

Rail for All
Mini-report on Rail Decarbonisation

Final Report to John Finnie MSP, Scottish Green Party

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Introduction

Rail electrification is a key theme of the *Rail for All* main report, and a review of the Scottish Government's views on rail electrification was expected to be included in the original report, but the former was delayed from the intended March publication date.

This mini-report is therefore a supplement to *Rail for All*, which was largely completed before Transport Scotland published its *Rail Services Decarbonisation Action Plan* ('Decarbonisation Plan') on 28 July 2020
<https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf>

***Rail for All* report and Decarbonisation Plan comparisons**

The *Rail for All* report is well-aligned with the Decarbonisation Plan, with the differences relating to options for the less intensively-used parts of the network.

The major difference is that *Rail for All* proposes a strong focus on full electrification of the Edinburgh/Glasgow to Aberdeen and Inverness routes by 2030 so that it is fully aligned to the age of the diesel rolling stock with the Inter7City High Speed Trains (HSTs), expected to be at the end of their viable working life in 2030, when they will be over 50 years old.

Had a proper Rolling Programme been taken forward a decade ago – as set out in the Strategic Transport Projects Review (STPR) in 2008 – then the remaining Glasgow area suburban routes would be operating electric trains now, the Borders Railway would be in the process of being electrified, and design and route clearance work would be happening on the Inter7City routes north to Perth and Dundee, en route to Aberdeen and Inverness. And the replacement of the HSTs with electric trains by the end of their operational service life in 2030 would have been easily achievable.

Rail for All is less certain about providing fixed electrification equipment on the (Glasgow-) Kilmarnock-Dumfries-Gretna (-Carlisle), Aberdeen-Inverness, Ayr-Girvan and Inverness-Dingwall routes, but as these were considered to be for implementation later in the programme (post 2030) it was felt that a definitive view was not required at this stage, as decisions may change with advances in technology.

The implications of the Decarbonisation Plan are that more complex and expensive bi-mode rolling stock is going to be required for a relatively short transition period, which will lead to very substantial whole-life cost increases over the 30-year life of the trains.

The critical issue is whether the focus in the Decarbonisation Plan on short Central Belt urban routes (Glasgow-Maryhill-Anniesland, Glasgow-East Kilbride / Barrhead / Kilmarnock, the Borders Railway, Levenmouth and parts of Fife) takes resources away from the key need to focus on the long-distance Aberdeen and Inverness

routes (which involve important freight as well as passenger flows). Only the Levenmouth/Fife route can be considered to be aligned with the longer-distance routes (as well as offering freight potential), since an interim discontinuous electrification project, with battery power for the non-electrified sections, looks to be a sound transitional approach.

This could be applied to other routes, except for the Borders Railway, which is already substantially electrification-ready and where electrification and some modest infrastructure upgrades would deliver the required – but currently unachieved – punctuality and reliability performance levels.

Scottish Government policy

Transport Scotland is actively embracing the rail industry's analysis of the future decarbonisation of rail. Both the Rail Decarbonisation Task Force Final Report to the UK Minister of Rail – <https://www.rssb.co.uk/en/research-and-technology/sustainability/Decarbonisation/Decarbonisation-our-final-report-to-the-Rail-Minister> and Network Rail's new Traction Decarbonisation Network Strategy – <https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Interim-Programme-Business-Case.pdf> – are promoting traditional fixed electrification as the most cost and energy effective method of decarbonising much of the railway.

Rail is the only mode which can use electricity directly for traction (as opposed to using batteries or hydrogen to store and release electrical energy on the vehicle), so it is by far the most energy-efficient method of using electricity for traction. Figures from the *Rail Engineer* journal suggest that to deliver 1 Kilowatt of traction energy at the wheel using conventional electrification requires 1.2 Kilowatts of generation capacity, whereas use of hydrogen requires typically 3.4 Kilowatts, representing a near tripling of generation capacity, which is clearly unsustainable for universal use. By comparison battery power requires about 1.3 Kilowatts of generation capacity.

This principle applies to all energy use – direct use of electricity is much more efficient than use via batteries or a vector such as hydrogen. The implication for rail is that hydrogen or batteries are niche forms of decarbonisation compared with fixed electrification, for use only where the amount of fixed equipment is excessive compared with the number of trains operating – such as on rural routes.

