank everyone who gave evidence to the CPG. Their expertise and insight was invaluable.

Special thanks also to our secretariat, Transform Scotland, who have pulled together this report.

As with our previous report, we will send this to the Government for response.

Graham Simpson MSP, Convenor

FOREWORD



"The need to create attractive, high quality public transport services goes hand in hand with de-carbonisation and the big societal switch to clean electric power. The report shows that finding ways to resolve the funding challenge will be key."

Mark Ruskell MSP, Deputy Convener



"This report gives a great sense of direction towards zero-carbon public transport. It should focus all our minds on what should and can be done. Finance remains a key challenge, with costs of capital projects rising faster than available funds. Issuing bonds could help (although these are not additional finance)."

John Mason MSP, Deputy Convener



"This report makes important recommendations. We urgently need political leadership and investment to give people access to reliable, affordable and sustainable transport. That requires innovation, and a joined up approach to delivering and powering low carbon transport infrastructure."

Sarah Boyack MSP, Deputy Convener

EXECUTIVE SUMMARY

Public transport is vital. It provides people across the country with access to their workplaces, to shops and leisure activities, and underpins Scotland's tourism sector. Its ability to cut congestion is critical to Scotland's economy. And it is crucial for cleaner air and cutting emissions.

But transport is Scotland's single most polluting sector, with emissions from transport responsible for over a third of the nation's total greenhouse gas emissions. In light of the climate emergency, the Scottish Government has committed to **cut these emissions by over 50% in the next seven years (by 2030) before reaching net zero by 2045.**

To make big cuts in transport emissions, action will be needed both to reduce transport demand and to deliver modal shift to sustainable transport. But it will also be necessary to take action to decarbonise all remaining transport.

As the legally-binding target to be a 'net zero nation' by 2045 draws closer, the Cross Party Group (CPG) on Sustainable Transport has held an inquiry into the decarbonisation of public transport, in order to assess the challenges, opportunities and action required for delivering decarbonised bus, rail and ferry services across Scotland.

This report summarises the evidence presented to the inquiry before providing a set of recommendations to the Scottish Government for delivering a fossil-free future for public transport.

Challenges to be faced

- **Cost challenges:** Concern that zero-emission technologies, being currently more expensive than traditional fuels, are disadvantaged from a business perspective.
- **Political uncertainties:** Uncertainty caused by shifts in government commitments and priorities undermines the confidence and certainty required by operators and suppliers to invest, which ultimately increases costs.
- **Inconsistencies in delivery:** The lack of a clear and continuous decarbonisation programme and associated industrial strategy impedes an efficient transition.
- **Uncertainties around skills, technology choices & business models:** Concerns exist surrounding training, skills gaps and new business models as new zero-carbon technologies replace their fossil fuel equivalents.
- **Uncertainty of transport demand:** Uncertainty of future demand for bus, rail and ferry travel can make high-cost upgrades risky for some operators reliant on passenger revenue.
- **Competitive global market:** A limited number of major infrastructure providers means unclear timescales on a national level risk Scotland losing out to more clearly defined opportunities elsewhere in the world.
- **Resources and supply chain:** An increased demand for materials required for decarbonisation may place pressure on the supply chains of finite resources such as lithium and other precious metals.
- **Deficiencies in electricity supply:** Concerns exist around the capacity and infrastructure needed to accommodate vehicle and vessel charging in various locations across Scotland.

EXECUTIVE SUMMARY

Overarching themes

- **The need for clear and consistent policy signals and financial incentives:** Policy-makers should incentivise the transition to zero-carbon transport by using all financial and regulatory means within their power as passing costs on to operators & passengers will damage public transport demand.
- **The role of decarbonisation in assisting with modal shift objectives:** The transition to decarbonised public transport services should be leveraged to facilitate behaviour change and encourage travellers to choose public transit (energy efficient) over private vehicle use (energy inefficient).
- **The role of public transport decarbonisation as a key component in Scotland's low-carbon industrial strategy:** Scotland should capitalise on its renewable energy capacity to develop a clear and coherent industrial strategy to support transport decarbonisation and boost local low-carbon economic opportunities.
- **The need to enhance knowledge-sharing in delivering decarbonisation:** Measures to encourage knowledge transfer both between operators and within the respective industries should be encouraged to help minimise uncertainties for operators and deliver skills development and training opportunities across the sector.

Recommendations

RECOMMENDATION 1: Decarbonising buses

Incentivise the purchase of zero-emission buses by introducing an enhanced Network Support Grant (NSG) rate for their use.

RECOMMENDATION 2: Decarbonising the railway

Put in place a rolling programme of rail electrification as part of a refresh of Transport Scotland's Rail Services Decarbonisation Action Plan.

RECOMMENDATION 3: Decarbonising ferries

Make the presumption that, where possible, all new ferries procured should be plug-in electric.

RECOMMENDATION 4: Financing the transformation

Use the Scottish Government's planned bond issue to finance investment in zero-carbon public transport infrastructure.

RECOMMENDATION 5: Boosting Scotland's zero-carbon economy

Ensure the Scottish Government's forthcoming 'Green Industrial Strategy' facilitates the development of local renewable energy sources which can be used to power Scotland's future vehicle and vessel fleets.

CONTENTS

Foreword	2
Executive Summary	4
Abbreviations	7
Definitions	8
1. Introduction	9
2. The benefits of decarbonisation	11
3. The challenges faced	13
4. Priorities for decarbonising bus, rail and ferry services	16
5. Overarching themes raised in the evidence	22
6. Financing decarbonisation	24
7. Conclusions and recommendations	26
Appendices	29

ABBREVIATIONS

CICERO	Centre for International Climate and Environmental Research
CMAL	Caledonian Marine Assets Ltd
CPG	Cross Party Group
CPT	Confederation of Passenger Transport
DAP	Decarbonisation Action Plan
EMEC	European Marine Energy Centre
HVO	Hydrogenated Vegetable Oil
NSG	Network Support Grant
OREF	Orkney Renewable Energy Forum
RIA	Railway Industry Association
ScotZEB	Scottish Zero Emission Bus (challenge fund)
SPT	Strathclyde Partnership for Transport
SULEBS	Scottish Ultra Low-Emission Bus Scheme
TCO	Total Cost of Ownership
ZEB	Zero Emission Bus

DEFINITIONS

Decarbonisation

Decarbonisation refers to the act of removing or reducing carbon dioxide (CO₂) output into the atmosphere, and is achieved by switching to low-carbon energy sources. The decarbonisation of public transport is then concerned with reducing emissions from public transport operations with the eventual goal of eliminating them altogether.

De-fossilisation

De-fossilisation refers to the act of removing the use of fossil fuels (non-renewable fuel sources such as coal, gas or oil) from a process or sector, in favour of alternative energy sources such as electricity or hydrogen.

E-fuels

Electrofuels, or e-fuels, are a class of synthetic fuels manufactured using captured carbon dioxide or carbon monoxide together with hydrogen obtained via sustainable electricity sources such as wind or solar power.

