



RAILWAY INDUSTRY ASSOCIATION
Championing a dynamic rail supply sector

RIA Electrification Cost Challenge 2.0

June 2026

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Executive Summary

This report (RIA Electrification Cost Challenge 2.0) sets out why rail electrification remains essential to delivering a lower cost, higher performing, net-zero railway (the title of RIA's 2024 strategy report) and what must change to make delivery affordable and repeatable at a national scale. It builds on RIA's 2019 Electrification Cost Challenge and the 2024 strategy report, and responds to the stop-start pattern of electrification in England, which has weakened capability, reduced productivity and undermined supply-chain confidence.

For GBR leadership, the core message is that electrification is not primarily a technical challenge; it is a system leadership and programme delivery challenge. Electrification is widely proven to reduce whole-life costs and improve performance: electric traction lowers operating and maintenance cost, improves reliability, acceleration and capacity, and supports air-quality and carbon objectives. The report also highlights an under-recognised strategic benefit: electrification strengthens national energy security and resilience.

Despite these benefits, progress has been constrained by high up-front capital costs, and a project-by-project delivery model that repeatedly mobilises and demobilises teams. This creates avoidable cost, drives risk into individual projects, and prevents learning and productivity gains from being retained.

The report reiterates the case for electrification (Section 2) and then sets out how a rolling, programme-based approach can reduce delivery costs and improve whole system outcomes (Sections 3 and 4). RIA's cross-industry workshops concluded that, if key strategic enablers are put in place by GBR, electrification infrastructure costs could be reduced by around 30% compared with a well-delivered project today (with a range of 16% to 37% depending on the degree of adoption of the new delivery paradigm). The main drivers are continuity of workload, standardised ways of working, stronger portfolio planning, and commercial arrangements that sustain capability while maintaining performance incentives and competitive tension.

Central to the proposed approach is: (i) clear long-term direction on outcomes through an integrated infrastructure and rolling stock strategy; (ii) a defined maximum funding envelope that provides budget certainty and creates an incentive to outperform by retaining savings within the programme; and (iii) integrated 'track and train' planning so that rolling stock deployment (including Battery EMUs), electrification delivery and other major changes (e.g. signalling) reinforce each other.

The recommendations focus on actions that GBR can lead or influence now – updating the programme business case, setting the governance and funding framework, aligning infrastructure and rolling stock decisions, engaging early with the electricity supply industry, and restarting delivery to gain early benefits and protect critical capability – so that a rolling programme can commence credibly from 2029.

From 2029 the report proposes commencing a GBR-led rolling programme with sufficient continuity to sustain specialised resources and drive continuous improvement. For GBR, this is an opportunity to demonstrate competence in end-to-end whole-system delivery: setting outcomes, securing a stable funding approach, procuring delivery partners and converting continuity into measurable cost, time and performance gains.

Key points

- Electrification is a significant lever for GBR's core objectives: lowering whole-life cost and subsidy and improving performance and capacity. It also enables a credible net-zero trajectory while strengthening energy security and resilience.
- The affordability barrier is largely structural: stop-start authorisation and project-by-project mobilisation drive avoidable overhead, risk and loss of experience; continuity is the critical enabler.
- Industry estimates that, with the right strategic enablers, a GBR-led rolling programme could reduce infrastructure delivery cost by ~30% versus a well-delivered project today.
- GBR leadership actions now (to 2029) should focus on protecting capability and credibility (Battery EMU procurement, restart MMLe) and on putting in place a programme business case, programme governance, portfolio controls and commercial arrangements ready for CP8/FP1.
- Commencing in 2029 the GBR led rolling programme would provide the continuity of workload to support capability and reduce cost. Defining the required outcomes and the funding envelope will allow the programme to be agile and flexible, adapting to challenges and opportunities (Section 3.1.2).

Recommendations

Recommendation 1 – GBR to collaborate with industry to develop an efficient delivery plan for the whole system rolling stock and infrastructure strategy. This plan should address the strategic enablers (Section 4.2) and implement the programme-based approach (Recommendation 7) identified in this report

Recommendation 2 – To deliver the outcomes of the rolling stock and infrastructure strategy a maximum funding envelope should be defined. This will give government budget certainty and give industry confidence in the programme and an incentive to outperform as savings would be retained in the programme. There should be a separate smaller fund for development of electrification schemes to support timely and cost-efficient development and to ensure that learning is applied to future schemes.

Recommendation 3 – To prepare for the start of a rolling programme of electrification and the allocation of a funding envelope from 2029 (CP8/FP1) GBR should commission an updated whole system programme business case for network electrification to reduce the whole life cost of running the railway. This business case should include the wider economic benefits of the programme (Section 3.11) and the energy security and national resilience benefits (Section 2.5)

Recommendation 4 – To realise early benefits and protect industry capability government should urgently authorise the procurement via private finance of a significant tranche of Battery EMUs and restart the Midland Main Line Electrification Programme

Recommendation 5 – GBR to develop a flexible decade-by-decade delivery programme for the rolling stock and infrastructure strategy. Whilst flexible, this programme should always have sufficient activity to sustain core specialised resources.

Recommendation 6 – GBR to engage strategically with the electricity supply industry to develop a mutually beneficial plan for providing cost-effective electricity supplies to the rail industry

Recommendation 7 – GBR to implement a production line/rolling programme approach supported by appropriate commercial arrangements

1.0 The context of this report

In April 2024 RIA published a 'strategy for delivering a lower cost, higher performing net-zero railway by 2050 which showed what would need to be electrified to achieve net-zero and what could be operated by battery trains. GBR¹ are currently working on an integrated infrastructure and rolling stock strategy which, it is understood, will include additional electrification.

This new report will make recommendations about the most cost-efficient way to deliver the electrification² to support the strategy.

It will build on the '2019 RIA Electrification Cost Challenge (ECC) report which set out to identify the lessons from the debacle of the Great Western Electrification Programme

(GWEP). That report demonstrated that beyond certain problem projects, in 2019 electrification could be and was being delivered efficiently. In more recent years this has been further demonstrated in Scotland and on the Midland Main Line the latest phase of which was on time and under budget.

This new ECC 2.0 report will ask 'what needs to be different' to achieve a further significant reduction in the cost of electrification compared to the benchmark of a well delivered project today.

First however, given that electrification in England is currently 'paused', it is important to reiterate the case for electrification.

2.0 The case for electrification

It is widely accepted around the world that electric railways are lower cost and higher performing as well as zero-carbon. Yet the UK has less electric railway than its European peers. Recent historical reasons for this derive from the legacy of the Great Western Electrification Programme in the 2010s and the government's corresponding loss of faith in the industry's ability to deliver on time and on budget at that time. This overlooks the Scottish Government's successful on-time and on-budget electrification programme and the delivery of the latest phase of Midland Mainline electrification in 2025 within both spending and time envelopes.

RIA has been consistently arguing for electrification as the optimum option for rail traction since the Electrification Cost Challenge report in 2019. A series of reports have followed (The RIA bibliography is in Appendix D) making the case for the technology and continuity of delivery in contrast to the 'stop - start - stop again' reality of recent years.

This latest analysis is an extension of the RIA programme of work and is an explicit argument for a programme based approach for realising and maximising the economic and operational benefits of electrification.

The pausing or cancellation of further Midland Main Line electrification work in 2025 shows that railway electrification is not a current government funding priority. The cessation of the project has led to significant redundancies within supply chain businesses involved in the scheme. It further demonstrates that government

and some senior industry stakeholders remain unconvinced that continuity in workload is a key enabler of efficiency. For some, it seems that electrification is perceived as being too difficult, too expensive and too risky. RIA believes that this view is unambitious and defensive.

From a supply chain perspective, this pause and the resulting redundancies mean that there will be little confidence in any new strategy being long-lived. As a consequence, there will be a need to rebuild supplier confidence to underpin the investment in people and plant that will be necessary to deliver at lower cost than a well delivered project of today.

