Intervention 14 – Delivery of Rail Decarbonisation Programme (Phase 1)

1 Description of Package

Transport Scotland's Rail Services Decarbonisation Action Plan (DAP) published in July 2020, focusses on decarbonising rail traction energy through the removal of diesel-only passenger trains from the Scottish network by 2035. At present, just under a third of the Scottish rail network is electrified meaning diesel trains are the only realistic option to service the majority of Scotland's railways. However, diesel trains are the largest contributor to rail's annual emissions and if rail is to become a zero-emissions transport mode and play its role in supporting Scotland's net zero target by 2045, diesel must be removed and replaced with other technologies. From a freight perspective, electrification would enable longer and heavier freight trains to run faster with lower operating costs per tonne carried. Higher speed freight provides network capacity benefits, making it easier to provide regular, robust paths in the timetable for freight to run between passenger services, as well as passenger service journey time improvements, and lower performance risks across the rail network.

Edinburgh-Glasgow Improvement Programme

Around three-quarters of the 1,040 vehicles in Scotland's rolling stock fleet need to be replaced over the next 15 years and given the long lead in times for the procurement and delivery of replacement fleets, this process will commence imminently. We are keen to smooth this significant programme across 2025-2035 and the initial phase will look at replacing ageing diesel fleets in 2025-26. This procurement process will also allow for future DAP project fleet requirements to be added once funding approval has been granted. Early work on this fleet procurement strategy is underway which will enable infrastructure and rolling stock investment to be aligned and benefits maximised.

Progress is already underway to decarbonise the East Kilbride and Barrhead routes as part of the first phase of delivery against the DAP:

- East Kilbride Enhancement: holistic package of enhancement

measures including electrification of existing route to Glasgow, allowing fully electric services to run in this corridor to allow these to interwork with Barrhead and other south Glasgow routes.
- Decarbonisation of Barrhead services: electrification of network section allowing electric trains between Barrhead and Glasgow.

The remainder of phase 1 of the DAP includes the following 2 routes:

- Borders Line Decarbonisation: removal of diesel-powered units through the introduction of Battery Electric Multiple Unit (BEMU) train services, via partial electrification, with the potential for full electrification of the line and move to full-electric (EMU) services in the future.
- Fife Circle Decarbonisation (Leven services): removal of diesel-powered units through the introduction of BEMU services, via partial electrification, with the potential for full electrification of the line and move to EMU services in the future.

These routes have largely been selected as a first phase due to their strong alignment with the rolling stock strategy to replace Class 156 fleets (will become life expired around 2025) and the efficiency this drives. For example, Fife and Borders diesel rolling stock (Class 158s/170s) can be cascaded to other areas to replace Class 156s. New electric trains will reduce maintenance/other operational costs, drive more efficient fleet use and produce greater emissions reductions. Introduction of new vehicles can also be phased as rail demand changes to support wider transport decarbonisation aspirations.

2 What we have heard?

As part of the regional engagement work for STPR2, rail electrification schemes have been identified by stakeholders as options for further consideration across a number of regions including the South of Scotland, Ayrshire & Arran, Glasgow City Region, Edinburgh and the South East, Forth Valley, Tay Cities and the Highlands and Islands. Findings from the STPR2 Online Survey also showed that some 44% of respondents were either dissatisfied or very dissatisfied with the current overall passenger carrying capacity on the rail network.

Electrification provides an opportunity to improve journey times (with better acceleration) and the reliability of services (newer trains with fewer moving parts to maintain) and in doing so improve infrastructure capacity (i.e. enable more trains to run), while there will also be an opportunity for passenger carrying capacity upgrades (i.e. longer trains) depending on the rolling stock procured.

The potential for rail freight to make a major contribution to carbon reduction targets was also highlighted by stakeholders at the national STPR2 Freight Workshop.

The long-term commitment of the Scottish Government to achieving net zero carbon emissions by 2045 reinforces the importance

of greening Scotland's transport network, and trialling new technologies to support delivery of this legally binding, but widely supported goal; as evidenced by several local authorities following the Scottish Government's lead in declaring their own climate emergencies.

The Scottish Government aim to phase out new petrol and diesel-only cars and introduce LEZs which prohibit certain types of road-based vehicles travelling into city centres. This could result in a publicly inconsistent situation where LEZs prohibit or restrict diesel vehicles whilst diesel trains continue to operate to and from city centre stations.