‘Green jobs’

‘Green jobs’ refer to jobs which help reduce negative environmental impact and lead to environmentally, economically and socially sustainable enterprises and economies. These are jobs which, amongst other things, work to reduce consumption of energy and raw materials, limit greenhouse gas emissions, minimise waste and pollution, or protect and restore ecosystems.

Modal shift

Modal shift refers to efforts to shift transport movements to the more sustainable modes: so, for example, shifting passenger transport trips from private car use to walking, cycling and public transport use, or from aviation to rail; or freight haulage from HGVs to rail or sea freight.

Net-zero

Net-zero refers to the balance between the amount of greenhouse gas (GHG) that is produced and the amount that is removed from the atmosphere, and can be achieved through a combination of emission reduction and emission removals. The Scottish Government’s target is to reach net-zero by 2045.

1. Introduction

1.1 The inquiry

Public transport is vital. It provides people across the country with access to their workplaces, to shops and leisure activities, and underpins Scotland's tourism sector. Its ability to cut congestion is critical to Scotland's economy. And it is crucial for cleaner air and cutting emissions.

In light of the Scottish Government's declaration of a climate emergency in 2019, it is increasingly necessary that we, as a nation, remove the reliance of our transport systems on heavily polluting and environmentally-degrading fossil fuels. In the years following the declaration, Scottish Ministers have set out a number of ambitious [commitments to public transport decarbonisation](#), perhaps most strikingly to:

- "remove the majority of diesel buses from public transport by the end of 2023"
- "reduce emissions from Scotland's railways to zero by 2035"
- "ensure that 30% of state owned ferries are low emission by 2032"

Despite these welcome commitments, [recent research](#) from Transform Scotland has established that inadequate progress is being made towards meeting them. As the legally-binding target to be a 'net zero nation' by 2045 draws closer, the Cross Party Group (CPG) on Sustainable Transport has held an inquiry into the decarbonisation of public transport, in order to evaluate progress and to establish the opportunities and next steps needed to deliver decarbonised bus, rail and ferry services across Scotland.

Sustainable transport policy typically applies an 'Avoid-Shift-Improve' analysis, firstly focussing on traffic demand management measures ('Avoid'), then modal shift ('Shift'), and then technological improvements ('Improve'). In 2022, the CPG published the 'Targeting Traffic' report, which considered the Scottish Government's road traffic reduction target; the report's recommendations concentrated on demand management and modal shift interventions. The focus of this new report is instead on the decarbonisation of public transport, hence a focus on improvement of the efficiency of public transport by the use of improved technology such as more efficient vehicles and fuels.

The inquiry included a series of evidence sessions held in spring 2023 at which the Group heard expert evidence from representatives of the rail, bus and ferry sectors. Subsequent to this, an open call for evidence was published and written evidence submissions were collected from across Scotland's transport sector during summer 2023. The full set of minutes and recordings from the meetings are available on the CPG webpage on the [Transform Scotland website](#).

This report summarises the evidence presented to the Group, including the benefits and challenges of decarbonisation and key themes from the sessions. It then goes on to provide a set of recommendations to the Scottish Government for delivering a fossil-free future for public transport.

1.2 CPG membership

MSPs

- Graham Simpson MSP (convener)
- Sarah Boyack MSP (vice-convenor)
- John Mason MSP (vice-convenor)
- Mark Ruskell MSP (vice-convenor)
- Liam Kerr MSP
- Brian Whittle MSP

Organisations

- Allan Rail Ltd.
- CalMac
- Capital Rail Action Group (CRAG)
- Community Rail Network
- Community Transport Association (CTA)
- CoMoUK
- CPT Scotland
- Cycle Law Scotland
- Cycling Scotland
- Cycling UK
- Disability Equality Scotland
- Edinburgh Bus Action Group
- Enterprise Holdings
- Friends of the Earth Scotland
- Friends of the Far North Line
- GoBike Strathclyde Cycle Campaign
- Grand Union Trains
- Heritage Railway Association
- Hitrans
- Intelligent Health
- Levenmouth Rail Campaign (LMRC)
- Light Rail UK
- Light Rail Transit Association (LRTA)
- LNER
- Midlothian Disability Access Panel
- Mobility and Access Committee for Scotland (MACS)
- Network Rail
- Paths for All
- Patrick Miner (individual)
- Pedal on Parliament
- Rail Action Group, East of Scotland (RAGES)
- Railfuture Scotland
- Rambler Scotland
- RNIB
- ScotRail
- Scottish Association for Public Transport (SAPT)
- Scottish Canals
- Siemens Mobility
- Spokes, the Lothian Cycle Campaign
- St Andrews Rail Link Campaign (StAR Link)
- Stagecoach Group
- Strathclyde Partnership for Transport (SPT)
- Sustrans Scotland
- Transform Scotland
- Transport Focus
- Transport Research Institute, Edinburgh Napier University
- Women's Cycle Forum Scotland

2. The benefits of decarbonisation

Evidence submitted to the inquiry reported on the wealth of benefits that a decarbonised public transport network will provide. These are summarised below.

2.1 Environment and health

Decarbonising Scotland's public transport network contributes to the global collaborative effort to reduce greenhouse gas emissions and address the climate and ecological emergencies. The reduced reliance on fossil fuels will help preserve finite resources and minimise the environmental impact of extracting, refining, and transporting these fuels for use in the transport sector.

At a local level, a decarbonised public transport network reduces local pollution and results in cleaner air, particularly in high-density areas like towns, cities, ports and stations. Given that electric buses, trains and ships are also quieter than their diesel counterparts, they help limit the harmful [impact of noise pollution on wildlife and biodiversity](#). Additional environmental benefits also exist and vary between modes. For instance, the use of battery-powered ships will reduce the potential for oil spills from bunkering.

Decarbonising public transport will improve public health as the [likelihood of disease](#) and other health ailments associated with poor air quality (particularly for vulnerable members of society) will be reduced. The ability of electric vehicles and vessels to reduce noise pollution also minimises the harmful impact of transport noise on communities' well-being.

2.2 Job creation

A move to a decarbonised public transport network presents a major opportunity for the zero-carbon economy. It will generate and sustain jobs in the transport and manufacturing sections that have a focus on reducing carbon emissions or on preservation or restoration of the environment. Electrified public transport will necessitate significant investment in power supply and charging infrastructure, which requires a local, skilled workforce for delivery, installation and maintenance of such developments. Similarly, vehicle manufacturers will benefit in the Scottish context, with associated employment opportunities.

Increasing the demand for alternative fuels and renewables will create more 'green jobs' in these areas and provide Scotland with the opportunity to become a hub for innovation in these technologies. The use of alternative fuels such as hydrogen or hydrogenated vegetable oil (HVO) in the short-term and synthetic fuels in the medium-term could also secure jobs in the future by transforming the existing oil distribution chain into a zero-emission fuel distribution chain. Alternative fuels (for internal combustion engines) offer an immediate carbon benefit but do not eliminate particulates.

