



STRATEGIC TRANSPORT PROJECTS REVIEW

PROTECTING OUR CLIMATE
AND IMPROVING LIVES



Appendix I: Recommendation Appraisal Summary Tables

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1. Detailed Appraisal Summary

An 'Appendix I: Recommendation Appraisal Summary Tables (ASTs) Explanatory Note' accompanies this AST.

1.1. Recommendation 25 – Decarbonisation of the rail network

Recommendation Description

This option proposes delivery of a continued, rolling programme of rail decarbonisation across Scotland's railways, through further electrification and alternative powered rolling stock, in line with [Transport Scotland's Rail Services Decarbonisation Action Plan \(DAP\)](#)ⁱ.

Replacing diesel trains, the largest source of rail carbon emissions, with cleaner technologies offers multiple benefits in addition to helping meet net zero targets. Electrification would improve journey times and strengthen reliability of both freight and passenger rail services. Capacity could be expanded through the use of longer trains and timetable efficiencies from improved acceleration. These provide indirect benefits because of the new incentives for passengers and freight to switch from road to rail.

The priorities for decarbonising key rail routes should align with the DAP, and while these would be subject to full business case assessment, they are likely to include:

- East Kilbride/Barrhead->Muirhouse Junction;
- Tweedbank->Newcraighall (Borders Line);
- Edinburgh->>Dunfermline->-Thornton->-Kirkcaldy->-Edinburgh (Fife Circle);
- Thornton->-Ladybank->-Perth;
- Ladybank->-Dundee;
- Perth->Dundee->Aberdeen->Dyce (including Raith's Farm freight terminal);
- Dunblane->Perth->Inverness->Dalcross.

Beyond these priority routes, the recommendation would include for the delivery of options to support the 2035 route map to decarbonisation set out in the DAP. Alongside further electrification of rail infrastructure (for freight and passenger services), decarbonisation of the rail network would also require the use of alternative fuel sources. The two 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.

1.2. Relevance

Relevant across Scotland

Further decarbonisation of the rail network in line with the DAP is likely to be relevant to:

- Existing rail users who could benefit from increased operational capacity, improved journey times and rolling stock enhancements;
- New users attracted by the benefits of a rail network with increased capacity (through faster freight trains and reduced headways) and connectivity;
- Users of other modes (through modal shift to rail); and
- The rail freight industry (electrification could enable longer and heavier freight trains to run faster with lower operating costs per tonne carried).

1.3. Estimated Cost

£2.5 billion - £5 billion Capital

As set out in the DAP, the major infrastructure cost components of electrification are:

- clearance of structures;
- installation of overhead line electrification;
- power feeding and sub-stations; and
- development, design and project management costs.

[Based on the estimated costs per kilometre of single track rail electrification from UK researchⁱⁱ](#) and the total length of Scotland’s rail network that requires to be electrified, it has been estimated that total capital costs for this recommendation could be within the £2.5bn to £5bn cost band.

In the longer-term, decarbonisation could support reduced operational costs in the future.

1.4. Position in Sustainable Investment Hierarchy

Targeted Infrastructure Improvements

The recommendation would contribute to five of the 12 NTS2 outcomes, as follows:

- Help deliver our net-zero target;
- Promote greener, cleaner choices;
- Get people and goods to where they need to get to;
- Be reliable, efficient and high quality; and
- Use beneficial innovation.

1.5. Summary Rationale

Summary of Appraisal

	TPO					STAG					SIA				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Low Scenario	+++	+	++	++	+	+	++	+	+	+	+	+	0	+	0
High Scenario	+++	+	++	++	+	+	++	+	+	+	+	+	0	+	0

Decarbonising Scotland’s railway network through further electrification and alternative powered rolling stock aligns with the STPR2 Transport Planning Objectives (TPOs), STAG criteria and aspects of the Statutory Impact Assessment criteria, particularly with respect to working towards the net zero target.

Rail traction is the single biggest source of rail industry carbon emissions and offers the most significant opportunity to achieve carbon net zero. Work has already been initiated in this area through the development of the Rail Services DAP – this recommendation would support delivery of the DAP.

Details behind this summary are discussed in Section 3, below.