This is recognised in Transport Scotland's Decarbonisation Plan. However, the long term choice between hydrogen and battery is one that is currently difficult to predict. The Scottish Government is at present focussing on hydrogen, with a major Scottish Enterprise-led '**Zero Emission Train**' project. It is not clear that the focus on hydrogen will yield clear results compared with the wider private sector focus on battery-based solutions. It is important that this does not distract from the key tasks – to decarbonise the long-distance routes to and between Aberdeen and Inverness and the remaining suburban routes around Edinburgh and Glasgow.

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As an interim or transitional solution, battery additions to existing electric multiple units (EMUs) would decarbonise the remaining Glasgow suburban routes and may be able to do the same with the shorter Edinburgh suburban routes, especially as electrification progresses on the Edinburgh–Aberdeen route through Fife.

Comments on the Decarbonisation Plan

The Decarbonisation Plan takes as an initial reference the Scottish Government’s National Transport Strategy 2 (published in early 2020) and the UK Rail industry Decarbonisation Task Force’s recently published plan. The Decarbonisation Plan clearly and correctly focuses on the decarbonisation benefits which flow from (i) modal shift to rail, and (ii) removing diesel passenger trains from the network. It does not make specific reference to the substantial benefits which can flow from replacing diesel freight trains with electric.

The Decarbonisation Plan recognises that the benefits can only be delivered if **the whole rail system is considered in an integrated manner** – route, rolling stock, power supply, structures and service operations. This is an absolutely critical point, especially on single lines such as much of the Highland Main Line or the Borders Railway, where reductions in journey time arising from the better performance characteristic of electric traction need to be accompanied by revising the location of the train crossing points – otherwise the reduced running time is wasted sitting at crossing points waiting for trains coming in the opposite direction.

We are entering a critical phase in the development of Scotland’s railways, as not only is there a need to provide the trackside electrification equipment, but also this needs to be preceded by defining what infrastructure is required for future operations and traffic levels, by re-signalling compatible with electrification, and determining the life cycle, particularly the end of life, for the diesel rolling stock.

This phase will involve **a substantial peak in rail investment compared with current levels** and will require a concentration on rail investment over the next 15 years, potentially assisted by the scaling back of further road-building plans.

As the key task is decarbonisation to meet the Climate Emergency, it is suggested that the primary focus for rail investment needs to be on the remaining fossil fuel powered routes (as opposed to those which are already electrified), because this will reduce carbon production and at the same time drive mode switch onto rail to remove long-distance passenger and freight operation from the roads, which will deliver higher carbon reductions.

Consequently it is suggested that whilst the ultimate outcome as set out in the map on page 41 of the Decarbonisation Plan – of the railway-decarbonised network in Scotland in 2045 – is an excellent objective, the interim stage (page 40) – **the projected railway-decarbonised network in Scotland in 2035 is five years too late for the key long-distance rolling stock lifecycle so likely to result in expensive rolling stock solutions for transient interim phases.**

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The Review Process is too extended, with the first review in Spring 2023 (page 7) at which point there will be very little time left for rolling stock procurement. This is particularly relevant in the context of costs (page 6) as there will be considerable route upgrade works required to deliver the full benefits of electrification, especially modal shift by the provision of faster services. Annual reviews of progress will be important in the relatively short delivery timescale.

While Section 3 of the Decarbonisation Plan focuses on the carbon benefits, which are crucial in terms of the Climate Emergency, it fails to take into account the *changes in electricity demand* required to replace oil-based transport fuels with renewable electricity. It is suggested that **minimising energy use for transport is a vital part of delivering the 2045 targets, otherwise there may not be enough electricity to power the nation**. This is particularly the case with freight where electrification will greatly reduce energy and emissions directly associated with the movement, will result in shorter and less resource-intensive journey times, and will create the ability to haul longer trains – whilst the higher Loading Gauge inherent in providing electrification clearances will improve the rail freight offer to the market. All of these will reduce rail freight unit costs.

One key passenger market benefit will be the ability to provide additional stations on some routes, thereby improving connectivity, where the superior acceleration of electric trains will compensate for the additional calls (page 13).

It is disappointing that **the opportunity has not been taken to state the percentage of vehicle and train kilometres which are electric and how that will change**, both now as a base line and for the future plan, with subsets of battery and hydrogen powered mileage. This is the key metric in reducing the carbon output of Scotland's railway.

Without sight of Network Rail's internal report '*enabling efficient electrification in Scotland*' (page 16) it is difficult to draw conclusions of the planning. **The use of bi-mode non-diesel trains is an act of faith as there are none currently available** to deliver the long-distance high-speed services which are the most urgent for electrification.