2.3 Developing the zero-carbon economy

A fossil-free transport system will encourage investment and development of green fuel supply chains in Scotland, making alternative fuels available for other industries. By expanding its growing renewable sector, wealth of natural resources and manufacturing base, Scotland could become self-sufficient, but also a net exporter of alternative fuels and associated expertise, using ports as hubs to transport fuels across the country and beyond. The result of locally-produced fuel will also mean the supply chain is less impacted by geopolitics as the nation ends its reliance on the fossil fuel chain and imported oil. Improvements associated with zero-carbon infrastructure will also help to drive local communities and wider society to decarbonise.

2.4 Modal shift and traffic reduction

Buses, trains and ferries already play a significant role in decarbonising the whole transport network given their ability to replace private car journeys and air travel (the two most polluting modes of transport). The act of decarbonising these services presents an opportunity to improve service quality and passenger experience, incentivising people to use these modes. For example, evidence submitted by the regional transport partnership SPT (Strathclyde Partnership for Transport) suggests that investment in new, environmentally friendly buses supports an overall increase in bus network quality.

The Railway Industry Association (RIA) noted that electric trains are widely recognised to deliver a '[sparks effect](#)' [which increases passenger numbers and satisfaction due to improved journey times and reliability](#). Modal shift resulting from such improvements would increase demand, allowing public transport providers to increase service frequencies and improve network coverage. Individuals and communities would then benefit from improved accessibility and availability, and the increase in the proportion of journeys made by sustainable modes would have cut emissions and lead to various social, environmental and health benefits. Such benefits have been reported in depth and have led to the introduction of the Scottish Government's target to cut traffic by 20% by 2030. This target can only be delivered by providing a public transport alternative; an alternative which is only likely to be taken up if it is efficient, affordable and zero-carbon.

3. Challenges to be faced

Evidence submitted to the inquiry identified a range of challenges and existing concerns, for both transport operators and industry suppliers, which may impede a swift transition to a decarbonised public transport network in Scotland. The eight key challenges identified are summarised here and suggestions for their mitigation will follow in the succeeding section.

3.1 Cost challenges

A recurring issue raised by inquiry contributors was the high capital costs and significant up-front investment required to procure and deliver electrified or zero-carbon transport – from the cost of vehicles or vessels themselves to the electricity and charging infrastructure. There is a concern that zero-emission technologies, being currently more expensive than traditional fuels, are disadvantaged from a business perspective. As an example, national trade body for bus and coach operators CPT Scotland noted that – despite the running costs of zero-emission buses being typically lower than those of diesel buses – battery-electric or hydrogen fuel-cell buses have higher up-front costs compared to their diesel equivalents. CPT advised that these cost challenges are exacerbated when charging infrastructure, including high voltage chargers, substations, upgraded supply, on-site storage and generation, also have to be paid for up-front. Another financing concern is the uncertainty about the future of electricity prices as the energy mix accommodates an increasing proportion of supply from renewables and as electricity demand increases as a result of other sectors' decarbonisation efforts.

3.2 Political uncertainties

In light of the high capital costs associated with transport decarbonisation, evidence provided to the inquiry highlighted the need for continued political support for investment. In particular, submissions suggested that the uncertainty caused by shifts in government commitments and priorities undermines the confidence and certainty required by operators and suppliers to invest, which ultimately increases costs. For the bus sector, CPT notes that uncertainty exists around financial support for the bus sector, including the Network Support Grant and the reimbursement payments for carrying concessionary passengers, and that this adversely impacts upon current and future operators' financial commitments to a decarbonised bus fleet. Moreover, for ferries, ferry procurement body CMAL (Caledonian Maritime Assets Ltd) reports that clarity on future regulation is needed to inform project continuity and current decisions on the design of ships which will be in operation beyond the Scottish Government's 2045 net zero target. For rail, whilst Scotland has a very clear and positive long-term commitment to the decarbonisation agenda, financial constraints are severely limiting progress.

3.3 Inconsistencies in delivery

Political uncertainty has meant that Scotland has been unable to implement a clear industrial strategy which will facilitate an efficient transition to zero-emission public transport. For example, evidence presented by RIA highlighted that the lack of a clear and continuous programme of electrification in the UK in previous years has led to inefficient, 'lumpy' delivery. The trade group advised that it takes at least 36 months to remobilise a team and much of the experience has to be re-learned. Employers also need the confidence in the strategy and the commitment to delivery to underpin their recruitment and training decisions. Therefore, a lack of long-term industrial strategy and inconsistent delivery are significant barriers to decarbonising Scotland's public transport.

3.4 Uncertainties around skills, technology choices & business models

A recurrent challenge cited in the evidence presented to the Group is the perceived lack of knowledge surrounding the process of decarbonisation. Given that a transition away from fossil fuel use requires developing and using relatively new or untested equipment and technologies, industry suppliers and operators are concerned about lacking the skills and knowledge required as they decarbonise. As an example, when adopting battery-electric buses, the bus industry faces uncertainty over vehicle maintenance costs, daily output, lifespan, residual value, and full life costs. Operators in the bus market are all at different stages in their decarbonisation efforts; as such, the bus industry advises that a scalable approach is required to ensure operators receive the focused support it specifically needs. Currently, an operator must ensure ZEBs work with the associated infrastructure and often are left to manage the challenges that can occur between the bus and the required infrastructure. Alexander Dennis reported that it has provided industry, financiers and policy makers the platform to experience and understand how best to operate and benefit from ZEBs. CPT adds that an uncertainty also exists for new and alternative business models linked to new ZEBs (e.g. leasing vs purchasing). This is in addition to knowledge and skills gaps for the development, deployment and operation of zero-emission bus depots in Scotland. For ferries, a lack of clarity on alternative fuels and what infrastructure will be needed is challenging. For example, the Orkney Renewable Energy Forum (OREF) notes that ambiguous infrastructure requirements are a barrier to decarbonisation as industry does not know whether to pursue the likes of e-fuel synthesis refineries or hydrogen tanks on quaysides.

3.5 Uncertainty of transport demand

In addition to the above, the future demand for public transport services is an area of uncertainty. This poses a challenge for operators, in light of the cost challenges discussed earlier, as the financial viability of operations is dependent on high passenger numbers to drive costs down and ensure a healthy commercial environment for operators. That is, these services need consistent customer and revenue bases to encourage investment. Therefore, uncertainty of future demand for bus, rail and ferry travel can make high-cost upgrades risky for some operators.

3.6 Competitive global market

Since there are a limited number of major infrastructure providers, manufacturers and suppliers – who are pursuing opportunities throughout the world as the climate emergency necessitates global decarbonisation – Scotland is facing a competitive and buoyant European procurement market. For rail, contributors to the inquiry note that significant delays and uncertainty surrounding procurement timescales, as well as transparency around requirements, are key barriers to making the necessary informed up-front investment for decarbonising railways and providing new trains. CMAL adds that unclear timescales on a national level inevitably result in more clearly defined opportunities elsewhere in the world being more attractive and considered a better use of resources. For buses however, Scotland has the largest UK bus manufacturer based in Falkirk; the manufacturer Alexander Dennis has sold around 2,000 zero-emission buses to date in the UK, many of which are now in operation in Scotland.