2. Context

2.1. Problems and Opportunities

This recommendation could help to tackle the following problems and opportunities:

Problems and Opportunity Themes Identified in National Case for Change

- **Global Climate Emergency:** the Scottish Parliament committed to an ambitious target of net zero emissions by 2045 and transport needs to play its part. Transport is currently Scotland's largest sectoral emitter, responsible for 37% of Scotland's total greenhouse gas emissions (greenhouse gas emissions encompass CO₂ emissions) ⁱⁱⁱ in 2018 ([National Atmospheric Emissions Inventory 1990-2017](#))^{iv}. Our transport system needs to minimise the future impacts of transport on our climate.
- **Air Quality:** transport, and road transport in particular, remains a significant contributor to poor air quality. Air pollution increases the risks of diseases such as asthma, respiratory and heart disease, particularly for those who are more vulnerable. Air quality is often worse in areas of deprivation and is a health inequality issue.
- **Trade and Connectivity:** transport is crucial for trade and competitiveness, within Scotland, across the UK and internationally.
- **Freight:** whilst recognising the importance of freight within Scotland's economy, a key challenge will be to ensure that the negative impacts generated by the movement of goods vehicles, such as increased emissions from road freight, are tackled.

2.2. Interdependencies

This recommendation has potential overlap with other STPR2 recommendations and would also complement other areas of Scottish Government activity.

Other STPR2 Recommendations

- Highland Main Line rail corridor enhancements (15)
- Perth-Dundee-Aberdeen rail corridor enhancements (16)
- Edinburgh/Glasgow-Perth/Dundee rail corridor enhancements (17);
- Rail freight terminals and facilities (44); and
- High speed and cross-border rail enhancements (45).

Other areas of Scottish Government activity

- [Climate Change Plan 2018-2032 Update](#)^v (including car kilometre reduction target and net zero target) and the [Climate Change \(Emissions Reduction Targets\) \(Scotland\) Act 2019](#)^{vi} – this outlines the plan to decarbonise the majority of the passenger rail network by 2032;
- [Revised Draft Fourth National Planning Framework](#) (Revised Draft NPF4)^{vii} (including the expansion of green infrastructure); and
- [Transport Scotland's Rail Services DAP](#)^{viii} - the action plan sets out an initial, indicative programme of interventions which will secure benefits towards climate change objectives, local environmental objectives (including air quality) and the rail network and rail users.

Decarbonisation also has a number of wider dependencies. For example, the introduction

of alternative traction technologies would be severely hampered if the appropriate infrastructure for their optimum performance was not in place (for example, signalling, charging stations and refuelling plants). A comprehensive and clear procurement strategy would also be required to ensure the savings associated with purchasing/leasing new non-diesel stock can be realised.

3. Appraisal

This section provides an assessment of the recommendation against:

- STPR2 Transport Planning Objectives (TPOs);
- STAG criteria;
- Deliverability criteria; and
- Statutory Impact Assessment criteria.

The seven-point assessment scale has been used to indicate the impact of the recommendation when considered under the ‘Low’ and ‘High’ Travel Behaviour Variant scenarios (which are described in Appendix F of the Technical Report).

3.1. Transport Planning Objectives

1. A sustainable strategic transport system that contributes significantly to the Scottish Government’s net-zero emissions target	
Low Scenario	High Scenario
+++	+++
<p>Decarbonisation of the rail network would contribute to the Scottish Government's net zero emissions target through the removal of diesel passenger and freight trains. Potential service enhancements – delivered as a result of the expanded capacity provided through the use of longer trains and/or timetables efficiencies gained from improved acceleration – 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 logistic supply chains for the Scottish economy.</p> <p>This recommendation is therefore expected to have a major positive impact on this objective in both Low and High scenarios.</p>	

2. An inclusive strategic transport system that improves the affordability and accessibility of public transport.

Low Scenario	High Scenario
+	+

[The delivery of new, modern rolling stock associated with network decarbonisation would contribute to improving the accessibility of the rail network^{ix}](#) particularly as new vehicles would be more accessible for users, including persons with reduced mobility. 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.

This recommendation is unlikely to impact on affordability.

This recommendation is therefore expected to have a minor positive impact on this objective in both Low and High scenarios.

3. A cohesive strategic transport system that enhances communities as places, supporting health and wellbeing.

Low Scenario	High Scenario
++	++

A cleaner railway, with increased network capacity and improved reliability, would improve connectivity to jobs, services and education, which in turn can deliver health and wellbeing benefits to communities. Minor place, health and wellbeing benefits would also 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.

