

TRACTION DECARBONISATION NETWORK STRATEGY

INTERIM PROGRAMME BUSINESS CASE
Executive Summary

FOREWORD

Climate change is a real and growing threat. Every year, across the planet, weather records are broken, and we see more frequent extreme weather, from flooding to drought. It is becoming increasingly urgent for countries and businesses across the world, to protect the planet for future generations.

In June 2019 the UK Government set out a legislative target to achieve 'net zero' greenhouse gas emissions by 2050. For rail specifically the Department for Transport (DfT) asked the rail industry to explore whether it would be possible to remove all diesel-only trains from the network by 2040 in England and Wales. The Scottish Government also set a target to decarbonise domestic passenger rail services by 2035.

The railway plays a vital role in supporting the economy and connecting communities across Britain. It is already the most environmentally friendly mode of public transport, contributing less than one per cent of UK annual greenhouse gas emissions. Rail has the potential to move large volumes of people and goods reliably with zero carbon emissions with current technology. We have a huge opportunity to play an important part in a green economic recovery following the Coronavirus pandemic and tackling climate change.

Today, traction energy accounts for the vast majority of rail's carbon emissions. As our power supply comes from nuclear energy, it is logical that we immediately focus on reducing diesel train usage on our network with the ultimate goal of removing them entirely.

Over the last year Network Rail has worked collaboratively with the rail industry to establish how we can best work together to achieve this. The result of this work is the Traction Decarbonisation Network Strategy (TDNS) and I am delighted that we are now able to set out the different ways how we could minimise direct carbon emissions from trains.

This strategy sets out why decarbonising rail traction is so important and considers the three main ways of doing it - overhead electrification, battery and hydrogen fuel cells. It then looks at every section of unelectrified line in the country to see where each solution can be most effectively used. While more work is still needed, in particular the development of regional delivery plans, this strategy will support and inform policy and funding decisions on what needs to be achieved and when.

Carrying out this work in a way that is efficient and represents best possible value for money is essential. This strategy shows that the best way of doing this includes a long-term, stable and efficient programme of electrification which will last for at least thirty years, alongside the introduction of new technology. If we can do this, I am confident that rail will play a vital role in helping build Britain back better and achieve the Government's commitment to achieve net zero by 2050.



A handwritten signature in black ink that reads "Paul McMahon".