3.7 Resource and supply chain concerns

The potential supply chains for public transport decarbonisation are an area of particular concern. As the transport network electrifies in its mission to reduce its reliance on fossil fuels, the sector will have an increased demand for batteries and other materials required for decarbonisation. This will place pressure on the supply chains and extraction processes of finite resources such as lithium and other precious metals. Moreover, long and distant supply chains should be avoided as they may, in themselves, generate carbon inefficiencies due to materials being transported greater distances.

3.8 Deficiencies in electricity supply

A commonly cited potential barrier to decarbonisation was lack of capacity and infrastructure needed to accommodate vehicle charging in various locations across Scotland. For instance, SPT highlights that a lack of a public bus charging infrastructure for en-route charging currently limits operators in the Strathclyde region to predominantly a depot-only charging model; this renders some routes and services unsuitable for zero-emission buses even if the buses are in the network. Ferry decarbonisation also faces this challenge, with concern surrounding overnight charging and electricity grid availability and capacity in certain areas. CMAL emphasises that, due to the remoteness of many of their ports, there are significant challenges in supplying sufficient electricity to power fully electric ferries and provide shore power for vessels when in berth.

4. Priorities for decarbonising bus, rail and ferry services

The following section summarises the efforts required to decarbonise Scotland's ferries, railways and buses, based upon evidence presented to the inquiry. For each mode, a commentary on the suggested approach is presented along with specific actions.

4.1 Decarbonising buses

With a manufacturing base for zero-emission buses and the support of Scottish Government capital subsidies – namely SULEBS and the ScotZEB challenge fund – Scotland has seen a successful roll-out of low-emission buses in recent years. However, strengthened supply chains, increased knowledge sharing and continued innovation are now needed to remove the mode's dependency on fossil fuels in full.

4.1.1 Electric buses

Battery-electric buses are currently the primary solution for low emission buses in Scotland. However, much progress remains to be made with the vast majority of the 4,800 buses in Scotland still running on diesel engines. It is critical that innovation in zero-emission technologies continues. In addition, increased specific support for R&D for design and development of smaller long-range electric buses is needed.

Moreover, while larger operators are rapidly gaining knowledge and understanding of zero-emission bus development, deployment, operation and maintenance, many smaller operators who may be less able to cope with the scale of operational change may be left behind. Knowledge sharing and support are necessary to ensure the opportunity to decarbonise is available to all operators.

An additional concern is that the initial capital cost of zero-emission buses remains substantially higher than diesel equivalents, which is discouraging in light of uncertainties surrounding maintenance costs, electricity prices, daily output, lifespan and residual value. However, a consideration should be made when looking at an optimised Total Cost of Ownership model (TCO). The TCO model is a summation of the costs involved in acquiring and operating ZEBs. This optimisation is realised through reduced fuel consumption, low-maintenance requirements and increased length of service. This will begin to shift the cultural perception from ZEBs being a cost to becoming an investment whilst removing barriers of entry for more operators. It is clear that improved understanding of electric buses' life cycles is required to encourage uptake. This understanding will also assist with the establishment of new business models and second-hand markets.

The established finance models and operating processes within the bus industry are based on diesel technology. To date, the industry is attempting to overlay a diesel business model on the market introduction of ZEBs. This is structurally impeding the industry's ability to successfully adopt ZEBs and realise its potential. Some smaller operators are reluctant to adopt these buses due to the upfront cost and perceived risks. A collaborative approach should be considered whereby manufacturers, operators and financiers are collectively able to better utilise and extract more value from ZEB assets beyond the primary operational bus life.

Evidence submitted argued that circular economy approaches can generate future revenue streams. For operators, battery and vehicle decoupling extends the usable life of the vehicle by allowing the battery to be upgraded mid-life. Used batteries can be repurposed as reservoirs of energy that are charged during off-peak times and then used to charge buses according to bus schedules. This reduces future fuel costs and increases charging flexibility in depots.

In addition, by charging used batteries when the grid has excess capacity and discharging that capacity back to the grid when it is required, operators will be able to generate new income. For example, Alexander Dennis notes that 10 used Enviro400EV batteries can have a repurposed capacity of 2,907kWh, enough energy to power c. 342 average Scottish households for a day; trading this energy back to the grid at £0.09/kWh per day

can generate a revenue of c. £95.5k per year. This new revenue stream would transform the market and is not possible with diesel buses. This demonstrates the greater intrinsic economic value which will begin to shift the mindset towards ZEBs being treated as an investment by operators. A greater number of repurposed batteries earning substantial revenue will drive future subsidy-free adoption of ZEBs. This will also support Zero Waste Scotland initiatives and the drive to promote a circular economy and more resilient national grid.

4.1.2 Alternative fuels

The two main zero-emission bus technologies available in the UK are battery-electric buses and hydrogen fuel cell buses. Evidence to the inquiry from SPT highlights that despite the prevalence of battery-electric buses in Scotland, battery-electric may not be a globally sustainable solution over the long term. CPT adds that battery-electric buses do not have the range to be the solution for all local bus services whilst hydrogen presents its own challenges in terms of storage and cost. Moreover, the only technology available at present for coaches is battery-electric and, as coaches serve longer and more geographically diverse routes than buses, they are often further away from charging infrastructure.

It is therefore encouraged that the Government continues to support a targeted, evidence-based mix of zero-emission strategies, technologies, and fuels to reduce risk to private companies and therefore facilitate investment and further innovation for zero-emission vehicles. This technology-neutral approach to bus decarbonisation will allow different technologies to advance and mature to a point whereby the decision for the most appropriate fuel will be made clear through the evidence base.

4.1.3 Infrastructure

Whether a bus operator chooses battery-electric or hydrogen fuel-cell buses, charging infrastructure is required and opportunities for collaboration with other energy users and providers emerge. This may relate to other energy users in the same geographical area (reconfiguring bus depots may be a significant undertaking) or in relation to the technology (e.g. batteries) having value to another part of the supply chain after the value to bus operations has receded. As an example, First Bus reported the community benefits of their business-to-business charging trial which allowed local businesses to charge their vehicles during the day using First Bus infrastructure.

CPT advises that electricity grid and hydrogen infrastructure upgrades could be made in a holistic way if total demand is understood and depots are connected ahead of zero emission vehicles being deployed. There is an opportunity and need for greater information sharing and strategic planning between energy providers, technological innovators and bus operators, and knowledge sharing with respect to infrastructure, grid and connection solutions across bus operators would be beneficial to the decarbonisation project.