This recommendation is therefore expected to have a moderate positive impact on this objective in both Low and High scenarios.

4. An integrated strategic transport system that contributes towards sustainable inclusive growth in Scotland.

Low Scenario	High Scenario
++	++

For passengers, reduced journey times and increased capacity offered by rail decarbonisation, complemented by quieter, more comfortable and modern train stock, would 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 (for example, reduced fuel costs) would contribute to modal shift as part of modern multi-modal supply chains. In addition, this would 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.

This recommendation is therefore expected to have a moderate positive impact on this objective in both Low and High scenarios.

5. A reliable and resilient strategic transport system that is safe and secure for users.

Low Scenario	High Scenario
+	+

Decarbonisation would be expected to deliver a step-change in the operational reliability and resilience of the rail network in Scotland with [electric traction more reliable than diesel](#)^x. Electrification of diversionary routes would also make the network more resilient for both passengers and freight.

Overall, rail is considered a safe mode of travel. [In 2015, the Department for Transport^{xi} reported 24.1 passenger casualties and 0.2 fatalities per billion passenger kilometres, significantly better than private car usage, which reported 163 casualties and 1.1 fatalities per billion passenger kilometres.](#) Encouraging modal shift from road to rail through development and promotion of a more resilient, attractive (faster journeys and enhanced rolling stock) and greener rail network would therefore be expected to have positive impacts on the safety criterion.

The procurement of modern rolling stock designed in line with up-to-date best practice would improve the security of the rail network, although the impact of this is likely to be negligible.

Overall, this recommendation is expected to have a minor positive impact on this objective in both Low and High scenarios.

3.2. STAG Criteria

1. Environment

Low Scenario	High Scenario
+	+

See Strategic Environmental Assessment (SEA) below.

This recommendation is expected to have a minor positive effect on this criterion in both the Low and High scenarios.

2. Climate Change

Low Scenario	High Scenario
++	++

This recommendation is likely to result in positive effects on Climate Change in terms of objectives related to Climatic Factors and Air Quality, particularly in relation to the achievement of a reduction in transport-related emissions; as it seeks to reduce emissions from rail through decarbonisation and the use of alternative fuelled rolling stock (electric, hydrogen). Encouraging modal shift from private to public transport and to rail for freight would also contribute positively to this criterion by reducing greenhouse gases from less sustainable modes.

There is not expected to be any impact on vulnerability to effects of climate change or potential to adapt to effects of climate change.

Overall, this recommendation is expected to have a moderate positive impact on this criterion in both the Low and High scenarios.

3. Health, Safety and Wellbeing

Low Scenario	High Scenario
+	+

Overall rail is considered a safe mode of travel. [In 2015, the Department for Transport^{xii} reported 24.1 passenger casualties and 0.2 fatalities per billion passenger kilometres, significantly better than private car usage, which reported 163 casualties and 1.1 fatalities per billion passenger kilometres.](#) Encouraging modal shift from road to rail through development and promotion of a more resilient, attractive (faster journeys and enhanced rolling stock) and greener rail network would therefore be expected to have positive impacts on the safety criterion.

The procurement of modern rolling stock designed in line with up-to-date best practice may improve the security of the rail network, although the impact of this is likely to be negligible.

A cleaner railway, with increased network capacity and improved reliability, would improve connectivity to jobs, services and education, which in turn can deliver health and wellbeing benefits to communities. There may also be a positive impact on access to health and wellbeing infrastructure.

Minor place, health and wellbeing benefits would also 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.

Depending on the location and nature of infrastructure required, there is potential for negative effects on visual amenity during construction and operation of this recommendation. For example, where overhead line equipment is installed for rail electrification. It is therefore recommended that further environmental assessment is undertaken when the locations of new infrastructure are identified in order to identify potentially significant location-specific environmental effects and mitigation where appropriate.

Overall this recommendation is expected to have a minor positive impact on this criterion in both Low and High scenarios.

4. Economy

Low Scenario	High Scenario
+	+

The increase in network capacity, potentially reduced journey times and improved connectivity created by electrification and the introduction of alternative tractions would be expected to increase access to employment, making rail an even more attractive option for commuters, business and leisure travellers. [Modal shift would be expected to help realise wider greener economic benefits with it 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^{xiii}](#). Wider economic impacts would also be delivered through the creation of more skilled, sustainable jobs in Scotland, associated with a sustained investment in the development, construction and operation of an electrified network, as well as associated with other technological advances required to decarbonise Scotland’s rail network.