Paul McMahon,
Managing director System Operator

THE DECARBONISATION CHALLENGE

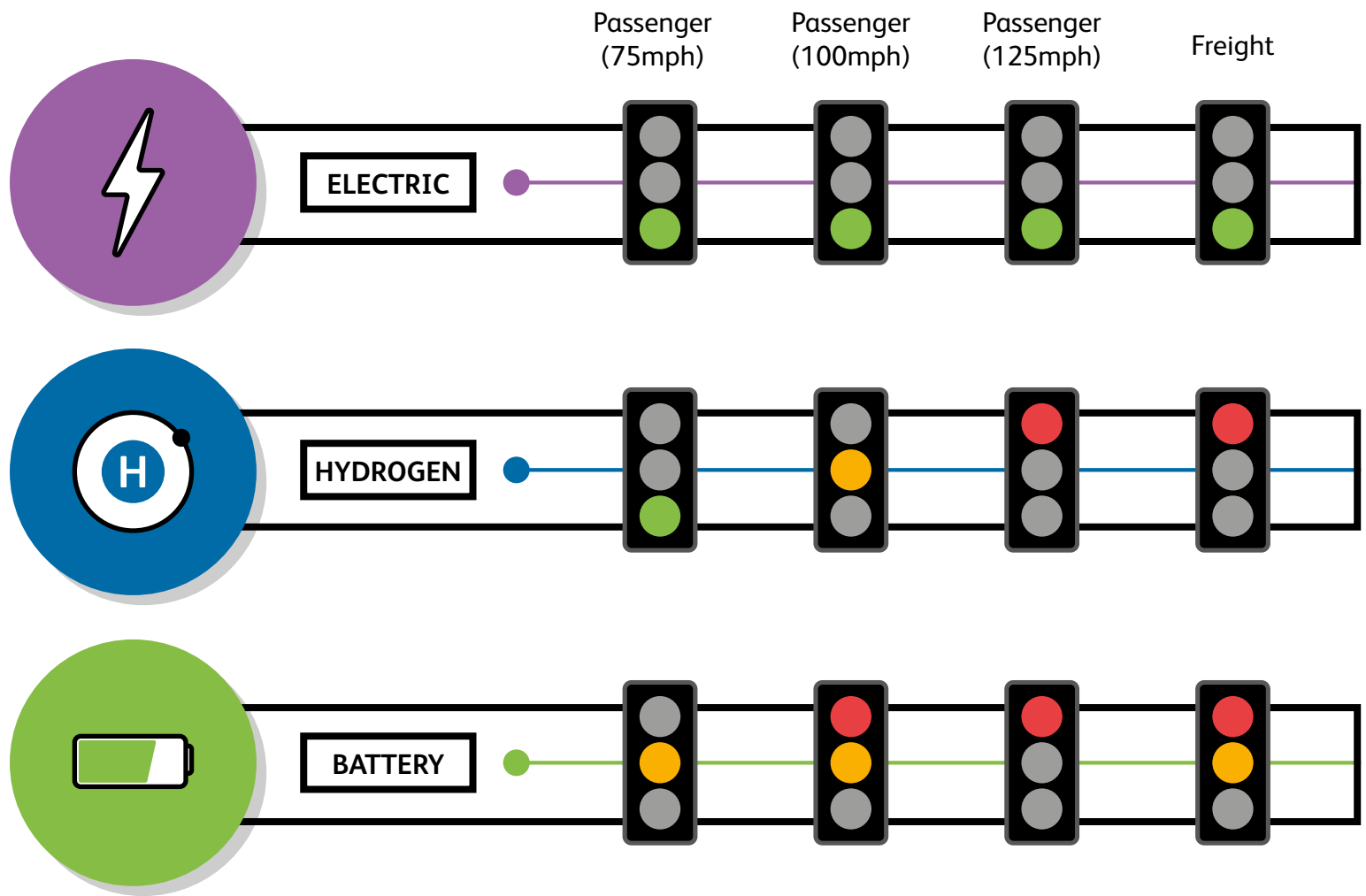
Reducing carbon emissions in rail is critical. It brings benefits directly to the rail industry and, by decarbonising transport overall, important knock-on benefits across the transport sector and wider economy.

These benefits can be organised into six key themes:

Emissions Reduction	Surface Transport Decarbonisation	Passenger and Freight End User	Direct Rail Benefits	Environmental Benefits	Wider Economy Benefits	
<p>Climate Change is a global threat.</p> <p>Paris Agreement has set ambitious targets for global average temperature rise.</p>	<p>Rail is already a green mode of transport.</p> <p>Potential to reduce overall emissions from transport by encouraging more people to choose rail over other forms of transport.</p>	<p>Reliability and resilience need to be improved.</p> <p>Capacity shortfall in some areas of the network.</p>	<p>Rail requires significant investment for ongoing operations, maintenance and renewals.</p> <p>Cost efficiency is critical.</p>	<p>Introduction of ULEZ and CAZ around the UK.</p> <p>Strong focus on air quality from local, regional and national governments.</p>	<p>UK Net-Zero Target.</p> <p>Getting to Net Zero requires significant infrastructure investment.</p>	The case for change
<p>Net Zero GHG by 2050 for UK as a whole.</p> <p>Other national and regional targets and aspirations for pre 2050.</p> <p>NR science-based target of 27.5 % reduction for traction by 2029.</p>	<p>Modal shift from road and air to rail.</p> <p>Even better if rail itself is decarbonised.</p> <p>Additional investment required to increase capacity.</p>	<p>Improving resilience to allow passengers and freight to rely on rail.</p> <p>Increasing capacity improves customer experience and opportunities.</p>	<p>Achieving cost efficiency provides sustainable pricing for passengers, customers and government.</p>	<p>Provide a longer-term solution to air quality issues.</p> <p>Support decision making from rail industry Air Quality Strategic Framework for short-term solutions required.</p>	<p>Traction decarbonisation programme will require skilled workers around the UK to deliver infrastructure and rolling stock.</p>	Strategic objectives
<p>Ending rail's contribution to emissions by removing diesel trains.</p> <p>Further minimizing carbon emissions through optimised cascade of the cleanest compliant diesel trains.</p>	<p>Safety improvements for users compared with roads.</p> <p>Congestion reduction on roads.</p> <p>Road maintenance cost savings benefits.</p> <p>Cross-modal cost saving with combined refuelling/recharging infrastructure</p>	<p>Faster journeys.</p> <p>Improved reliability.</p> <p>Greater tonnes hauled in same train paths.</p> <p>Improved resilience through electrifying diversionary routes.</p>	<p>Reduced rolling stock maintenance costs.</p> <p>Reduced track access charges.</p> <p>Reduced fuel costs.</p>	<p>Longer-term air quality solution for stations, depots and freight.</p> <p>Supporting rail industry Air Quality Strategic Framework.</p> <p>Noise reduction.</p>	<p>Increase jobs in design, integration, management, manufacturing and construction.</p> <p>“Level Up” economy through job creation away from London and South East.</p>	Strategic benefits

MAIN RECOMMENDATIONS

The Rail Industry Decarbonisation Taskforce has identified three possible traction technologies which are sufficiently mature to replace diesel – battery, electric and hydrogen. Each of these technologies has different technical capabilities which mean that not all are suitable for all types of rail services.

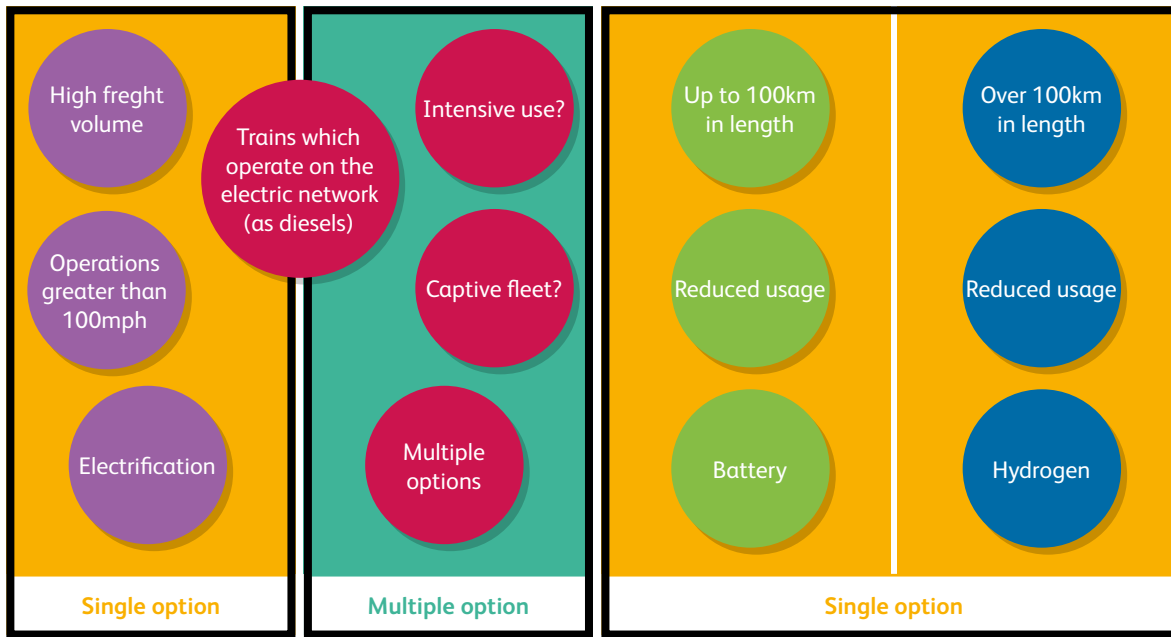


Battery and hydrogen technologies are unsuitable for long-distance high-speed and freight services as these services have higher energy needs than battery and hydrogen can provide.