4.1.4 Actions recommended by contributors to the inquiry

Evidence submitted to the inquiry suggests pursuit of the following actions to achieve a zero-emission bus fleet in Scotland:

- Encourage innovation in zero-emission technology to continue.
- Extend service contracts for bus operators only for zero-emission routes, to allow operators to make the jump to ZE as they have certainty for the future and therefore incentivise investment in zero emission buses and infrastructure.
- Consider zero-emission bus franchising in Scotland, looking to successful models in London and Manchester.
- Identify a decarbonisation pathway for Scotland's coaches, joined up with action across the UK.
- Increase support for R&D to support design and development of smaller long-range electric buses.
- Introduce further funding for purchase of zero-emission buses beyond ScotZEB2.
- Explore opportunities for wider community benefit, particularly for charging infrastructure.
- Retrain, upskill and redeploy staff to take forward the development, deployment, operation and maintenance of zero-emission buses.

- Identify and support the development of routes to recycling/refurbishing/disposing of zero-emission bus technology at end of life. For example, a recycling scheme for used bus batteries.
- Consider allowing bus operators access to preferential/fixed/hedged electricity rates for bus operators to maximise opportunities for onsite generation and storage of electricity (more control of unit costs).
- Facilitate training and knowledge sharing amongst operators of zero-emission bus depots in Scotland.
- Explore opportunities for en-route charging.
- Mandate for electricity network providers to prioritise the supply (and crucially distribution) of electricity to providers of registered local bus services to support zero-emission bus operation.
- Establish robust business models suitable for the new zero-emission bus market centred around leasing.
- Provide capital support to accelerate efforts by local bus operators to generate and store their own electricity.
- Encourage greater information sharing and strategic planning between energy providers, technological innovators and bus operators to assist with holistic infrastructure planning.
- Support smaller operators who may be less able to cope with the scale of operational change required.
- Analyse and plan for impacts on the second hand bus market.
- Develop markets for used components.
- Develop the strategy for the next generation of zero emission vehicles.

4.2 Decarbonising rail

The Scottish Government has a plan in place to remove fossil fuels from its railways. The Decarbonisation Action Plan (DAP), published in 2020, sets out Transport Scotland's intentions for electrification and alternative traction. For this to be realised, coordination of both infrastructure and rolling stock is required. The Plan proposes that for an optimal decarbonisation programme, the majority of rail services will be electrified with alternative traction being pursued for more rural routes.

4.2.1 Electrification

The electrification of Scotland's rail infrastructure, in addition to an adequate (decarbonised) power supply, requires firstly, overhead wires to supply electricity directly to a train equipped to use it; and, secondly, appropriate rolling stock i.e. (battery) electric trains/locomotives.

On the first point, RIA's evidence to the inquiry reports that 1400 single track kilometres (stk) of electrification is required in the next 12 years. It notes that this rate of electrification (120km per year) has been achieved in the past, but not in a continuous or cost-effective way. A pattern of 'boom and bust' can be seen in the UK's historic approach to electrification and this must be avoided as it causes skills to be lost and results in inefficiencies in the supply chain. Instead, there must be a rolling electrification programme, such as that implemented in Germany, which results in a lower cost and a professional delivery team with a production line approach.

For the second element, the procurement of new electric trains provides Transport Scotland with a significant opportunity to attract more passengers to the railways if the new specification, layout, and design is optimised to suit (new and existing) passenger needs. This may look like increasing bike capacity, providing family areas, or the implementation of level boarding solutions (such as deployable steps). By attracting new passengers, particularly those who would have otherwise travelled by carbon-intensive private cars, the decarbonisation of rail rolling stock can cut emissions from the wider transport sector in addition to those emitted directly from powering the trains.

Electrification is expensive and it should be noted that discontinuous electrification (leaving gaps in the overhead line equipment and instead using on-board energy storage systems to power trains across these

gaps) offers a way to reduce infrastructure costs. However, despite allowing passengers to have a decarbonised service, this technology would not be suitable for freight operations due to its higher energy demands.

Innovation in this area is still underway and Scotland should look to achievements elsewhere as it develops its decarbonisation plans. For example, Static Frequency Converters (SFCs), utilised in the UK, enables power to be taken from the national grid at 11kV or 33kV rather than the traditional 275kV or 400kV. This is beneficial for electrifying areas where only lower power supplies exist given that the time and cost of procuring a 33kV supply is minimal compared to the costs related to a higher voltage supply.

4.2.2 Alternative traction

In addition to electrification, the Decarbonisation Action Plan envisions alternative traction technologies facilitating the transition to a net-zero railway. In its evidence to the inquiry, RIA noted that for non-intensive (rural) routes, electrification is not cost-effective and rolling-stock-only solutions such as hydrogen or battery trains will be more pragmatic choices for services to the remote and less populated parts of northern and western Scotland.

Battery and hydrogen technology is constantly improving, and 'trolley wire' could be another solution for these routes, but an options appraisal is needed in order to make an informed decision. RIA notes that the current plan to prioritise the electrification of urban and suburban routes (in line with the resultant industrial and economic benefits) means consideration of alternative technologies can continue as they evolve. It adds that it would however be beneficial to procure some alternative traction trains early to support the learning. This will result in a more informed decision about traction requirements for the more rural routes.

4.2.3 Actions recommended by contributors to the inquiry

Evidence submitted to the inquiry suggests pursuit of the following actions to achieve a net zero railway network in Scotland:

- Continue to learn from international examples of rail decarbonisation.
- Establish close coordination between the Scottish Government, energy suppliers, the distribution network and the railway supply chain.
- Ramp up the decarbonisation programme and ensure a continuous cost-effective rolling programme of electrification thereafter, allowing skills to be acquired, developed and retained in Scotland.
- Prioritise electrification between the 'seven cities' where demand and economic benefits are greatest, noting that 75% of journeys are in the Central Belt.
- Introduce wider power supply interventions, including integration with renewable energy sources.
- Develop a cohesive plan which coordinates infrastructure developments alongside Transport Scotland's rolling-stock strategy.
- Assess the options for new technologies which will power the more remote and rural parts of the network.
- Optimise specification and design of new rolling stock to attract new passengers to rail.
- Ensure clients do not disadvantage low carbon solutions even if they may currently be more expensive than existing solutions.

4.3 Decarbonising ferries

By taking early action in decarbonising our ferries, Scotland can drive the development of effective solutions and influence global maritime regulations and legislation throughout the coming years.

4.3.1 Electric ferries

Evidence submitted to the inquiry proposes that there should be a presumption that all future vessels will be plug-in electric. However, as technology develops, it is prudent to assume that diesel backup will be utilised given the lifeline service of ferries is critical to island populations. Although, it is expected that this will be used

more and more infrequently and eventually only in the event of unexpectedly high power demands exhausting the batteries on a particular day.

CMAL notes that [the operation of a fully electric ferry has been shown to be a valid commercial alternative to ferries powered by conventional diesel engines](#). The EU Horizon 2020 funded project to build the Danish-flagged ship the MV Ellen has shown that while E-ferries have higher construction costs than conventional ferries, the operational costs (especially those dedicated to energy or fuel) are significantly lower; this means that the higher investment costs are paid out after 5-8 years of operation.