This recommendation is therefore expected to have a minor positive impact on this criterion in both Low and High scenarios.

5. Equality and Accessibility

Low Scenario	High Scenario
+	+

Decarbonisation would be expected to improve the accessibility of the rail network through the delivery of new, more accessible rolling stock. Potentially 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. It is noted that rail improvements would only provide benefits to those who can access the rail network and there would be no change to the geographical coverage of the rail network, nor would there be any change to active travel network coverage

This recommendation is unlikely to impact on affordability or comparative accessibility, in terms of the needs of socially excluded groups.

Also refer to EqIA/ICIA/FSDA/CRWIA Assessment in the next section.

Overall, this recommendation is expected to have a minor positive impact on this criterion in both Low and High scenarios.

3.3. Deliverability

1. 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. The [DAP estimated that to reach the target of decarbonisation by 2035, approximately 130 single track kilometres will require to be electrified, on average, per year^{xiv}](#). While this is challenging, in recent years a number of significant electrification projects have been introduced in Scotland in conjunction with major infrastructure enhancements, such as on routes between Edinburgh and Glasgow via Falkirk High and Shotts and Stirling to Dunblane and Alloa. While alternative traction technologies are still being developed and trialled, [battery is currently considered effective for lower-intensity services of up to around 55 miles^{xv}](#); Significant investment in production and distribution for hydrogen fuel is already taking place in Scotland and this is expected to become a major energy source for rail as well as other forms of transport.

2. Affordability

The cost of delivering and implementing a decarbonised rail network across Scotland would be significant and would require long-term investment over the next 15-30 years to achieve the final aim of a fully decarbonised rail network. Plans for prioritisation and phasing of work would aid in the planning for funding and allow long-term investment planning. As far as alternative traction is concerned, the DAP highlights that adding battery capability to electric trains adds around an additional 25% to their capital cost, while the cost-effective viability of hydrogen is expected to improve over time as usage volumes increase noting that the cost of diesel may increase as less diesel is required for road transport.

While capital construction costs would be high, decarbonisation could support operational cost savings in the future.

3. Public Acceptability

A rail network which is faster, operates at a higher capacity and is more environmentally friendly would be supported by the public - the STPR2 online survey (undertaken December 2019 to January 2020) showed that some 44% of respondents were either dissatisfied or very dissatisfied with the current overall passenger carrying capacity on the rail network.

The benefits provided by decarbonisation were reflected in the support for electrification schemes from many of the STPR2 regions, while the potential for rail freight to make a major contribution to carbon reduction targets was highlighted by stakeholders at the national STPR2 Freight Workshop. Electrification of various lines was also suggested in the STPR2 online survey.

3.4. Statutory Impact Assessment Criteria

1. Strategic Environmental Assessment (SEA)	
Low Scenario	High Scenario
+	+
<p>This recommendation would likely result in positive effects on the SEA objectives related to reducing greenhouse gas emissions (Objective 1) and improving air quality (Objective 3), particularly in relation to the achievement of a reduction in transport-related emissions; as it seeks to reduce emissions from rail through decarbonisation / use of alternative fuels (electric, hydrogen). The recommendation would also have a positive effect on maintaining the existing transport network (Objective 8) as it is promoting a more sustainable use and management of the existing transport network. It would also have a positive effect on noise and vibration (Objective 5) as a result of a move away from diesel engines to alternatives such as battery or hydrogen which would also result in a beneficial effect on noise and vibration during operation.</p> <p>There are possible positive effects on water, biodiversity and soil (Objectives 10, 11 and 12 respectively) as a result of a reduction in diffuse pollution on key receptors, however the significance of the effects are uncertain at this stage.</p> <p>Depending on the location and nature of infrastructure required, there is potential for negative environmental effects during construction and operation of the improvements, particularly on natural resource usage, the water environment, biodiversity, soil, cultural heritage and landscape and visual amenity (Objectives 9 to 14). For example, where overhead line equipment is installed for rail electrification. It is therefore recommended that further environmental assessment is undertaken when the locations of new infrastructure are identified, in order to identify potentially significant location-specific environmental effects and mitigation where appropriate.</p> <p>Whilst the recommendation is related to the remaining SEA Objectives, it is unlikely to have a notable effect on the achievement of these objective and is therefore considered neutral.</p> <p>Overall, this recommendation is expected to have a minor positive effect on this criterion in both the Low and High scenarios.</p>	

2. Equalities Impact Assessment (EqIA)

Low Scenario	High Scenario
+	+

There may be minor health improvements for those who live or work close to the rail network due to improved air quality, reducing health inequalities within communities. Improved health outcomes as a result of better air quality are of particular benefit to those who are more vulnerable to air pollution, including children, older people and disabled people.