3 The evidence base to support a case for change

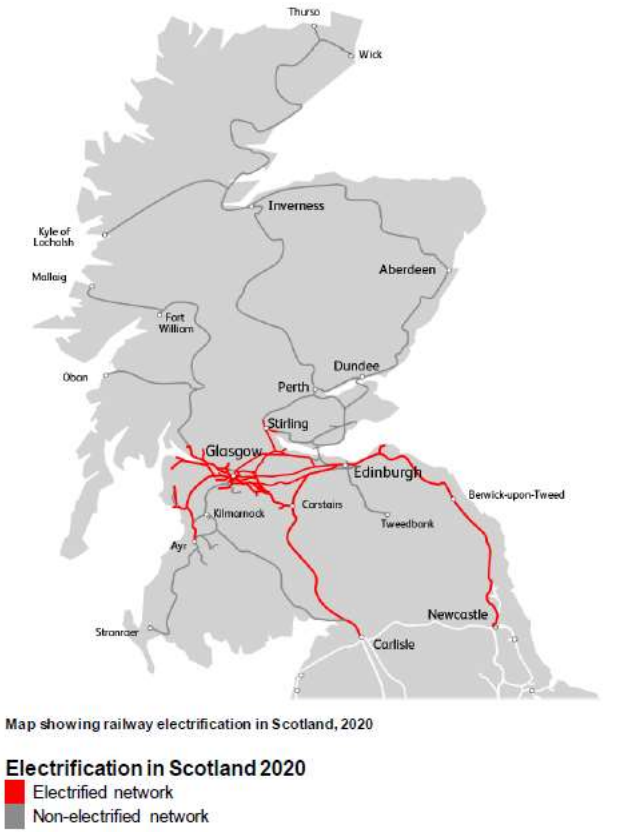
At present, around 29% of the routes which constitute the Scottish rail network is electrified[1] (see Figure 1) and accordingly, self-powered diesel trains are the only realistic options at present to service the majority of Scotland's railways. As set out in the NTS2, plans to decarbonise Scotland's passenger railways by 2035, including investments in battery-powered train and hydrogen fuel cell trains where electrification is not feasible, is therefore a key component in supporting delivery of the Scottish Government's net zero target by 2045.

[1] Rail Services Decarbonisation Action Plan, Transport Scotland. Available at https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf

Further electrification of the rail network, as well as decarbonising the wider surface transport sector in Scotland through modal shift to rail, therefore, has the potential to deliver significant environmental benefits; where this modal shift occurs to a zero emissions rail network, the benefits will be even greater. To further reduce emissions on Scotland's railway, particularly on routes with lower frequencies, new innovative options must be explored alongside already established 'green' solutions such as overhead line electrification. The recent rail industry decarbonisation taskforce[2] established that, alongside further electrification of rail infrastructure (benefitting freight and passenger services), the 2 technologies that are likely to be sufficiently mature to make a significant decarbonisation impact (for passenger services) in the future are hydrogen and battery powered trains. Being 'self-powered' reduces the required infrastructure investment, although infrastructure to support charging and fuelling would still be required.

These technologies, particularly hydrogen, are currently expensive and limited in power output and performance. However, they are flexible and can be used independently for some types of train service, in conjunction with discontinuous electrification, or as a transition measure prior to full route electrification schemes.

Transport Scotland has initiated work in this area by investigating opportunities for alternative traction models both for predominantly rural/scenic lines in Scotland and in areas where a policy of discontinuous electrification could be applied as an interim or transition measure.



Map showing railway electrification in Scotland, 2020

Figure 1 - Current Electrified Routes in Scotland

As set out above, the identification of potential schemes for the introduction of these alternative technologies, alongside location specific electrification, has already begun with progress already underway to decarbonise the East Kilbride and Barrhead routes as part of the first phase of delivery against the DAP. Other potential schemes that have been identified for decarbonisation include the Borders Line Decarbonisation, where the use of battery-operated trains could be used as an interim measure allowing for future full electrification of the line and help remove diesel fleets earlier, and the Fife Circle Decarbonisation (Leven services) scheme which aims to remove diesel powered units from this section of the network through the introduction of battery powered trains. These schemes would result in a further 3.5% electrification of the

[2] Rail Services Decarbonisation Action Plan, Transport Scotland. Available at https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf

Scottish Rail Network by route and an additional 3.3% of route which would be decarbonised through the deployment of BEMUs.