4.3.2 Other fuels

Although it is feasible that short voyages (up to approximately 1-2 hours each way) and smaller vessels will be fully plug-in electric, larger vessels on longer routes will require power beyond currently-available battery capacity. The appropriate alternative fuel choice – from hydrogen to ammonia to methanol – is contested. Analysis from the Orkney-based renewable energy test and research centre EMEC (European Marine Energy Centre) advises that a high energy density fuel is required for onboard generation and that green synthetic diesel, made from green hydrogen and direct air capture CO₂, is a suitable option. The Centre reports that it is highly unlikely that vessels will be entirely fuelled by hydrogen due to the logistics of bunkering and because liquid hydrogen is expected to remain too hazardous for passenger vessels. It is noted here that these synthetic liquid fuels will not be ‘decarbonised’ but ‘de-fossilised’ in that they will still emit carbon but it will only return it to where it came from, as opposed to adding additional net carbon to the atmosphere. These vessels can also incorporate batteries and plug in when in port (providing local air quality improvements).

On the feasibility of hydrogen, CICERO (the Center for International Climate Research Oslo) noted that despite some experimental vessels using hydrogen as a fuel source, there are various challenges to innovation in this area. In particular, there are concerns over energy losses along the supply chain and the need for significant infrastructure investment. Nevertheless, CMAL advises that the Government should remain technology-neutral as per FuelEU Maritime¹ as prioritising fuels or technologies at this stage would restrict innovation and delay progress on reducing emissions, undermining decarbonisation strategies within the shipping industry.

4.3.3 Ship design

Alongside pursuing climate-friendly power sources, cutting emissions from Scotland’s ferries can also be achieved through efficient ship design and speed reductions. Both of these measures reduce fuel use and so result in less emissions. The Orkney Renewable Energy Forum (OREF) note that catamarans use half the fuel of displacement hulls and that their layout makes disabled access easier and reduces supervisory crew levels. The vessels are also cheaper and faster to build and could be suited to Scottish fabrication.

As an example, private operator Pentland Ferries have successfully demonstrated the use of truck carrying catamarans such as MV Alfred. A comparison between the MV Alfred catamaran and the more conventionally designed MV Hamnavoe revealed that although their service speed and weather resistance levels are comparable, the Alfred uses half the fuel and cost a third of the price to build. OREF suggests that there is a level of conservatism and a general reluctance to consider catamarans for ferry routes in the UK shipping industry, and that this alternative approach to ship design would improve the efficiency of ferry operations and reduce ferry emissions.

4.3.4 Actions recommended by contributors to the inquiry

Proposed actions to help mitigate the barriers to reducing emissions from Scotland’s ferry operations include:

- Secure Governmental approval of green energy projects to support alternative fuel generation and upgrade supply infrastructure.
- Implement a near-term regulatory framework to bridge the cost differential between fossil and zero-carbon fuel, which should include a basket of measures but could include carbon pricing or zero-carbon fuel tax exemptions.
- Increase funding of R&D in zero-carbon technologies with investment in schemes to encourage retrofitting of existing vessels.

¹ FuelEU Maritime regulation will enter into force from 1 January 2025 and aims to support the decarbonisation of the shipping industry by increasing the share of renewable and low-carbon fuels in the European Union’s maritime transport. The law is technology neutral as it does not specify which fuels must be used in shipping, instead demanding that the greenhouse gas intensity of fuels is lowered over time.

- Prioritise operational efficiencies that can be made in the short and medium term through timetable optimisation and capacity utilisation.
- Use regulatory tools such as a zero emission berth standard at UK ports.
- Consider financial incentives for operators to use low- or zero-carbon fuels, increasing demand for the infrastructure and development of partnerships between first movers to establish long-term off-take agreements for zero-emission fuels.
- Enable industry leadership, collaboration, and early-stage investment from both the private and public sectors which is critical to kick-start the transition and reduce costs and risks.
- Design a clear framework between Government, National Grid and Distribution Network Operators for enabling the development of smart ports, addressing electricity supply needed to power electric ferries and planning for infrastructure development.
- Set Governmental targets for encouraging use of renewable fuels from non-biological origin (RFNBOs) to provide sufficient signals to shipowners to invest in zero-emission vessels.
- Secure Government support for alternative ship design and use for ferry routes (e.g. catamarans).

5. Overarching themes raised in the evidence

5.1 The need for clear and consistent policy signals and financial incentives

Evidence submitted to the inquiry was unanimous that continued government action and support is required to make Scotland's public transport networks fossil-free. This will require policy-makers to incentivise the transition to zero-carbon transport by using all financial and regulatory means within their power.

There was broad agreement that a technology-neutral approach should be pursued, but that signals are required to incentivise zero-carbon infrastructure development. That is, public support must be in place for particular technologies at particular times.²

The Government must be led by science. This implies certain basic principles: the primary objective being to reduce energy consumption and the second objective being to use renewable and zero-carbon power sources. Both of these must be achieved across *all* elements of the bus, rail and ferry industries (materials, manufacturing and operators).

It is clear that decarbonisation is not inexpensive so the Government's focus must pivot from 'value for money' to 'Best Value for Scotland's people, economy and environment' in order to capture the external benefits of transition away from fossil fuels. This will require a commitment to a long-term strategy and suitable supporting delivery plans.

5.2 The role of decarbonisation in assisting with modal shift objectives

Contributions to the inquiry repeatedly emphasise that decarbonisation of public transport, by switching to low- or zero-emission fuels, also presents the opportunity to cut emissions from the wider transport sector through behaviour change: by encouraging travellers to choose public transit (energy efficient) over private vehicle use (energy inefficient). This modal shift would maximise benefits as it results in reduced energy demand and emissions.³ It will also increase revenues which can be reinvested in further improving public transport.

In order to facilitate this behaviour change, the transition to decarbonised fleets of trains, buses and ferries should be delivered strategically in such a way that services aligns with [passenger priorities for punctual, reliable and frequent public transport](#) (as found by the independent watchdog for transport users, Transport Focus). Siemens, for example, reports that the digitalisation of the railway and its infrastructure helps improve predictability and accurate passenger information – the lack of which are often cited as reasons to not travel by train. As such, the inquiry highlights that pursuing wider transport policy targets for modal shift and sustainable travel behaviours alongside decarbonisation efforts would maximise the energy efficiency of the entire transport network.

² Discussion on potential options for financial support can be found in section 6.

³ Evidence from Paths for All notes that cars are by far the largest source of transport emissions, responsible for over 40% of Scotland's total. Providing passengers with access to alternative green and sustainable transport options will therefore assist with significant reductions of emissions in Scotland.

5.3 The role of public transport decarbonisation as a key component in Scotland's low-carbon industrial strategy

A key theme emerging from the submissions to the inquiry was the need for a clear and coherent industrial strategy to support decarbonisation and the low-carbon economy more generally. This involves developing Scotland's industrial base in zero-carbon transport technologies and securing a resilient and diversified supply chain within Scotland and the UK.