The procurement of modern rolling stock would also improve the accessibility of the rail network.

This recommendation is therefore expected to have a minor positive impact on this criterion in both Low and High scenarios.

3. Island Communities Impact Assessment (ICIA)

Low Scenario	High Scenario
0	0

This recommendation is not considered directly or indirectly relevant to island communities.

This recommendation is therefore expected to have a neutral impact on this criterion in both Low and High scenarios.

4. Children’s Rights and Wellbeing Impact Assessment (CRWIA)

Low Scenario	High Scenario
+	+

There may be minor health improvements for those who live close to the rail network, including children and young people, due to improved air quality, reducing health inequalities within communities. A cleaner railway, with increased network capacity and improved reliability, would improve connectivity to education which could also bring benefits for children and young people.

This recommendation is therefore expected to have a minor positive impact on this criterion in both Low and High scenario.

5. Fairer Scotland Duty Assessment (FSDA)

Low Scenario	High Scenario
0	0

A cleaner railway, with increased network capacity and improved reliability, has the potential to improve connectivity to jobs, services and education. However, it is noted that this recommendation would only provide benefits to those who can access the rail network and there would be no change to the geographical coverage of the rail network.

This recommendation is therefore expected to have a neutral impact on this criterion in both Low and High scenarios.

References

- ⁱ Rail Services Decarbonisation Action Plan, Transport Scotland, 2020, <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>
- ⁱⁱ Rail Electrification Cost Challenge, Railway Industry Association, 2019, <https://www.nsar.co.uk/wp-content/uploads/2019/03/RIA ECC.pdf>
- ⁱⁱⁱ Greenhouse gas emissions encompass CO₂ emissions
- ^{iv} National Atmospheric Emissions Inventory 1990-2017
- ^v Scottish Government, Securing a green recovery on a path to Net Zero: climate change plan 2018–2032 – update, 2020, <https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/>
- ^{vi} Scottish Government, Policy: Climate Change (Climate Change (Emissions Reduction Targets) (Scotland) Act 2019), 2019, [https://www.gov.scot/policies/climate-change/reducing-emissions/#:~:text=The%20Climate%20Change%20\(Emissions%20Reduction,2030%2C%2090%25%20by%202040](https://www.gov.scot/policies/climate-change/reducing-emissions/#:~:text=The%20Climate%20Change%20(Emissions%20Reduction,2030%2C%2090%25%20by%202040)
- ^{vii} Scottish Government, Revised Draft Fourth National Planning Framework, <https://www.transformingplanning.scot/national-planning-framework/>
- ^{viii} Rail Services Decarbonisation Action Plan, Transport Scotland, 2020, <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>
- ^{ix} ORR website summarises how trains built at different times are subject to different legislative requirements for accessibility: <https://www.orr.gov.uk/guidance-compliance/rail/health-safety/passenger-safety/rail-vehicle-accessibility>
New rolling stock has stricter accessibility requirements, with respect to: Wheelchair space; Scooter / mobility aid acceptance; Accessible toilet; Standard toilet; Boarding ramp; Priority seating; Aural information; Visual information; On-train staff to provide assistance.
- ^x Network Rail, Network Route Utilisation Strategy (RUS) Electrification Strategy, 2009, <https://www.networkrailmediacentre.co.uk/resources/networkrus-electrification>
- ^{xi} <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>
- ^{xii} <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>
- ^{xiii} Greenhouse gas emissions encompass CO₂ emissions
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/944176/rai0502.ods
- ^{xiv} <https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf>
- ^{xv} Rail Services Decarbonisation Action Plan, Transport Scotland, 2020, <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>
- ^{xvi} Rail Services Decarbonisation Action Plan, Transport Scotland, 2020, <https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>