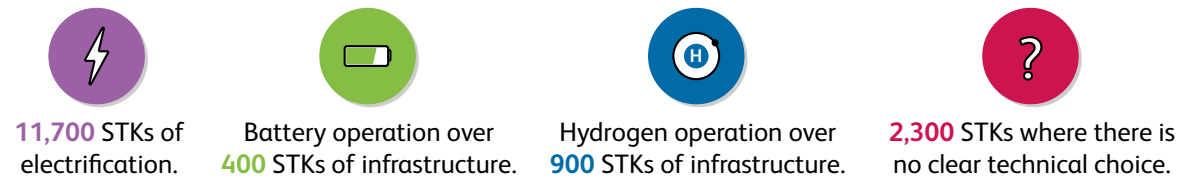
Electric traction is incredibly versatile in that it can successfully provide energy for all types of journeys. But it relies on fixed infrastructure to transmit electricity and this infrastructure has a relatively high capital cost compared with battery and hydrogen technology.

These technical and cost implications have been used to develop a 'decision tree' to identify areas of the rail network where one technology is most suitable. For example, only electrification is suitable for areas where trains travel at more than 100mph or where there are lots of freight services. Equally the capital costs required to deliver electrification mean that battery and hydrogen may offer a better value for money way of achieving a zero-carbon railway in areas of the network where fewer trains run.

In some areas of the network which are particularly busy electrification may also represent the most sensible option, even though it would be technically possible to use battery and hydrogen. These areas of the network are identified as 'multiple options' where further economic and operational analysis is needed before the best choice of technology can be decided.