As noted by OREF, Scotland's abundance of natural resources means it will be providing the majority of the renewable energy for the UK so it would be beneficial for energy capture to be provided by Scottish industry and that the means to convert or transport it are in place. The main barriers to this is the absence of an industrial strategy and a disjointed approach to energy policy. By ensuring that both are in place, the nation could plan the energy flows and also the means of its use in all sectors beyond and including transport. Meanwhile, the absence of both would result in inefficiencies and time and money losses.

Such a strategy could include: developing markets for used vehicle components; fostering partnerships between industries; setting standards and providing incentives that push technologies towards the market; establishing markets across borders that currently face export barriers; supporting the existing Scottish bus manufacturing industry's transition to zero-carbon designs; expanding on the experimental work being conducted in Orkney on synthetic fuels; and introducing additional schemes to encourage a just transition to zero-carbon fuels and the development of a workforce to support the growth of a zero-carbon economy. Initiatives such as these would help address the challenges surrounding supply chains, and knowledge and skills development and retention (as discussed in section 3).

5.4 The need to enhance knowledge-sharing in delivering decarbonisation

Knowledge sharing was consistently flagged as a necessary action to simplify and accelerate the transition to a decarbonised public transport system throughout the evidence presented to the inquiry. This includes knowledge transfer both between operators and within the respective industries more widely. Measures to encourage this should be included in initiatives for Scotland's industrial strategy and will help minimise uncertainties for operators as well as assisting with skills development and training opportunities across the sector.

6. Financing decarbonisation

Across the evidence that the inquiry received, the most commonly cited barrier to decarbonising public transport was cost. As it stands, the lack of a carbon tax (or a similar mechanism) often means that it is cheaper for the transport sector to pollute than innovate.

Evidence submitted to the inquiry made various proposals as to how the decarbonisation of public transport can be funded. Contributors argued that while continued government support will be required, private sector funding should be explored, increased revenue can be brought about by delivering modal shift, and, as was noted in section 4.1.1 above, circular economy approaches can also lead to the generation of new income.

Increased revenues through modal shift can be achieved if appropriate wider transport policies are implemented

Increasing public transport patronage would boost passenger revenue for operators and help fund the infrastructure required for decarbonisation. Evidence to the inquiry argues that measures to make public transport more attractive to new passengers are crucial to making sustainable transport pay for itself. That is, measures to tackle congestion on bus routes, discourage car use and limit excessive levels of flying are required to have more paying customers on Scotland's buses, trains and ferries.

Contributors proposed appropriate impact cost pricing on road transport, such as road user/congestion or parking levies, as a means of raising revenue. The results of such measures are two-fold: revenue raised can pay for public transport decarbonisation and car users are encouraged to shift to sustainable transport options, resulting in increased passenger revenue. Policies to achieve the Scottish Government's traffic reduction target (20% reduction in car km by 2030) and recommendations for financing public transport decarbonisation are therefore complementary. Although the details of implementation are outside the scope of this inquiry, it should be noted that a 'one size fits all' approach to car disincentives will not work well, not least as urban and rural transportation needs and challenges can be very different.

But passing costs on to operators & passengers will damage public transport demand

Although boosting passenger revenue is key to financing the transition to a zero-carbon public transport network, contributors to the inquiry cautioned that efforts to finance decarbonisation by passing costs on to operators would be unsustainable and likely lead to dire consequences for public transport use. That is, passing on costs to end-users, particularly in the context of the cost-of-living-crisis, could discourage the use of public transport and instead drive increased private motor vehicle use.

Continued government financial support will be required

The higher costs currently associated with zero carbon technology makes investment in climate-friendly transport not commercially viable for many operators. As such, contributors to the inquiry state that continued government funding is imperative to permit decarbonisation of public transport infrastructure. The Orkney Renewable Energy Forum notes that the Government has the ability to borrow at low rates and use powers to enable change at a faster rate and should therefore use its powers to enable borrowing (either directly or through bodies it directs) to commit to the capital projects immediately. The sooner this is achieved, the sooner the nation's industry can be reoriented away from fossil fuels and onto sustainable markets. This will give Scottish businesses a lead and provide an opportunity to develop and export technology.

Government support can be supplied through capital schemes as done for zero-emission buses through the SULEB and ScotZEB schemes. For ferries, CMAL notes that it is imperative that government capital funding continues to fund zero-carbon ferries and permit decarbonisation of port infrastructure.

A common argument presented in the evidence was the need for the Government to recognise and capture the benefits of decarbonisation accrued directly or indirectly – such as reducing health costs, community or regeneration benefits – in its investment decisions. That is, the Scottish Government must reduce expenditure

on carbon-intensive activities and instead pursue financing models structured around maximising these benefits and building a transport network that is aligned with the transport hierarchy.

New models of private financing should be actively explored

A variety of private financing options can also be adopted, and are of particular relevance for Scottish bus operators. A comprehensive review and analysis of funding models including refinancing, operation leases, green bonds, and integrated end-to-end financing (transport-as-a-service) are provided in the [Zero Emission Bus Financing Ideas Pack](#) provided by CPT.

Other financial levers are available to attract investment in public transport. For instance, the Scottish Government recently announced its intention to broaden the sources of financing available for infrastructure projects in Scotland. In October 2023, the First Minister outlined the [intention for Scotland to enter the international bond market for the first time](#); to issue bonds to help raise Scotland's profile and engagement with international investors to attract investment. It may be that this additional source of capital funding could be used to decarbonise and improve Scotland's public transport fleet and its associated infrastructure.

7. Conclusions and recommendations

Transport is Scotland's single most polluting sector, with emissions from transport responsible for over a third of the nation's total greenhouse gas emissions. In light of the climate emergency, the Scottish Government has committed to [cut these emissions by over 50% in the next seven years \(by 2030\) before reaching net zero by 2045](#). In light of this – and the fact the transport sector has failed to significantly cut its emissions in the past 30 years – it is critical that a swift and coordinated transition to a decarbonised transport network is achieved.

To make big cuts into transport emissions, action will be needed both to cut transport demand and to deliver modal shift to sustainable transport. But we also need to decarbonise all remaining transport. This report makes the case for public transport decarbonisation, outlining the benefits and opportunities of ending the reliance of Scotland's buses, trains and ferries on fossil fuels. It finds that policies to support the procurement and deployment of a zero-carbon public transport fleet are crucial, and argues that such a fleet will: cut emissions at the point of use to improve local air quality and health; attract passengers to new climate-friendly services and reduce private vehicle use; reduce dependence on the fossil fuel supply chain; contribute to the global effort for emissions reductions, and foster a zero-carbon economy in Scotland, along with green jobs and skills.

Decarbonising buses

Contributors to the inquiry flagged numerous issues: these included a request for specific support for R&D to support the design and development of smaller long-range electric buses; support for smaller operators in decarbonising their fleets; and the need to identify a decarbonisation pathway for coaches. However, the most consistent theme was the need to resolve uncertainty around financial support for the bus sector. This leads us to make the following recommendation:

RECOMMENDATION 1:

Incentivise the purchase of zero-emission buses by introducing an enhanced Network Support Grant (NSG) rate for their use.