This report will show how GBR can work with industry to restore mutual confidence in electrification as a viable technological proposition for rail in the 21st century while retaining the flexibility to manage future rollouts affordably and efficiently.

Adopting the approach proposed in this report would reduce the whole-life cost of both upgrading and operating the railway, thus reducing subsidies while delivering major passenger and freight customer benefits and wider economic growth in the meantime.

Success would demonstrate that GBR and the wider industry have the competence to develop and deliver a complex whole system programme.

The next sections summarise the benefits of electrification.

2.1 A lower cost (to operate) railway

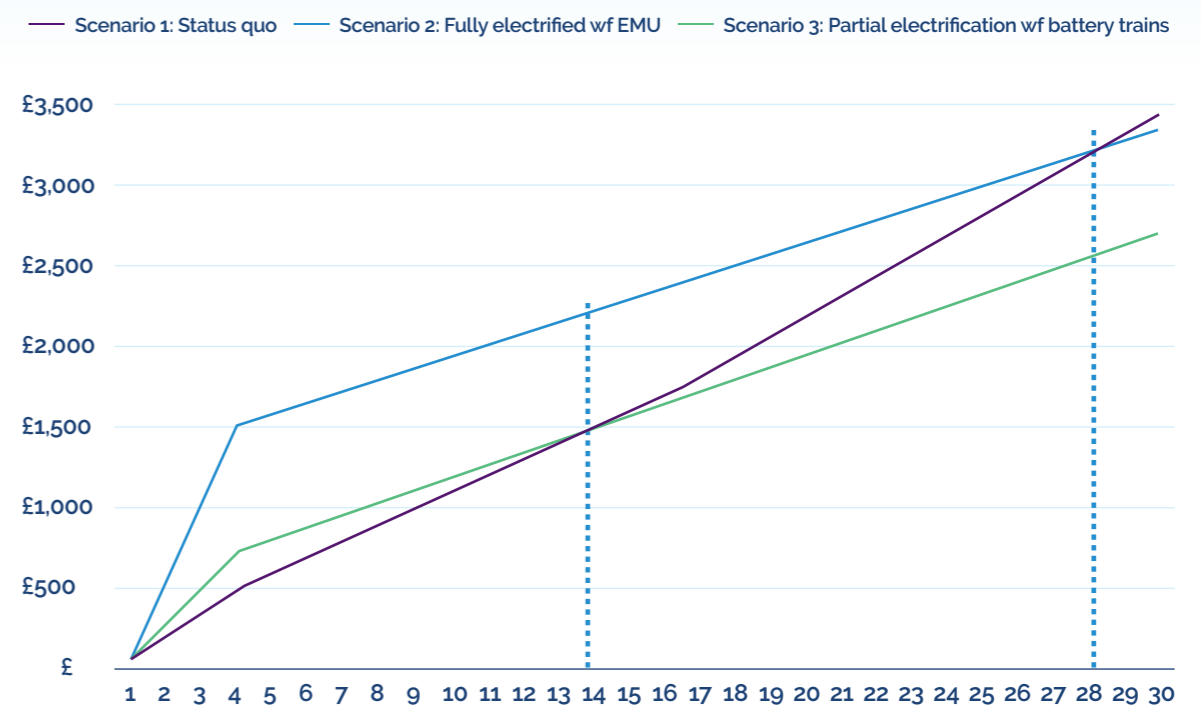
The cost of the railway falls largely on the government and railway customers and has increased in recent years. For the government the challenge is to reduce the net subsidy by increasing revenue and reducing operating costs. An electric railway supports both these objectives.

An electric railway is cheaper to operate than a diesel railway and it can be confidently predicted to have a positive business case, as shown by two different high-level assessments (Box 1 and Box 2). The challenge is making the case to fund the up-front investment.

Box 1. An electric railway is cheaper to operate in the long run – example route

The 2024 RIA report included a 'Totex' or whole life analysis of three scenarios for a railway (Exeter to Penzance) that would be considered a marginal case for full electrification.

Compared to the status quo of new diesel trains the analysis showed that a battery train is more economic after 14 years and continues to be the lowest cost solution for this route (consistent with the RIA 2024 strategy that it need not be fully electrified). However, even on this marginal route electrification is still a better option than retaining diesel after 28 years. The higher initial cost of the battery and electrification options are clearly shown.



¹ In this report references to GBR include GBR precursor bodies such as DfT, DfTO, NR etc

² In this report the term electrification includes both continuous and discontinuous electrification unless stated otherwise

* https://www.riagb.org.uk/RIA/Newsroom/Publications%20Folder/A_lower_cost_higher_performing_net-zero_railway

** https://www.riagb.org.uk/RIA/RIA/Newsroom/Publications%20Folder/Electrification_Cost_Challenge_Report.aspx

Box 2. An electric railway is cheaper to operate in the long run – programme business case

The October 2020 Traction Decarbonisation Network Strategy Programme Business Case proposed increasing electrification from 38% to 90% of the network. It had a positive Programme Business Case.

It was written before battery trains were in service and so the more recent RIA 2024 Strategy, which takes advantage of the potential of battery trains, only recommends increasing electrification from 38% to 66% of the network.

It follows that if 90% electrification has a positive business case then 66% electrification must have an even better business case.



Traction Decarbonisation Network Strategy
Programme Business Case

2.2 A lower cost (to build) railway

Previously expected electrification infrastructure costs have reduced significantly because a) battery electric passenger trains mean we need to electrify much less of the network than was assumed and b) the industry continues to reduce the cost of electrification delivery as demonstrated by recent projects, including in Scotland, the Midland Main Line and Cardiff Valley Lines.

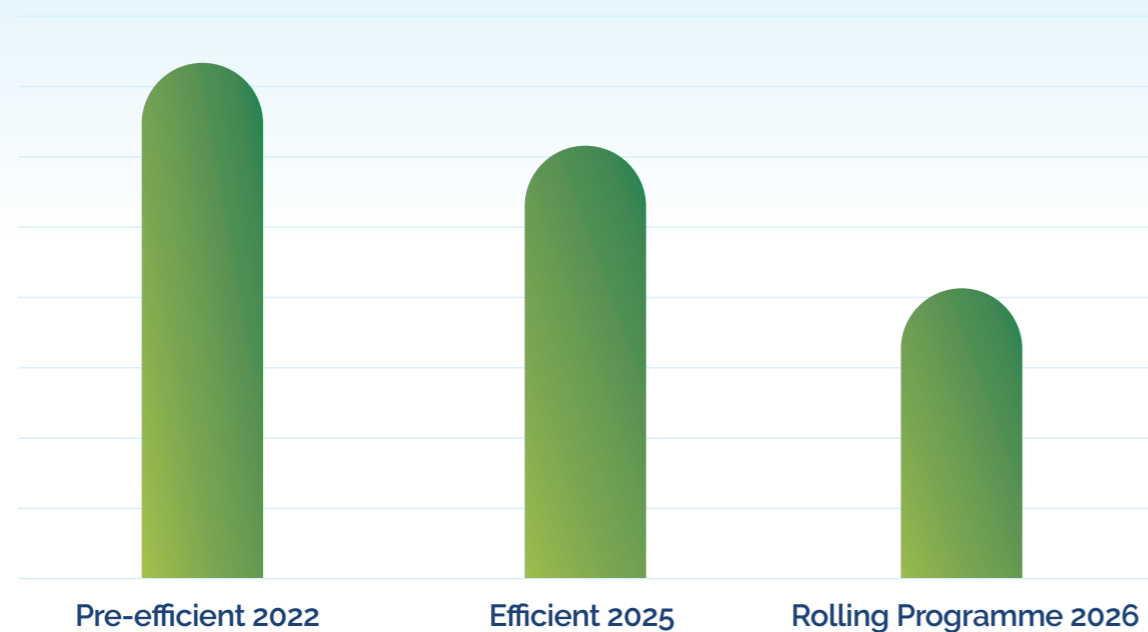
Responding to the failure of the Great Western Electrification Programme, RIA wrote the

'Electrification Cost Challenge' in 2019. Progress in implementing the recommendations of that report is summarised in Appendix B and practically demonstrated by the cost reductions in recent projects.