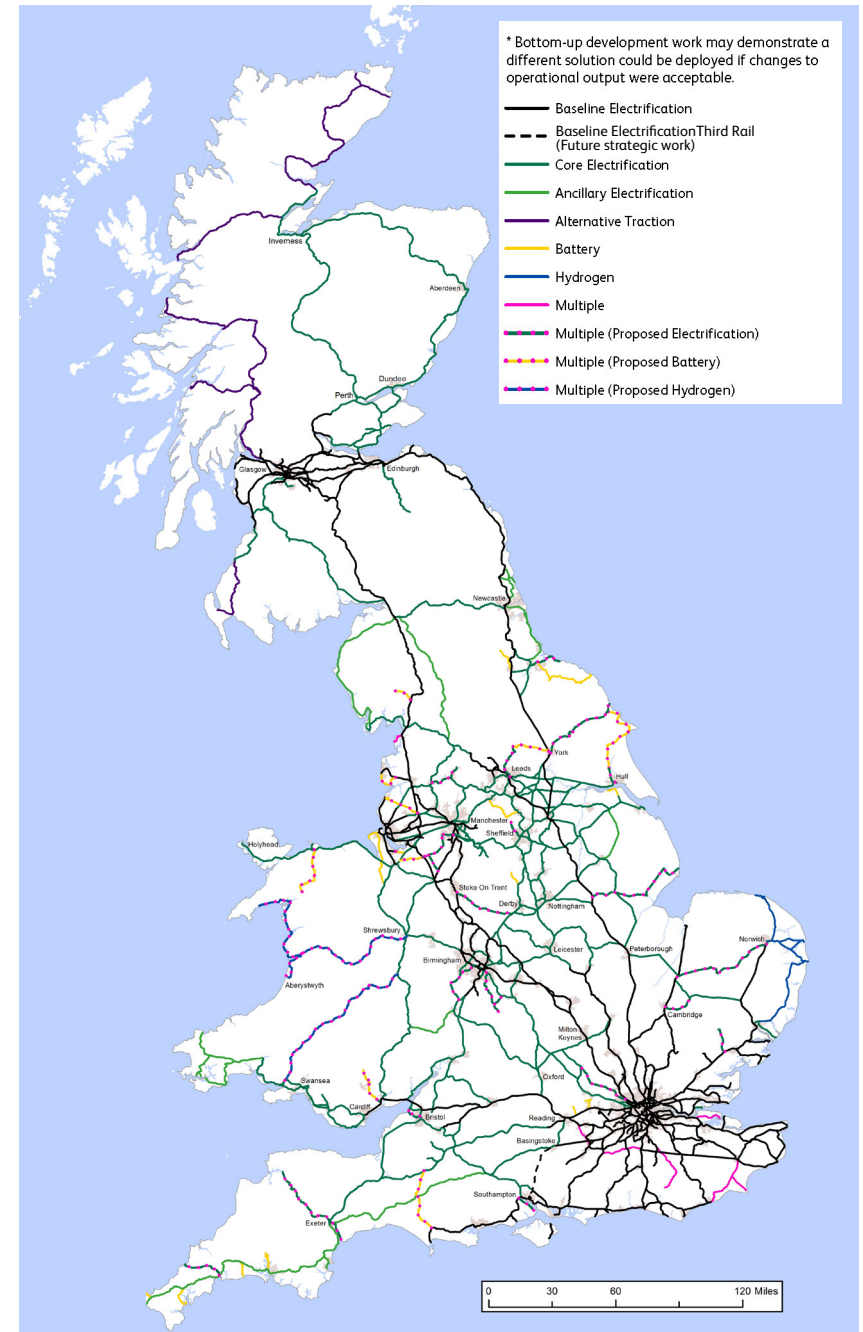


By applying this approach to the 15,400 single track kilometres (STK) of unelectrified rail network in Great Britain, we have calculated a need to provide:



Of the 2,300 STKs where “multiple options” could be delivered, operational and economic analysis has identified a further 1,340 STKs of electrification, battery operation over an additional 400 STKs and hydrogen operation over an additional 400 STKs.

That leaves us with 260 STKs of infrastructure where no clear decision has yet been made but a likely technology is identified within the TDNS National Recommendations document. Further work at a local level will be needed to confirm this.



* Bottom-up development work may demonstrate a different solution could be deployed if changes to operational output were acceptable.

FURTHER RECOMMENDATIONS



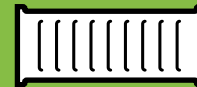
Any proposed new railway should consider the need to operate using zero carbon rolling stock (i.e. battery, electric or hydrogen), in conjunction with the wider network to which it is linked.



Battery and hydrogen train operations should now start wherever this is possible to ensure standards are developed, whole-system operational experience is gained, and lessons are learned. That way, best practice can be learned and embedded in good time.



From now on, diesel-only trains should only be bought where there are clear strategic and economic reasons for doing so. Where this is necessary, only trains where the possibility exists in future to replace the diesel engines with a zero-carbon alternative should be chosen. Hybridisation and the use of multi-mode trains offer an excellent opportunity to progressively reduce emissions and realise the benefits of electrification.



Projects and programmes which increase capacity for passengers and/or freight should continue in order to support a modal shift to rail. These projects and programmes could draw on the strategic and economic benefits of decarbonisation and modal shift in their business case. This is especially true for freight projects because of the significant modal shift they deliver.