The concept of **discontinuous electrification (avoiding electrification through difficult structures) is likely to restrict or completely prevent electric operation of freight trains, so should only be seen as an interim solution** to deliver early benefits, not as a final outcome (box on page 17).

The operational benefits are generally well stated (page 19), but whilst electric trains are lighter and cheaper, bi-mode of all types are not!

The point about Power Supply (box on page 20) is important, as railway feeder points create significant costs in the provision of grid feeder points which also have long lead times. The benefit of this action plan is that the planning and delivery of grid feeder points can start now – but there is no indication that it is being started.

The rationale for alternative traction models (Page 22) refers to the ‘growing hydrogen economy that is developing in the North East’ (Followed by the Aberdeen Hub on page 23). This appears to be the opposite approach to what is required – the railway needs to define its optimal methods of powering trains and the infrastructure should then be provided, rather than what seems to be advocated – that the railway will subsidise the development of a hydrogen production facility. The limited rail network in the Aberdeen area, largely long-distance routes, does not seem to offer the right location for hydrogen-powered trains. It is suggested that **if hydrogen is the right solution it should be focused in rural areas such as the north or west Highlands, or the Stranraer area**, where hydrogen can be produced from surplus local wind energy.

There is a danger that the Longannet Rail Research Hub,(which is being centred around the proposed Talgo train production facility (note that the Talgo Research and Development facility is proposed for Chesterfield) is strongly focussed on hydrogen, at the expense of batteries. There is some **innovative battery development happening at the Vivarail company** – <https://vivarail.co.uk/> – which is a new and innovative business pushing the limits of the provision of lower-cost trains and new technology traction systems, which could be of value to the Scottish rail network – and should also be explored.

The diesel dilemma box (page 30) is an important and innovative point – diesel will not immediately disappear, but it is possible to significantly reduce the emissions from diesel trains over their remaining life and there are good opportunities to do this as a relatively low cost transitional element of the Action Plan.

Market Capacity (page 26) is a key factor. Scotland is well ahead of England in electrification planning and delivery (Wales is currently delivering a significant electrification programme in South Wales) and should seek to build on a strong local capability to deliver cost-effective electrification works. However HS2 has already started the tendering for its electrification system, which will be a massive project in comparison with Scotland, and England will start to catch up, with Trans-Pennine electrification already a possibility, so **there is real urgency to build a strong local ‘design and delivery’ electrification capability in Scotland.**

Innovation in electrification schemes (page 32) is a critical part of the Action Plan and one which is long overdue. The concept of developing electrification appropriate to Scottish needs is important and to be lauded. One area not mentioned is **‘planning approvals’ and access and land acquisition arrangements, which can create a significant burden in terms of cost, uncertainty and delay.** This is one area where the Parliament may be able to help by making appropriate changes to ease the process whilst still retaining proper scrutiny and accountability.

The Freight Benefits of electrification (page 34) are well argued and should not be overlooked, especially as decarbonisation of road haulage is extremely challenging.

Electrification of rail freight could make a very significant difference to transport carbon emissions.

However there is not currently a solution for rail freight (or passenger charter trains) on the long rural routes, which are not planned for electrification. Both battery and hydrogen carry significant weight penalties. Moreover the bulk of rail freight in Britain will be able to be hauled by electric locomotives with some, probably battery, on-board off-wire capability, so it is not obvious what will drive the development of suitable rural designs. The possible solution for this niche sector could be bio-diesel, which fits with the focus on bio-fuels for aviation and marine transport.

The proposed timescales and actions (page 35/6) for the remaining Glasgow suburban network and the Borders Railway are possibly not the key areas on which to focus immediate efforts. There is an urgent need to start the programme for electrification of the long-distance routes from Edinburgh and Glasgow to Aberdeen and Inverness in order to complete them by the time when the HSTs are coming to the end of their service life.

Vital time has been lost as result of not continuing the Rolling Programme after the completion of the Edinburgh-Glasgow and related routes electrification programme. Only now, some four years late, has the start of electrification design work of the next routes in the programme (the remaining Glasgow area suburban lines) been announced – in spite of the preliminary work having been undertaken some years ago. These routes could well be served by battery-fitted electric multiple units as part of an early transition to electric traction. This would enable the Rolling Programme to be ***refocussed to prioritise the InterCity routes to Aberdeen and Inverness, with their substantial passenger and freight potential – and avoiding the otherwise unnecessary purchase of bi-mode InterCity trains, which will add many millions to the costs of the current electrification programme.***