However, RIA-led industry workshops estimated that adopting a new programme delivery approach (described in Section 4) would realise around 30% further cost reduction compared to a well-delivered project today (Box 3).

Box 3. Electrification Cost Trajectory

The graph compares an actual project before and after the application of current best practice efficiencies with the estimated benefit of delivery through a programme approach as described in Section 4.0.



2.3 A higher performing railway

It is widely recognised that an electrically operated railway³ performs better than a diesel operated railway due to:

- Reduced journey time due to superior acceleration and braking
- Increased capacity, for example by speeding up freight services
- Reduced passenger delays, as electric trains are more reliable than diesel trains

The benefits translate into timetable improvements and make the railway more attractive to customers – the 'SPARKS' effect. Customers are also attracted by a better experience with:

- Improved air quality
- Reduced noise
- Reduced carbon emissions

This improved customer proposition, often combined with new trains, results in increased demand, and therefore revenue and, of course, wider economic growth.

Electric railways increase revenue and wider economic growth

<https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Executive-Summary.pdf>

³ The performance of Battery Electric Passenger Trains may not match full electric trains but will perform equal to or better than a diesel train.



2.4 A net-zero railway

Previous government policy has been to decarbonise transport, including railways, by 2050, and RIA has worked to identify options for lowering the cost of achieving this. We would urge the government to consider investment in electric railways as an opportunity to reduce net subsidy over the whole life cost of the investment.

RIA has previously recommended that the focus should be on maximising cumulative carbon reduction rather than setting 2050 as an absolute net-zero target for the railway.

What is important is that the railway is making progress at a pace which balances affordability for the government with maintaining rail as a strong economic and environmental competitor for passenger and freight traffic.

**Electric railways
reduce net subsidy AND
deliver net-zero**

2.5 Electrification for energy security and national resilience

The rail network is strategic national infrastructure and vital to the economy. Recent global events have highlighted how the UK is vulnerable to volatility in fossil fuel supply. Against this background, there is a strong energy security argument for further electrification as a matter of national resilience and economic security.

Energy security is explicitly recognised by the Indian Government⁴ as a benefit of railway electrification, which is mitigating the effects of current fossil fuel prices. India has implemented an impressive and rapid electrification programme, increasing from 24% of the broad gauge network electrified in 2000 to 99.2% in 2025. This includes 46,900 route kilometres, which have been electrified since 2014. The network is supported by 898 MW of solar power, about 70% of which is used for traction power.

As far as RIA is aware the contribution of rail electrification to energy security and national resilience has not previously been included in business case assessments.

2.6 A higher performing, higher capacity freight railway

To complement this report, RIA will shortly publish a separate report on electrification for rail freight. This will highlight the whole system benefits of electric freight, including the potential for increased capacity for both passenger and electric trains enabled by the higher power and acceleration of electric locomotives.

The report also includes a simulation-backed analysis of the potential for battery freight operation and concludes that battery-only locomotives are not viable for mainline electrification and do not represent an alternative to electrification.

Hybrid electric-battery locomotives show more promise but only in narrowly defined circumstances. They are not a direct replacement for diesel traction and cannot replicate its historic flexibility. Their feasibility is highly route and traffic specific, depending on the length of unelectrified sections, gradients, trailing loads and recharging opportunities.

⁴ <https://static.pib.gov.in/WriteReadData/specific-docs/documents/2026/jan/doc202616752101.pdf>

3.0

What needs to be different to efficiently deliver the benefits of electrification?

The benefits of electrification are documented in the previous section, yet progress in realising them has been inconsistent, with up-front costs increasingly a deterrent in decision-making.

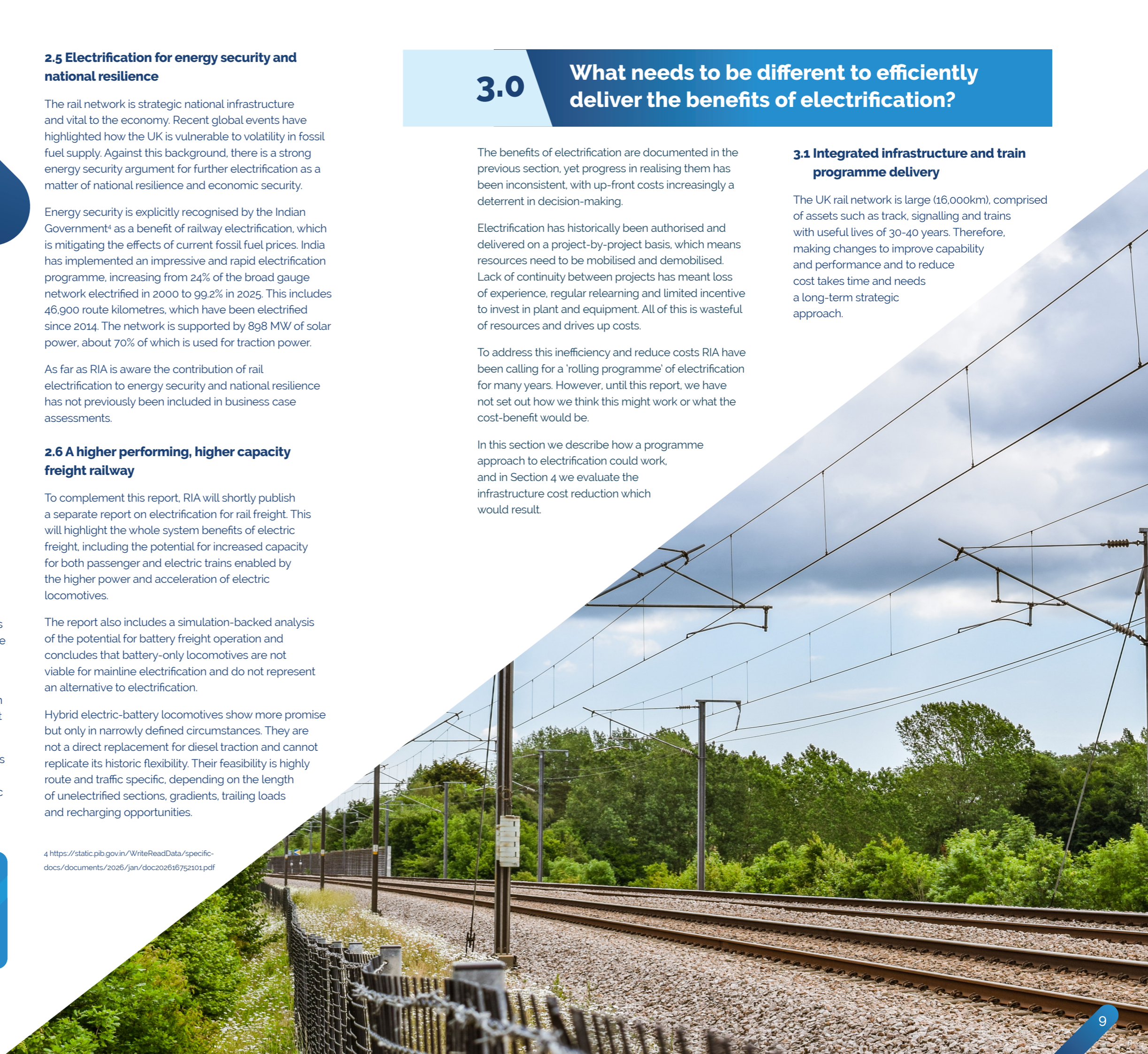
Electrification has historically been authorised and delivered on a project-by-project basis, which means resources need to be mobilised and demobilised. Lack of continuity between projects has meant loss of experience, regular relearning and limited incentive to invest in plant and equipment. All of this is wasteful of resources and drives up costs.

To address this inefficiency and reduce costs RIA have been calling for a 'rolling programme' of electrification for many years. However, until this report, we have not set out how we think this might work or what the cost-benefit would be.