At present, NSG rates provide no incentive for operators to use zero-emission buses (ZEBs). Reforming NSG rates will enable more SMEs and rural operators to consider investment. It will also benefit suppliers who should receive orders year round rather than only during ScotZEB bid windows. This change could be implemented as part of the Scottish Government's review of NSG intended as part of its ongoing Fair Fares Review.

Decarbonising the railway

A consistent theme in evidence submitted to the inquiry was that a cohesive plan for the delivery of infrastructure and rolling stock was imperative, and that this would require close coordination between Transport Scotland, Scotland's Railway, energy suppliers, the energy distribution network, and the railway supply chain. Evidence flagged the need for early progress in determining how to deliver zero-emission services on rural lines where hydrogen or battery trains may prove a more cost-effective option. However, the most consistent theme was around electrification, which leads us to the following recommendation:

RECOMMENDATION 2:

Put in place a rolling programme of rail electrification as part of a refresh of Transport Scotland's Rail Services Decarbonisation Action Plan.

Historically, the UK has suffered from a stop-start approach to electrification. In order to decarbonise Scotland's railway, electrification of around 1,400 single track kilometres will be required within the next 12 years. A rolling programme of electrification will allow skills to be acquired, developed and retained in Scotland.

Decarbonising ferries

The inquiry identified a wide range of actions to decarbonise Scotland's ferry fleet. There was a need for much greater clarity on the future regulatory framework and intended programmes of investment; that emissions reduction from the fleet may be achieved by pursuing alternative ship designs; that retrofitting of existing vessels could be brought about through targeted investment in R&D; and that shorter-term operational efficiencies may be achieved through timetable optimisation and capacity utilisation. But the strongest message heard across the inquiry was to make a policy decision to:

RECOMMENDATION 3:

Make the presumption that, where possible, all new ferries procured should be plug-in electric.

Electric shipping will deliver both a reduction in pollution and a reduction in energy needed for propulsion. The inquiry heard that 37% of Norway's car ferries (49 out of 132) are already electric, and that these had all been introduced since 2015, so it is evident that swift progress can be made. Plug-in electric ferry technology will initially need to be focussed on shorter routes (less than two hours each way) as larger vessels on longer routes will require power beyond existing battery capacity. However, the imperative was to electrify whatever is possible now, and to look at other fuel sources (e.g. non-fossil liquid fuels) for the rest of propulsion requirements. Future electrification will be facilitated by good investment decisions so that we're not procuring larger, heavier vessels which will be harder to retrofit for decarbonisation at a later date.

Financing the transformation

Inquiry respondents consistently highlighted that the higher capital costs and significant up-front investment required to deliver zero-carbon transport — whether new vehicles/vessels or energy supply and charging infrastructure — can make investment commercially unviable. While continued public funding/grants from the Scottish Government will be required, inquiry respondents also recognised the opportunities provided by alternative financing options.

RECOMMENDATION 4:

Use the Scottish Government's planned bond issue to finance investment in zero-carbon public transport infrastructure.

Governments have the ability to borrow at lower rates than are typically available to commercial entities such as public transport companies. In October 2023, the First Minister announced the Scottish Government's intention to "issue its first ever bond to finance key infrastructure in Scotland", stressing that infrastructure investment should "delivering high quality public services, boosting a green and thriving economy and ensuring equality of opportunity for everyone". The decarbonisation of Scotland's public transport networks would seem an ideal fit with these worthy policy objectives.

Boosting Scotland's zero-carbon economy

Evidence submitted to the inquiry highlighted that zero-carbon transport infrastructure will help to drive wider society to decarbonise and end reliance on fossil fuels, noting that a clear and coherent industrial strategy is needed to realise these benefits. Such a strategy could include: developing markets for used vehicle components; fostering partnerships between industries; supporting the existing Scottish bus manufacturing industry's transition to zero-carbon designs; and expanding on the experimental work taking place on e-fuels for use in ferries. These initiatives would help address the challenges surrounding long or complex supply chains and knowledge and skills development and retention.

RECOMMENDATION 5:

Ensure the Scottish Government's forthcoming 'Green Industrial Strategy' facilitates the development of local renewable energy sources which can be used to power Scotland's future vehicle and vessel fleets.

In its Programme for Government 2023-24, the Scottish Government commits to develop a Green Industrial Strategy which will set out how it intends to 'help businesses and investors realise the enormous economic opportunities of the global transition to net zero and of creating good, well-paid jobs in sectors such as offshore wind and hydrogen'. This new industrial strategy should facilitate the development and investment in local renewable fuel supply chains such that Scotland can become both self-sufficient and a net exporter of alternative fuels and associated expertise.

APPENDIX 1:

With thanks to the inquiry contributors

Alexander Dennis

Caledonian Marine Assets Ltd (CMAL)

Centre for Climate and Environmental Research Oslo (CICERO)

Confederation of Passenger Transport (CPT)

Edinburgh Bus Users Group

European Marine Energy Centre (EMEC)

FirstGroup

Heritage Railway Association

Light Rail UK

Orkney Renewable Energy Forum (OREF)

Railway Industry Association (RIA)

Siemens Mobility

Strathclyde Partnership for Transport (SPT)

Tactran

Transport Focus

APPENDIX 2:

Topics beyond the immediate scope of the inquiry

Light rail

It is important to note the value and role of trams and light rail in a zero-carbon public transport network alongside decarbonised buses, trains and ferries.

Scotland features the world's third-oldest metro systems (Glasgow Subway) as well as a newly-expanded light rail network (Edinburgh Trams); furthermore, the Scottish Government set out in its recent Strategic Transport Projects Review a commitment to develop mass transit systems in Aberdeen, Edinburgh and Glasgow, with an expectation that the latter two of these be wholly or predominantly light rail-based.

As light rail is already a fully-decarbonised form of public transport, being entirely reliant on electric traction, the topic was deemed as falling outwith the scope of the inquiry. However, evidence provided by Light Rail UK highlighted the benefits of tram installation and operation as including: an absence of pollution at the point of use; improved energy efficiency and lower energy consumption due to lower rolling resistance of steel wheels and rails compared to rubber tyres; the ability to encourage urban stability and inward investment by being a source of fixed infrastructure; the provision of a high capacity urban transport option to complement other modes, like trains and buses; and its ability to encourages modal shift from cars.

Heritage rail

Concerns have been raised with regards to the potential unintended consequences of decarbonisation for the heritage rail industry given its dependence on fossil fuels. Noting that heritage rail generates around £600m for the UK economy annually and takes cars off the road in some of the most sensitive environments by allowing people to reach remote landscapes via public transport, the Heritage Railway Association cautions that policy in this area must be very tightly framed to protect heritage rail together with its economic and cultural benefits for Scotland.

Credits:

Report written by Laura Hyde-White (Transform Scotland). Editing by Colin Howden (Transform Scotland).
Report design by Ana Soldatenko (Transform Creative).