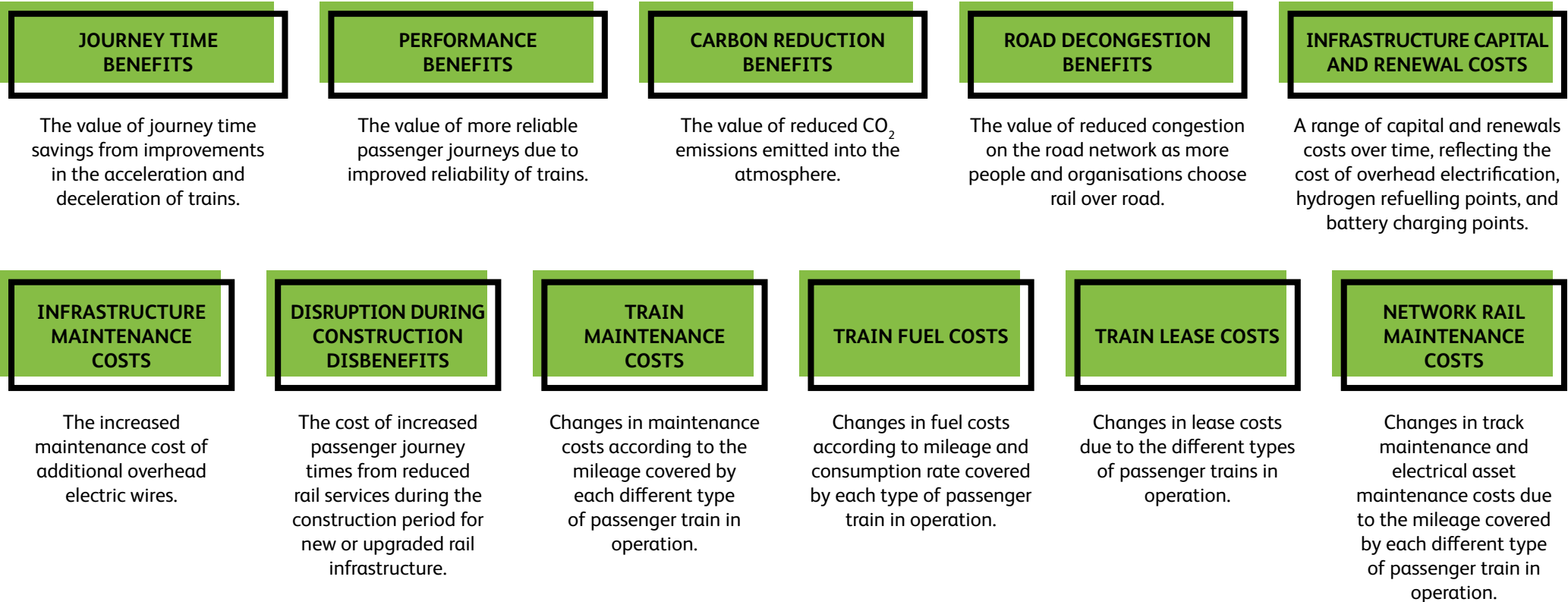


A stable and efficient programme of traction decarbonisation is the most efficient way for us to deliver this work and will enable us to incorporate all the lessons learned from previous electrification. This programme is also likely to include interim solutions to make the most effective use of resources and keep disruption to passengers and freight to a minimum, while meeting emissions reduction targets. This programme will be considered as part of the TDNS programme business case.

ECONOMICS

The economic case considers the economic impact of minimising traction emissions and provides an indicative assessment of the net economic value from the different ways of doing this. The results establish an initial, nationwide view of the potential costs and benefits from the recommendations. It should be stressed that this analysis provides an initial, limited view of benefits and costs and has been based on a number of assumptions.

Aside from the significant environmental benefits of reducing rail-related carbon emissions, there are also a number of economic benefits that could be realised:



The economic analysis undertaken relates specifically to the costs and benefits we would expect to see from traction decarbonisation. It is likely, however, that as traction decarbonisation projects or programmes are brought forward, they will have their scope enlarged to include other railway work that is needed. Working in this way helps to minimise disruption to passengers and maximise overall efficiency. In those cases, we would expect both costs and benefits to be higher because more work is being carried out.