In this section we describe how a programme approach to electrification could work, and in Section 4 we evaluate the infrastructure cost reduction which would result.

3.1 Integrated infrastructure and train programme delivery

The UK rail network is large (16,000km), comprised of assets such as track, signalling and trains with useful lives of 30-40 years. Therefore, making changes to improve capability and performance and to reduce cost takes time and needs a long-term strategic approach.



3.1.1 Developing an implementation plan and securing funding

RIA believes that the creation of Great British Railways (GBR) creates an opportunity for such a long-term strategy and the leadership to deliver it. RIA welcomes the current government-led work to develop a whole system rolling stock and infrastructure strategy, the publication of which will give much needed clarity and guidance to the industry. To efficiently deliver the benefits of that strategy, an implementation plan will be essential.

Recommendation 1 – GBR to collaborate with industry to develop an efficient delivery plan for the whole system rolling stock and infrastructure strategy. This plan should address the strategic enablers (Section 4.2) and implement the programme-based approach (Recommendation. 7) identified in this report.

Whole-system considerations are also important tactically. For example, a GBR-led railway will be able to optimise access on a whole-system basis. Access is one of the most significant cost drivers in electrification projects. Much UK electrification work is delivered mid-week, and it is common for productive time on site to be less than half of the shift length that staff are paid for. As a result, even small increases in access can have a disproportionate effect in reducing unit costs. International benchmarking has shown that blockades are very cost-effective, as would be expected. However, even modest increases in access can be highly beneficial, and there are encouraging examples of Network Rail (NR) and train operating companies (TOCs) working together to make the trade-offs that deliver the best overall outcome for the railway.

To create the conditions and incentives for efficient delivery of this strategy, RIA recommend that the Swiss-style approach be considered. The Swiss decide what outcomes they want the railway to deliver (typically a timetable) in say 30 years and allocate an annual investment fund, which gives railway management funding certainty. It is then their challenge to deliver the upgrade as quickly and efficiently as possible within this funding envelope. So, the 'what' is agreed and the precise 'when' depends upon efficient delivery against a known level of funding. As an efficiency incentive, savings are retained in the programme.

A small suitably funded team should be established to create a centre of expertise for the development of electrification schemes to help prioritisation and whole system plan integration, to develop estimates, support timely decision making, to recommend how the delivery teams are deployed and collate learning from schemes to apply to future schemes.

Recommendation 2 – To deliver the outcomes of the rolling stock and infrastructure strategy a maximum funding envelope should be defined. This will give government budget certainty and give industry confidence in the programme and an incentive to outperform as savings would be retained in the programme. There should be a separate smaller fund for development of electrification schemes to support timely and cost-efficient development and to ensure that learning is applied to future schemes.

To make the case for a programme of further electrification to support the GBR whole industry rolling stock and infrastructure strategy, it will be necessary to update the programme business case. Whilst, as described in Section 2.1, it is expected this will be positive, it is essential to support funding approval and establish both a baseline and the proposed funding envelope.

Recommendation 3 – To prepare for the start of a rolling programme of electrification and the allocation of a funding envelope from 2029 (CP8/FP1) GBR should commission an updated whole system programme business case for network electrification to reduce the whole life cost of running the railway. This business case should include the wider economic benefits of the programme (Section 3.11) and the energy security and national resilience benefits (Section 2.5).

3.1.2 To 2029 - Realising early benefits, protecting industry capability

The Government has recently acknowledged⁵ that "previous stop-start approaches to electrification may have contributed to higher unit costs and loss of capability, reinforcing the case for a more continuous and efficient approach in future". Despite this, electrification remains 'stopped' in England.

There are many pressing priorities for government investment across public services and electric railways are not currently high on the list. There is however an immediate opportunity to realise early benefits because rolling stock and associated infrastructure can be privately financed. Conversely, doing nothing both delays the benefits and reduces industry capability and capacity as resources will not be retained in the absence of work.

The 2024 RIA report recommended deploying battery electric multiple units (BEMUs) to replace the c1650 oldest passenger diesel multiple units (DMUs). This would give immediate benefits including:

- Improved reliability and passenger experience encouraging modal shift and thus revenue growth
- Support for the advanced manufacturing sector

- Sustaining and creating high value jobs
- Privately financed so no government capital investment required

As Box 4 illustrates there has been a significant reduction in electrification capability since 2018. As an industry we can either treat this as a problem where projects become more difficult and expensive to deliver, or an opportunity where a programme approach creates the environment for recruitment, retention and continuous improvement of skilled staff.

NSAR estimate that the electrification programme proposed by RIA of 350stk per annum would require

circa 4,300 staff, representing a total GVA of £350m annually, of which £140m would be delivered directly, thus representing a significant benefit to the wider economy.

To halt the loss of infrastructure capability and prepare for a long-term programme RIA recommend the electrification of Midland Main Line is restarted.

Recommendation 4 – To realise early benefits and protect industry capability government should urgently authorise the procurement via private finance of a significant tranche of Battery EMUs and restart the Midland Main Line Electrification Programme.

Box 4. Understanding, developing and sustaining a competent delivery capability

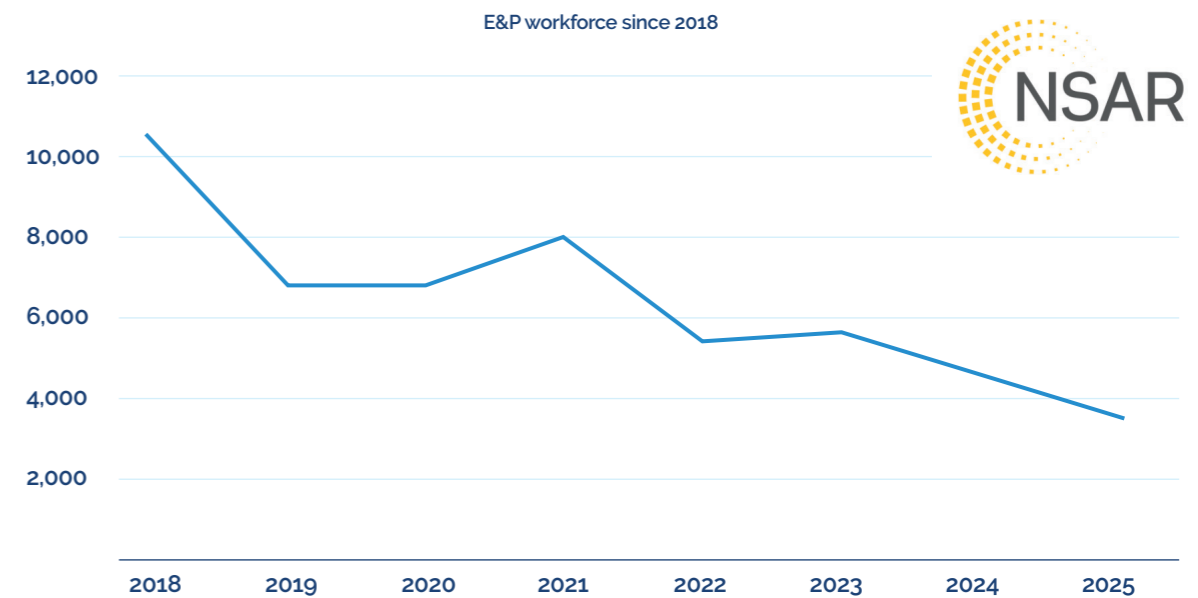
All sections of the supply chain are subject to the 'boom and bust' of rail projects and electrification is a particularly acute example.

Data from the National Skills Academy for Rail (NSAR) in this graph shows that the numbers of Electrification & Plant staff with recorded competencies reduced by 68% from 2018 (when Great Western electrification was cancelled) to 2025 which included over 300 redundancies following the pause in Midland Mainline electrification.

Considering that around 1650 of the remaining staff are Network Rail maintenance staff, there is clearly a dramatic reduction in industry capability.