The combination of electric and alternative traction technolgies will contribute to a range of both user and environmental benefits for all. These include improved local air quality, reduced noise, as well as improved network resilience through the electrification of diversionary routes, journey time reductions and improved network capacity. The impact of these benefits could potentailly help further increase patronage on the network in Scotland which (prior to the COVID-19 pandemic) has been rising steadily over recent decades, with 97.8 million passenger journeys being made in 2018/19[3]. Understanding the current uncertainty in future travel demand (see Section 3.3 of the STPR2: Update and Phase 1 Recommendations Report), should this trend continue into the future, the increase in capacity created by electrification and the introduction of alternative tractions would make rail an even more attractive option for commuters, business and leisure travellers. Wider greener economic benefits could also be realised, and it was recently identified that a 5% shift in travel from cars to other modes (such as rail) would result in a monetised benefit of 0.5% of GDP in 2030[4].

Therefore, the benefits of investing in alternative traction will have wide ranging and positive changes within local and wider communities as well as linking in with the Scottish Government Hydrogen Policy statement and the wider transport proposals to create more robust demand. There is also the added incentive of becoming a world leader both in the use of alternative tractions on a national scale and in the reduction of carbon emissions – complementing Scotland's exisiting pedigree within the renewable energy industry. This could include building on Aberdeen's centre of excellence in hydrogen fuel technologies, with expansion of such technologies to rail potentially creating the levels of demand that will reduce the costs of hydrogen fuel and support the long-term sustainable growth of the sector in the region.

4 The strategic rationale

As set out above, the increased capacity, improved journey times and rolling stock enhancements that would be provided by rail decarbonisation presents an opportunity for rail to play its part in contributing to Scotland's net zero targets by encouraging a modal shift to rail for both passengers and freight. Rail traction is the single biggest source of rail carbon emissions; and the part of the rail industry where the most significant opportunity to achieve carbon net zero, with the least cumulative emitted carbon by taking the action set out in Transport Scotland's Rail Services DAP. As part of the route map to implement alternative fuel technologies for those routes which at present are not planned to be electrified, alternative traction technologies offer significant opportunities for the

[3] Scottish Transport Statistics No. 38 2019 Edition, Transport Scotland. Available at https://www.transport.gov.scot/media/47300/scottish-transport-statistics-2019.pdf
[4] https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf

development of new 'green jobs' as part of their associated supply chains most notably for battery and hydrogen traction energy sources.

For the freight sector in particular, higher power allows heavier trains to operate faster and at lower cost per tonne carried and makes it easier to operate more freight trains between passenger trains. Opportunities presented by further electrification of Scotland's rail network will enhance and protect the attractiveness for investors and organisations operating in Scotland that there is a confirmed and committed pathway to Zero Carbon freight movements as part of the logistics for the Scottish Economy. Increasingly funders and investors are being required to report on their carbon activities and their investments.

In addition to contributing to net zero targets, decarbonising the country's rail network could help contribute to a green economic recovery following the COVID-19 health pandemic through the development and growth of sustainable sectors involving green technology, most notably through battery and hydrogen traction energy sources.

It is in this context that this option has been promoted for taking forward as part of STPR2 Phase 1, with pilots of alternative traction technologies and a committed smoothed electrification programme providing an opportunity to develop Scotland's capability in this area, supporting modal shift of both passengers and freight to rail, net zero carbon emission targets, and aiding a green economic recovery. This intervention provides the Scottish Government, from a transport perspective, a significant opportunity to present to the Global Community its commitment to the decarbonisation of its transport sector for passengers and freight.

Why now?