DELIVERY

Most of the railway in London and South East is already electrified which means that most of this programme will be delivered in other parts of the country, drawing on skills and resources in those regions. The Eastern region has the largest volume of electrification required, but there are significant volumes in all regions outside the South.

With a total length of over 13,000 STKs in need of electrification and recent supply chain activity average of 450 STKs per year having fallen to much lower levels, there is a clear challenge to re-build our capability to efficiently deliver electrification.

Analysis undertaken by RIA, shows that delivering 450 STK of electrification per year is within the capability of the supply chain, assuming that activity is gradually built up over several years and a commitment is made to a stable and efficient programme of work. This stability is critical to ensuring that jobs are retained, the need for additional training is reduced and the programme is a cost-effective solution.

A highly skilled and specialised workforce is also needed to deliver this work, and this could be efficiently achieved by employing specialist delivery teams that consistently move from project to project, each delivering 75 to 100 STK/year.

OPTIONS FOR CONSIDERATION

Five different pathways for delivering decarbonisation have been developed. These help funders consider the trade-offs which need to be made around the degree of decarbonisation achieved, the pace of delivery and cost.

For all five pathways costs and benefits are broadly balanced over a ninety-year appraisal period and those pathways which provide higher emissions reductions offer the best value for money when delivered over a longer period.

All except pathway 4 are feasible based on the industry's assessment of delivery capability. Further work is being undertaken with RIA and the supply chain to validate this.

TRACTION DECARBONISATION PATHWAY	AVERAGE ANNUAL STKs OVER PROGRAMME	MAXIMUM STKs IN ANY ONE YEAR
Pathway 1 (-80 %)	259	377
Pathway 2 (-95 %)	303	447
Pathway 3 (Net-Zero by 2050)	355	691
Pathway 4 (Net-Zero by 2040)	658	922
Pathway 5 (Net-Zero by 2061)	303	447

COSTS

Most capital expenditure arises from the cost of overhead electrification and to identify these costs we have assessed the complexity of the work to be undertaken on each part of the network that needs to be electrified. This considers the length of the section, the engineering complexity (for example, tunnels and bridges), the economic cost of disruption while the work is carried out and the likely duration of the project. Capital costs at this stage have been estimated using a wide total cost bracket spanning from £1m/STK to £2.5m/STK (2020 prices).

Capital cost of battery charging points and hydrogen refuelling locations were determined using preliminary estimates from RSSB's T1199 project. These costs were then scaled according to the number of battery and hydrogen trains required in the recommended areas.

Analysis of the recommendations suggests that between 3,600 and 3,800 electric and 150 and 200 battery and hydrogen trains will be required for the traction decarbonisation recommendations but the need for interim solutions will likely increase the number of battery and hydrogen trains needed in the short-term. Around 650-700 freight trains will also be required and are likely to be delivered as a mixture of electric and multi-mode vehicles.

The delivery of this strategy is subject to funding from HM Government, the Scottish Government, and the Welsh Government.

DELIVERING TRACTION DECARBONISATION

Priority decarbonisation projects and programmes will be decided by working with industry stakeholders and will be presented in the TDNS programme business case in October 2020.

The delivery of decarbonisation projects and programmes is devolved to Network Rail regions who are now working with Network Rail System Operator to begin to develop regional traction decarbonisation strategies and identify early schemes to take forward.

Once decisions have been made to develop or deliver schemes, those projects will be governed by the RNEP and GRIP processes.

A further important consideration is that this decarbonisation programme will need careful integration with other major national programmes such as the Long-Term Deployment Plan (Digital Railway), Northern Powerhouse Rail, High Speed Two and projects arising from the rail industry Air Quality Strategic Framework. The programme will be able to highlight areas of potential conflict but further work will be required beyond October 2020 to resolve these issues and ensure all work is smoothly integrated and delivered as efficiently as possible.