NSAR analysis finds that the remainder will reduce by a further 35% by 2040 assuming a retirement age of 65.

It is no coincidence that this decline has coincided with a period of limited project activity. A further problem is that many of these competent project staff work on an agency basis and so there is no continuity for employer or employee which mitigates against retaining learning and continuous improvement.



⁵ <https://publications.parliament.uk/pa/cm5901/cmselect/cmtrans/1852/report.html>

3.1.3 From 2029 – An affordable GBR-led 'track and train' delivery programme

Building on Recommendations 1 to 3, it is proposed that a rolling programme of electrification commences from 2029 (CP8/FP1) with a maximum funding envelope attached (Recommendation 2). This would give immediate benefits including:

- Reduced operating costs with bi-mode trains able to use wires as they are completed, delivering the benefits detailed in Section 2.0.

- Sustaining high-value jobs and electrification capability
- Building capability and demonstrating the value of a production line/rolling programme approach by delivering at reduced cost.

Recognising the current challenges for public funding and taking advantage of the long-term nature of rail, RIA propose the following indicative pathway for the passenger railway.

Table 1. Indicative flexible pathway to deliver a lower cost, higher performing, net-zero railway

Timeframe	Action	Benefits
2020s Balance of CP7	<ul style="list-style-type: none"> • Replace oldest DMUs with Battery EMUs • Un-pause MMLe and prepare for a rolling programme, optimising track and train solutions 	<ul style="list-style-type: none"> • Immediate customer, advanced manufacturing and job benefits without public capex • Sustains industry capability
2030s CP8/FP1 onwards	<ul style="list-style-type: none"> • Start rolling programme of electrification 	<ul style="list-style-type: none"> • Demonstrates efficient delivery • Immediate benefits to customers, jobs, the economy, and modal shift
2040s	<ul style="list-style-type: none"> • Continue a rolling programme of electrification • Re-evaluate battery technology 	<ul style="list-style-type: none"> • Adjust strategy as appropriate to reflect improved battery capability
2050s	<ul style="list-style-type: none"> • Continue rolling programme of electrification 	<ul style="list-style-type: none"> • Early electrification projects achieve payback • A (say) 90% net-zero railway • Electrification resources switch to maintenance and renewal.
2060s	<ul style="list-style-type: none"> • Replace fleet bought in the 2020s with a higher proportion of pure electric 	<ul style="list-style-type: none"> • Further reduction in operating costs • A 100% net-zero railway

This approach is flexible and can be adjusted as necessary. The key is that the desired outcome (a lower cost railway) does not change and there is always a level of activity to sustain core specialised resources (in both infrastructure and rolling stock industries). However, the pace might be adjusted to reflect over or under performance within the funding envelope.

The nature of the work might also change, for example, to reflect developing battery capability. Batteries will certainly continue to develop and are likely to have an increased role in all forms of transport. However, it seems unlikely that they will be a viable solution for the fastest long-distance passenger and the

heaviest freight (Section 2.6) nor will they be the lowest cost long-term solution for intensively used routes. There is therefore no reason not to progress with decarbonising the railway now because the programme can be adjusted as shown in Table 1 to take advantage of improvements in battery technology.

Recommendation 5 – GBR to develop a flexible decade-by-decade delivery programme for the rolling stock and infrastructure strategy. Whilst flexible, this programme should always have sufficient activity to sustain core specialised resources.

4.0

Assessing the benefits of a programme approach to infrastructure delivery

Since the publication of the 2024 report, RIA hosted a series of workshops with members and industry stakeholders, including Network Rail, to identify 'what would need to be different' to deliver an electric railway at significantly lower cost.

4.1 Industry Workshop Process

The workshop process is described in detail in Appendix A. In summary, electrification costs were considered in the Rail Method of Measure Work Breakdown Structure (RMM WBS). For each element of the WBS, workshop participants brainstormed the opportunities to reduce cost relative to the baseline of a well-delivered project today. Between workshops, RIA consolidated these opportunities into themes and 'what needs to be different' statements to describe a new delivery environment.

4.2 Industry Workshop Outputs

The RIA-led industry workshops allowed a new contract delivery environment to be described where the things identified in Table 3 in Appendix A 'were true'. The workshops then estimated what the range of potential cost reduction in each cost element would be if that environment existed.

The conclusion was that if this new contract delivery environment existed, there would be a further cost reduction of around 30% compared to an efficient project today.

Table 3 in Appendix A is colour-coded based on the degree of current adoption of the various delivery efficiency opportunities. Two things are immediately striking.

Firstly, there is a positive amount of Green (already widely/near universally adopted by industry) and a lot of Orange (adopted in some locations, could be easily adopted nationally).

Many of these represent the implementation of opportunities identified in the 2019 RIA Electrification Cost Challenge report, progress against which is summarised in Appendix B.

Secondly, it is clear that addressing a handful of strategic enablers (Purple) could have a multiplier effect and unlock widespread adoption of good practice (Orange). The key policy changes would be:

- Agreed national strategy and funding envelope aligned with new industry financial model under GBR (Rec 1)
- Aligned strategies for decarbonisation, signalling and rolling stock renewal
- A long-term strategic plan with the electricity industry
- Moving from a project-by-project to a production line approach as part of an approved national programme
- A new commercial approach for CP8 which rewards good performance on time/ cost/quality

These strategic enablers have already largely been adopted by Transport Scotland and have contributed significantly to the cost of electrification in Scotland being lower than anywhere else in the UK.

A further strategic enabler identified by the workshop was appropriate commercial arrangements.

These strategic enablers are discussed in the following sections.

30%

further cost reduction by moving to a rolling programme/production line approach

4.2.1 Agreed national strategy and funding envelope

There is a golden opportunity for the expected GBR Infrastructure and Rolling Stock Strategy to support these strategic enablers in England and Wales and thus create the platform for a rolling programme of electrification to deliver this 30% efficiency (Recommendations 1 and 2).

The clarity on what will and will not be electrified would also inform private sector investors, for example, creating the environment to invest in electric and battery trains and related infrastructure.

4.2.2 Aligned strategies for decarbonisation, signalling and rolling stock renewal

The high cost and long lead times associated with new power supplies are often cited as a barrier to further electrification. Discontinuous electrification brings new challenges because more local power supplies may be required as the OLE can no longer be used as a transmission network.

However, there are exciting new opportunities, including DNO Connections, Static Frequency Converters and 'energy hub' and 'smart grid' approaches, potentially integrating battery storage, renewables and conventional power supplies. A pilot project for an 'energy hub' is currently underway at Ayr⁶ co-funded by the electricity industry, demonstrating their appetite to collaborate.

As the largest electricity customer in the UK the railway has a strong opportunity for a more strategic engagement with the electricity industry. An agreed national strategy and plan (Recommendation 1) would allow strategic discussions with the electricity generation industry on issues such as future demand, programming and collaboration on 'smart grid', renewables and other efficiency innovations.

Such a collaboration should be a 'win-win' situation with the potential to reduce investment costs and lead times for all parties.

Recommendation 6 – GBR to engage strategically with the electricity supply industry to develop a mutually beneficial plan for providing cost effective electricity supplies to the rail industry.

4.2.4 Moving from a project-by-project to a production line approach as part of an approved national programme

Recent electrification projects have been delivered on time and under budget⁷. However, these have been individual projects which have had to bear mobilisation and demobilisation costs and at the end of the project an experienced team has been dispersed. They have also had to bear significant overheads and project-specific costs which could have been amortised over a larger volume of work if the opportunity was there.

By moving to a production line or rolling programme approach all of these inevitable inefficiencies of a project-by-project approach are removed thus reducing cost. Appendix A shows that adopting a production line or rolling programme approach can further reduce the cost by around a third compared to a well-delivered project today.

RIA envisage that the production line approach would involve GBR procuring capability from industry to form a number of delivery teams which would operate on multiple sites over time under the commercial arrangements described in the next section.