- To deliver the Scottish Government's target of decarbonising rail passenger services by 2035, a clear commitment to a route level rollout of infrastructure and rolling stock investment is required over the next 15 years. Early planning is required to ensure there is strong alignment between the elements of this investment, with a focus on replacing life-expired rolling stock. Spreading rolling stock replacement over a 10 year period, from 2025, will also have significant operational and funding benefits. Maximising freight opportunities, which is a significant driver of transport decarbonisation, is also a critical factor as the replacement cycle for freight locomotives (approx. 632 locomotives) will increase rapidly from 2029 (40-year life).
- Some parts of the rolling stock fleet are ageing and decisions will soon be required on replacement fleets as a long lead time is needed to invest in new and/or retrofitted models from Rolling Stock Companies. The relatively small number of vehicles involved in the UK and Scotland rail system in comparison with the automotive industry, coupled with the lifespan of fleets (up to 35-40 years), means that investment in new rolling stock is a major decision and, accordingly, there are significant benefits from maximising use of the asset over its lifetime (cascading and refurbishing where possible).
- Small, older life expired fleets are relatively exepensive to run and require significant support. Moving towards larger, modern fleets will drive greater efficiencies together with operational and staff training benefits to push down ongoing costs.
- Alternative fuel technologies are continually evolving and at a fast pace. Accordingly, Scotland's rail industry will need to adapt

quickly to maximise the benefits offered by these technologies; given the timescales associated with delivering improvements on the rail network, it is important that early work starts now.

- Decarbonising the country's rail network could help contribute to a green economic recovery following the COVID-19 health pandemic through the development and growth of sustainable sectors involving green technology, most notably through battery and hydrogen traction energy sources. Arguably, COVID-19 provides a once-in-a-lifetime opportunity to 're-purpose' rail as a key contributor to the long-term growth and development of the economy. Investing in rail now will help to avoid a future where "pre-COVID-19" rail users have switched to car and use increasingly congested roads.

5 Meeting the STPR2 Transport Planning Objectives

TRANSPORT PLANNING OBJECTIVE	CONTRIBUTION	SCALE OF IMPACT (-3 to +3)
A sustainable strategic transport system that contributes significantly to the Scottish Government's net zero emissions target.	Decarbonisation of the rail network will contribute to the Scottish Government's net zero emissions target through the removal of diesel passenger and freight trains. Service enhancements associated with this intervention can also increase the attractiveness of the rail network, encouraging modal shift from private to public transport and to rail for freight, particularly for trunk haul as part of net zero multi-modal logistics supply chains for the Scottish Economy.	✓✓
An inclusive strategic transport system that improves the affordability and accessibility of public transport.	The delivery of new, modern rolling stock associated with network decarbonisation will contribute to improving the accessibility of the rail network. Quicker and more reliable journeys brought about by rail electrification and the associated rolling stock enhancements can also provide an opportunity for timetable enhancements which in turn can improve the accessibility of rail for the travelling public.	✓
A cohesive strategic transport system that enhances communities as places, supporting health and wellbeing.	A decarbonised network will help make rail a more attractive option with benefits delivered to places connected to the rail network. A cleaner railway, with increased capacity and improved reliability will provide scope for improved connectivity; connecting people to jobs, services and education, which in turn can deliver health and wellbeing benefits to communities. Minor benefits would be generated for those living and/or working near rail lines due to improved local air quality from the removal of diesel traction on the network and noise reduction.	✓
An integrated strategic transport system that contributes towards sustainable inclusive growth in Scotland.	For passengers, reduced journey times and increased capacity offered by rail decarbonisation, complimented by quieter, more comfortable and modern train stock could facilitate improved access to places of employment and other economic opportunities. For freight, heavier, faster and longer trains with improved path efficiency and operating economics (e.g. reduced fuel costs) could contribute to modal shift as part of modern	✓

	multi-modal supply chains. In addition this could increase investor confidence to commit private sector funds towards the supporting investments of terminals, wagons, last mile/first mile in response to public sector decarbonisation investments.	
A reliable and resilient strategic transport system that is safe and secure for users.	Decarbonisation is anticipated to deliver a step-change in the operational reliability and resilience of the rail network in Scotland with electric traction more reliable than diesel. Electrification of diversionary routes would also make the network more resilient for both passengers and freight. Improvements translate into a more secure and safe system for users.	✓✓

6 Addressing the Post COVID-19 Priorities

POST-C19 PRIORITIES	CONTRIBUTION
Employment	Decarbonisation can support enhanced network capacity, reduce journey times and improve connectivity, positively impacting on the ability of people to access employment and other economic opportunities. There are also employment opportunities across the country associated with both an immediate and sustained investment in the development, construction and operation of an electrified network, as well as associated with other technological advances required to deliver the DAP.
The Environment	Decarbonisation of the rail network will support improved air quality, reduce noise pollution and further reduce greenhouse gas emissions of rail travel, contributing to Scotland's net zero targets. Environmental benefits will also be delivered through the promotion of modal shift to rail from less sustainable modes. This will also help reduce greenhouse gas emissions and improve air quality.
Education	Decarbonisation is likely to have a negligible impact on this priority but may assist in Research & Development opportunities for Higher Education establishments.
Equalities	Improved rolling stock associated with this option could deliver accessibility improvements for vulnerable groups. There may be minor health improvements for those who live or work close to stations due to improved air quality, reducing health inequalities within communities.