This approach would ensure experience is not lost and drive continuous improvement as delivery staff move from site to site seamlessly. The continuity of activity would incentivise investment in productivity-enhancing plant and machinery, which would have better utilisation and so lower cost. Overheads would be reduced with contractor staff and a lean central client team able to support more than one site.

4.2.5 All supported by appropriate commercial arrangements

Suppliers have asserted for a long time that a 'rolling programme' would be a much more efficient way to deliver work. Section 4.2 and Appendix A above demonstrates and values the benefit.

However, up to now the 'rolling programme' approach has not gained traction in England and Wales due perhaps to client concerns that they would be tied to contracts without adequate flexibility or incentive to continuously improve.

To address this legitimate concern, it is proposed to adopt a commercial approach along the following lines:

- Contracts span at least 2 funding periods to build and sustain capability
- Client decides how many framework suppliers (delivery teams) are needed
- Delivery teams are expected to work nationwide

- Delivery teams receive a minimum volume of work based on their tender assessment and ongoing performance. This minimum volume is intended to support the supplier's core resource/capability.
- The minimum volumes total c50% of the workbank in aggregate. Framework suppliers compete for the other 50%, thus maintaining competition.
- Further incentives for reducing unit costs

A very similar commercially innovative approach has been adopted by Network Rail for the Train Control Systems Framework (TCSF) where there was a similar need to build and sustain industry capability to repeatedly and efficiently deliver similar work whilst maintaining competitive tension.

Unfortunately, TCSF has not yet demonstrated its potential because the expected workbank volumes have not materialised due to external factors. This illustrates the importance of the funding envelope approach (Recommendation 2) to building confidence and successfully delivering at reduced cost.

Recommendation 7 – GBR to implement a production line/rolling programme approach supported by appropriate commercial arrangements.

⁶ https://www.spenergynetworks.co.uk/pages/resilient_and_flexible_railway_multi_energy_hub_networks_for_integrated_green_mobility_hubs.aspx#tablist1-tab1

⁷ <https://www.networkrailmediacentre.co.uk/news/electrification-projects-major-milestone-delivered-on-time-and-under-budget>

Appendix A – Industry workshop process



During 2025 RIA hosted a series of online workshops with electrification practitioners from Network Rail and the supply chain.

The key question was 'what would need to be different' to deliver an electric railway at significantly lower cost?

RMM Framework

The Rail Standard Method of Measure (RMM) work breakdown structure (WBS) for an electrification project was used as a framework (Table 2).

Direct Construction Works

- 1.01 Railway Control Systems
- 1.02 Train Power Systems
- 1.03 Electric Power & Plant
- 1.04 Permanent Way
- 1.05 Telecomms
- 1.06 Buildings & Property
- 1.07 Civil Engineering
- 1.08 Enabling Works

Indirect Construction Works

- 2.01 Prelims
- 2.02 Overhead & Profit
- Other Project Costs
- 3.01 Design
- 3.02 Project Management
- 3.03 Other Costs
- 4.01 Risk
- 5.01 Inflation

Table 2. The RMM Work Breakdown Structure for an Electrification Project

Identifying what needs to be different

During the workshops each element of the work breakdown structure was considered in turn. Using an online 'whiteboard' workshop participants were asked to 'brainstorm' and add their 'post it' notes of current best practice and improvement opportunities.

Between workshops RIA would group like items together into themes and summarise the outcome with 'what need to be different' statements which were reviewed at the next workshop.

For example, the 'what needs to be different' statements for 1.01 Railway Control Systems were agreed to be:

- We have integrated the national signalling and rolling stock strategies
- We have integrated the local signalling maintenance and renewal programmes
- We are adopting an MVP approach to signalling changes driven by electrification including betterment being funded by the asset owner

As the process continued, some 'what needs to be different' statements were elevated to global assumptions which resulted in the following list:

Global Assumptions - What needs to be different?

- We have an agreed national strategy and funding envelope
- We have aligned strategies for decarbonisation, signalling and rolling stock renewal (building on the signalling LTDP approach)
- We have moved from project by project to production line approach as part of an approved national programme
- This includes separating and de-conflicting: consents, design, power, route clearance, OLE, such that they have their own dedicated teams, programme and prelims
- We adopt an MVP approach to changes driven by electrification including betterment being funded by the asset owner

Assessing the degree of challenge

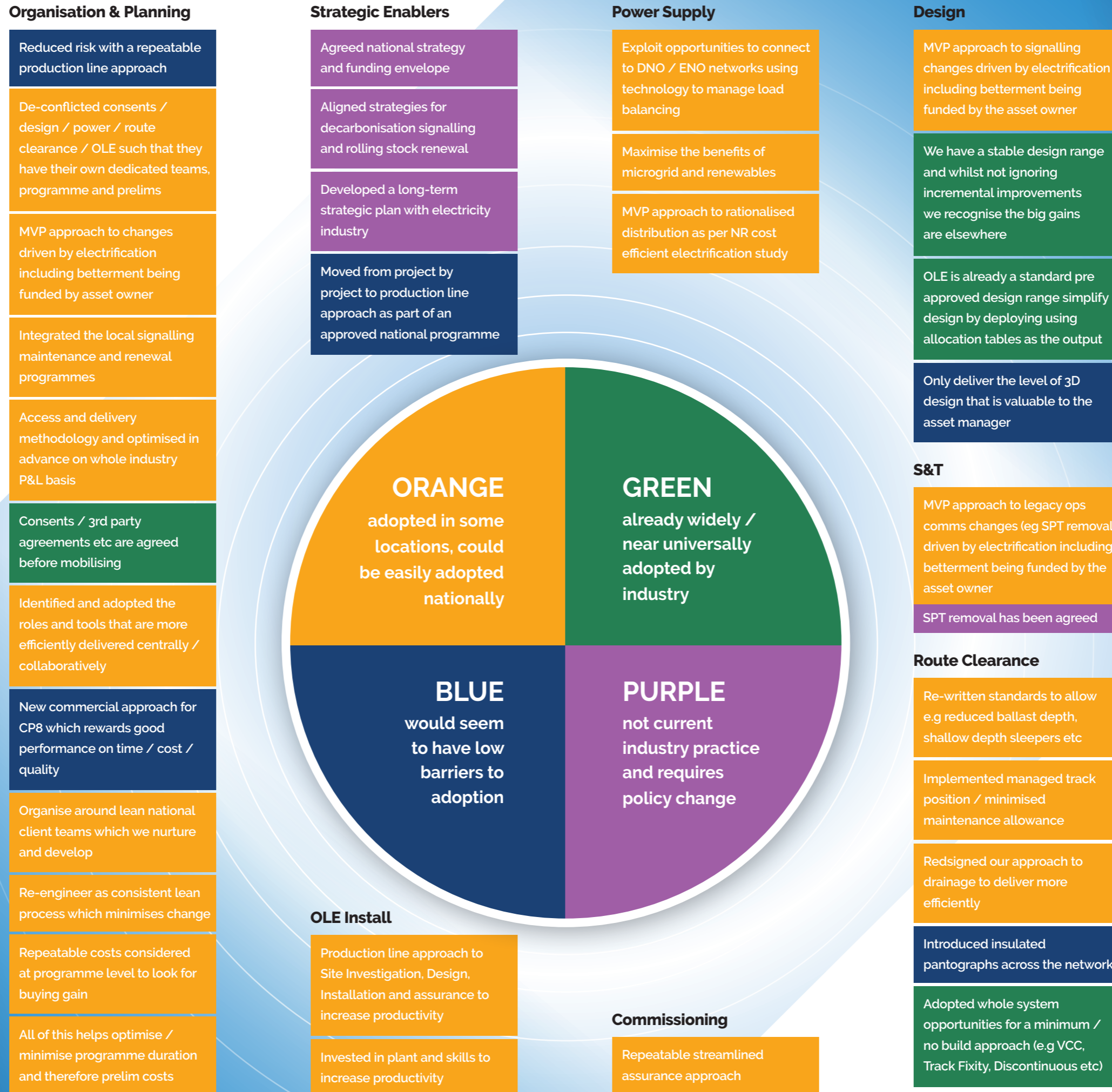
To support projects in adopting this approach the 'what needs to be different' statements were assembled into a matrix of enablers and project phases as follows:

- Policy Enabler
- Industry Enabler
- Organisation and planning
- Design
- Power Supply
- S&T
- Route Clearance
- OLE Install
- Commissioning

The result (Table 3) was colour coded to indicate the level of current industry adoption and therefore indicate the degree of challenge in implementing the new approach.

Table 3. Matrix of best practice to deliver an efficient electrification programme

The colour code indicates the degree of current industry adoption of the relevant scenario as follows:



Assessing the benefit of the new approach

Once the entire work breakdown structure had been reviewed and the 'what needs to be different' agreed for each cost element the cost benefit of adopting this new paradigm was assessed.

To do this the workshop group were asked to individually estimate the % cost reduction for each element of the WBS for low, medium and high levels of adoption of the new paradigm based upon the following framework (Table 4).

Table 4 – Paradigm adoption framework

Compared to a well delivered recent project the estimated potential benefits were as follows (Table 5): following framework (Table 4)

Degree of adoption of new paradigm	Workload continuity	Adoption of best practice in Table 3
Low	Better than today but still with gaps of up to 6 months	Orange to green, blue to orange
Medium	Good continuity gaps less than 3 months	Plus purple to green
High	High level of continuity. Negligible gaps	Almost all green

Table 5 – Potential benefits of adopting new paradigm

Implementation of the recommendations in this report would lead to at least the medium level of paradigm adoption. This is the basis of the workshop consensus that electrification can be delivered for 30% less than a well delivered project today – approximately the midpoint of medium and high levels of adoption. following framework (Table 4)

Degree of adoption of new paradigm	Estimated cost reduction compared to a well delivered current project
Low	16%
Medium	27%
High	37%

Appendix B – Review of progress since the 2019 RIA Electrification Cost Challenge

The well publicised problems with the Great Western Mainline Electrification Programme (GWEP) led to the government curtailing all electrification in 2017. RIA recognised that the GWEP was a problem project but wanted to demonstrate that other GB projects had performed well and so learning lessons rather than curtailing all electrification would be a more appropriate reaction. RIA therefore researched and published the 2019 Electrification Cost Challenge (ECC)⁸ report which used examples from the UK and internationally to show that the high costs seen on GWEP could be avoided in the future.

It found that GWEP had suffered from an unrealistic programme of work with a timetable commitment before the project was costed and unpreparedness in using novel technologies resulting in poor productivity and cost escalation. This lesson is similar to the conclusions of the Wild and Stewart reports on HS2. This was compounded by the 'feast and famine' of electrification delivery meaning skilled resources were in short supply when GB tried to deliver not one or two but ten projects in a 5-year period having not done any significant electrification for around 20 years.

Despite these handicaps, the report found that the majority of projects were delivered successfully. However, their success was negated in the mind of funders by the failure of GWEP, the largest project.

The report identified a range of lessons from both successful and unsuccessful projects. These were reflected in the report recommendations – see Table 7 overleaf.

What has happened since 2019?

Since 2019 there have been some significant and complementary developments including:

- The introduction of battery trains into passenger service
- The implementation of discontinuous electrification for example on the Cardiff Valley lines
 - Together these innovations make possible the decarbonisation of one-third of the network without full electrification as proposed in the 2024 RIA strategy.

- The inclusion of 'Voltage Controlled Clearances' into standards dramatically reducing the number of bridge reconstructions required for electrification.

- On MMLe the number of bridge reconstructions has been reduced from over 40 to 1 using this technique resulting in substantial savings.
- In Scotland the application of Probabilistic Pantograph Gauging and Voltage Controlled Clearances have reduced the cost of the Scottish electrification programme by £366m⁹.

- Adoption of numerous innovations as 'business as usual' such that we now have an efficient and flexible overhead line system that can be rolled out.

- Electrification projects whilst still few in number compared to what is needed for full decarbonisation are now being delivered efficiently. Albeit there is still opportunity to reduce cost.

- In hindsight the 2019 ECC focussed largely on technical matters and this is reflected in the recommendations in Table 7. Whilst these technical matters are important and significant progress has been made, this ECC 2.0 report highlights that the greatest efficiency opportunity is in the 'how' we build electrification not the 'what' we build it with.

Table 7 reviews the recommendations in the 2019 ECC report.

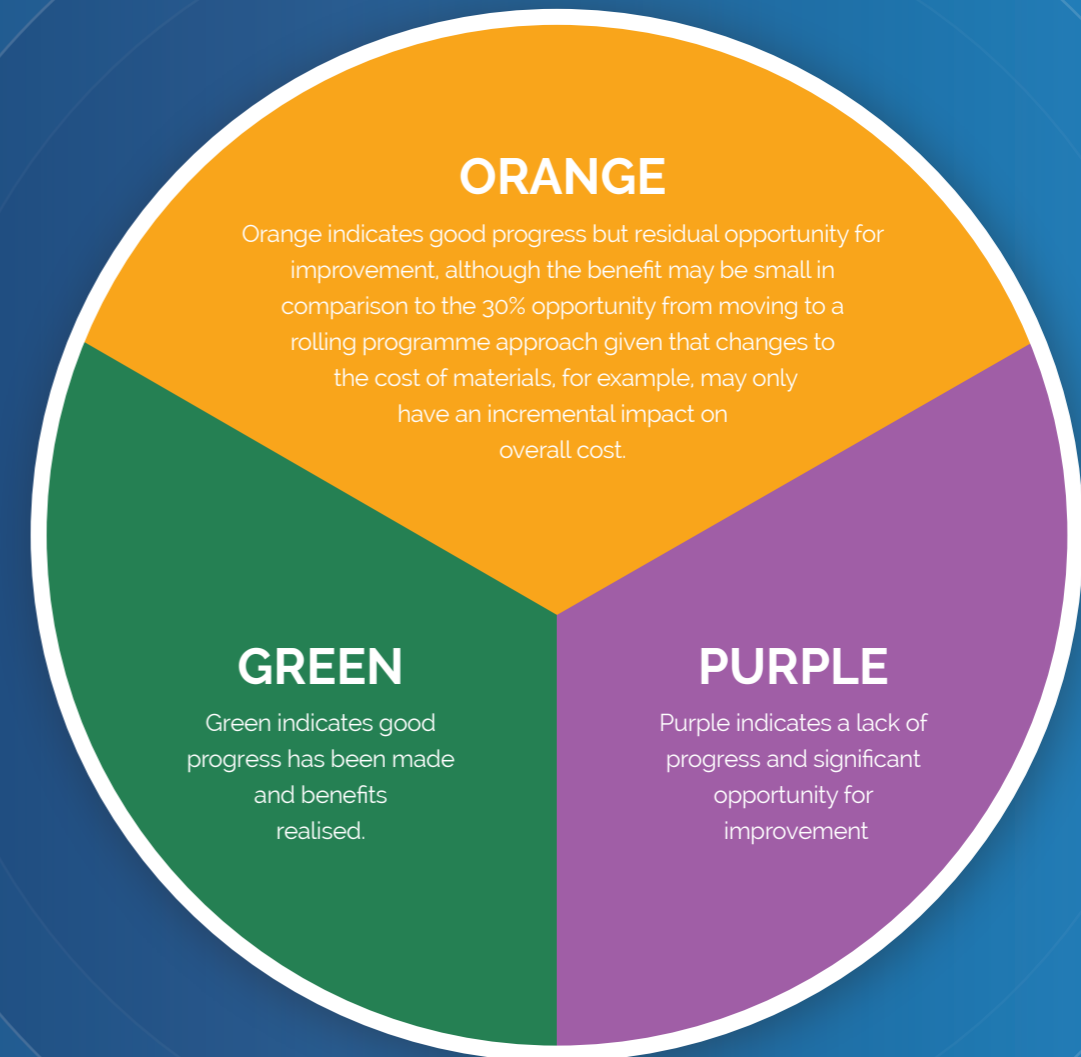
Recommendations identified in the 2019 report:	RIA assessment of progress since 2019:	Progress rating
Cost		
1. To establish a minimum 10 year rolling programme of electrification to progressively lower the long-term operating costs of the railway towards European norms and to support investment in people, process and plant.	<ul style="list-style-type: none"> ● The rolling programme in Scotland has successfully reduced costs ● Core Valley Lines has reduced cost using discontinuous electrification ● There is no rolling programme in England and Wales and projects have been paused 	PURPLE
2. To endorse electrification as the first choice in a hierarchy of options for decarbonising the rail network.	<ul style="list-style-type: none"> ● There is no clarity of policy in England and Wales 	PURPLE
3. To ensure future projects adopt a realistic programme and risk apportionment.	<ul style="list-style-type: none"> ● Risk evaluation improved but projects have risk pots and must also contribute to central risk pots ● Whereas construction playbook recommends pooling risk for repeatable work 	ORANGE
4. To use the Rail Method of Measurement to allow comparison between projects on a consistent basis.	<ul style="list-style-type: none"> ● Not used consistently 	ORANGE
Standards		
5. Future projects should use proven systems that comply with the relevant standards.	<ul style="list-style-type: none"> ● Generally applied but value engineering can sometimes be counterproductive ● Assurance is still burdensome ● NR have identified an £80m cost of complying with NTSN dynamic testing and have successfully had the requirement disapplied on two projects ● NR estimates compliance with the NTSN regime costs c£250m and is working with industry to propose an alternative approach 	ORANGE
6. Avoid developing and obtaining approval for new systems as part of a project.	<ul style="list-style-type: none"> ● Network Rail has deliberately established the Cost-Efficient Electrification R&D Programme to develop new products, systems, and techniques outside live projects ● This approach reduces delivery risk and enables more rigorous, evidence-based developments before project deployment 	GREEN
7. Review the NR standards suite to support output specification.	<ul style="list-style-type: none"> ● Specification still tends to be input-based ● However new NR standards on electrical clearances and bridge parapets whilst prescriptive have reduced ambiguity and are estimated to have saved the industry £300m+ ● There is need for more dialogue between suppliers and NR on where costs can be reduced by output specification 	ORANGE
8. Implement a 'standards freeze' for the duration of a project.	<ul style="list-style-type: none"> ● NR advocate controlled and justified change, rather than prohibiting change outright, to allow beneficial improvements to be realised where impacts are clearly positive. 	GREEN
Foundations		
9. Have an appropriate level of design maturity before commencing foundation installation.	<ul style="list-style-type: none"> ● Lesson learnt ● Work is continuing, and NR is engaged in a project with UIC to benchmark foundation design 	GREEN