7 SEA, EqIA and Other Impact Assessments[5]

ASSESSMENT	COMMENTARY
SEA (Strategic Environmental Assessment)	Reducing carbon emissions from rail travel and its associated infrastructure will have environmental benefits across the country, particularly at major stations within our cities. Increasing the attractiveness of the rail network through decarbonisation could encourage modal shift to rail for both passengers and freight. This will help to reduce greenhouse gas emissions and improve air quality. The intervention will therefore complement the SEA and help progress the SEA objectives. However, any new infrastructure will need to be designed to improve the public realm and setting of cultural heritage assets, as well as considering how to promote active travel.
EqIA (Equality Impact Assessment)	There may be minor health improvements for those who live or work close to stations due to improved air quality, reducing health inequalities within communities. The procurement of modern rolling stock will improve the accessibility of the rail network.
ICIA (Island Communities Impact Assessment)	This intervention is aimed at the rail network across Scotland, and is therefore not directly relevant to islands (where there are no railways).
CRWIA (Children's Rights and Wellbeing Impact Assessment)	There may be minor health improvements for those who live close to stations, including children and young people, due to improved air quality, reducing health inequalities within communities..
FSDA (Fairer Scotland Duty Impact Assessment)	Option likely to have a negligible outcome impacts against this Act given it is focused on improving the existing railway.

[5] All of these impact assessments are currently underway, but no formal assessments have yet been undertaken. Please note SEA and EqIA scoping reports have been produced and consulted upon.

8 Implementability and Interdependencies

IMPLEMENTABILITY CRITERIA	COMMENTARY
Feasibility	Decarbonisation of the rail network is feasible and achievable. Further assessment and investigation is required to determine the optimum strategy for implementing and operating alternative traction. Further consideration of procurement and maintenance for new rolling stock will also have to be undertaken.
Affordability	The cost of delivering and implementing a decarbonised rail network across Scotland will be significant and will require long term investment over the next 15-30 years to achieve the final aim of a fully decarbonised rail network. However, plans for prioritisation and phasing of work would significantly aid in the planning for funding and allow long term investment planning. It is also a component in the Government's legal obligation to achieve net zero emissions by 2045. It is also to be noted that while capital construction costs will be high, decarbonisation could support operational cost savings in the future.
Public Acceptability	A rail network which is faster, operates at a higher capacity and is more environmentally friendly would be supported by the public.

Key Interdependencies

The introduction of alternative traction technologies would be severely hampered if the appropriate infrastructure for their optimum performance was not in place (e.g. signalling, charging stations, refuelling plants etc.). Therefore, a review of infrastructure requirements should be prioritised prior to the implementation of new rolling stock.

A comprehensive and clear procurement strategy will also be required to ensure the savings associated with purchasing/leasing new non-diesel stock can be realised.

Rail traction is the single biggest source of rail carbon emissions and the part of the rail industry with the most significant opportunity to achieve carbon net zero with the least cumulative emitted carbon by taking the action set out in Transport Scotland's Rail Services DAP. Progress is already underway to decarbonise the East Kilbride and Barrhead routes, as part of the first phase of delivery against the DAP, with the remainder of phase 1 of the DAP including the Borders Line and Fife Circle (Leven) decarbonisation. These routes have largely been identified for decarbonisation as a first phase due to their alignment with a rolling stock strategy to replace life-expired stock through full or partial electrification and introduction of electric or battery-electric trains, reducing operational costs, driving more efficient fleet use and greater emissions reductions.

In addition to contributing to net zero targets, decarbonising the country's rail network could help contribute to a green economic recovery following the COVID-19 health pandemic through the development and growth of sustainable sectors involving green technology, most notably through battery and hydrogen traction energy sources.