8 https://www.riagb.org.uk/RIA/RIA/Newsroom/Publications%20Folder/Electrification_Cost_Challenge_Report.aspx

9 <https://www.dgauge.co.uk/news/probabilistic-pantograph-gauging-assists-with-cost-saving-of-336million>

Masts		
10. Future procurement should allow for alternative designs and site specific modelling that deliver outcome requirements, including life cycle reliability and maintainability against the benchmark of NR Master Series.	<ul style="list-style-type: none"> ● NR Master Series now provides many permutations including 115m span lengths which have been implemented in Scotland ● Network Rail has deliberately moved away from site-specific modelling for every structure ● A comprehensive Civil Design Manual has been produced as part of UKMS, providing example design methods for a wide range of common structures. This approach improves consistency, reduces design cost, and supports repeatability. ● Remaining opportunities are incremental oling risk for repeatable work 	GREEN
Overhead Line Equipment (OLE)		
11. To maximise value for money, the procurement process should allow for proven compliant proprietary designs to deliver outcome requirements, including life cycle reliability and maintainability against the benchmark of NR Master Series.	<ul style="list-style-type: none"> ● Specification still tends to be input based ● NR have found no evidence that proprietary systems offer higher reliability or lower whole-life cost. NR considers UKMS, as an open-source system, supports competition, innovation, and new supplier entry. ● An independent external assessment valued the changes between 2023 and 2025 at £117k per STK including: <ul style="list-style-type: none"> ● A 20% increase in maximum span length (95m to 115m), reducing the number of masts, foundations, and components per STK ● A 33% increase in maximum half-tension lengths (750m to over 1,000m), reducing overlaps, anchor structures and tensioning equipment ● Introduction of graded bridge approach spans, reducing the likelihood of costly civil interventions at low bridges ● UKMS now provides many permutations, allowing projects the flexibility to select appropriate solutions ● Remaining opportunities are incremental 	GREEN
Power Supply		
12. At the optioneering stage, future projects should ensure that all options for traction power supplies are considered, including distribution and traction power storage options.	<ul style="list-style-type: none"> ● Scotland and Eastern region have developed detailed power strategies ● A national power strategy based on a national electrification strategy is needed. (Recommendation 6) ● At project level, realistic power / train service modelling is essential ● Positively there are many innovations ready for deployment (Section 4.2.3) 	ORANGE
Clearances to Bridges and Structures		
13. Wherever possible, future projects should secure all necessary consents, such as via a Transport Works Order, and undertake route clearance in advance of OLE works, even if this means extending the programme.	<ul style="list-style-type: none"> ● Lesson learnt 	GREEN
14. Sufficient detailed design should be undertaken at GRIP 3 (Option Selection)	<ul style="list-style-type: none"> ● The application of Voltage Control Clearances by NR standard NR L2 ELP 27716 and the pantograph modelling experience from Steventon Bridge has dramatically reduced the number of bridge interventions 	GREEN
Plant		
15. The recommendation to establish a 'rolling programme' of electrification would both reduce the competition for scarce plant by allowing forward planning and create the incentive to, over time, invest in more productive plant, process and skills to further optimise delivery.	<ul style="list-style-type: none"> ● Road Rail plant has continued to be developed and is the default solution ● High output plant is not being used and the Alstom Wiring Train has been exported ● There is little incentive to invest in plant 	PURPLE

Key to RAG rating



Appendix C – RIA Electrification and Decarbonisation Bibliography

The following are all available on the RIA website www.riagb.org.uk

- **2019 Electrification Cost Challenge**

The report responded to the problems of the Great Western Electrification and identified the lessons learnt. It demonstrated that electrification could be delivered efficiently and, indeed already was being delivered efficiently with 15 of the 20 projects examined being delivered within an efficient cost range.

- **2023 Rail Electrification - The Facts**

A 'two-pager' detailing all the benefits of electrification which highlights that decarbonisation is only one benefit and, until recently the only reason to electrify was because it was a 'better/ cheaper way to run the railway'. There is more data in the earlier 2021 'Why Rail Electrification' report.

- **2023 Rolling Stock Report**

This proposed urgently buying a fleet of BEMU to deliver immediate passenger/ AQ and carbon benefits and alleviate the order book gap. It also set out a longer term strategy for the national fleet that in addition to age and condition considered supply chain sustainability, air quality and decarbonisation whilst smoothing the previous 'boom and bust'.

- **2024 lower cost, higher performing, net zero railway report**

This report aimed to 'draw a map' of what would and what would not need to be electrified to achieve net zero by 2050. To do this we modelled the whole network and its train services. Our conclusion was 'the plan of thirds' -

one third is already electrified, one third can be decarbonised with BEMU and the remaining third which does need to be electrified. This work fed into the work now being led by Jonathan Williams at Network Rail. It brought together infrastructure and rolling stock in a plan that, if implemented would lower cost by breaking the 'boom and bust cycle'.

- **The RIA Traction Decarb Tool**

a new interactive resource containing rail decarbonisation and rolling stock data. It uses detailed information and data points from last year's report 'Delivering a lower cost, higher performing, net zero railway'. The tool includes the GB network, passenger train fleet and timetable.



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