Catalysing a green recovery

Creating jobs by building Britain's net zero railway

October 2021

We Mean Green

Contents

Rail Delivery Group

National Rail

Foreword

> **Far from being simply a cost to be borne, decarbonising the rail network is a once-in-a-generation opportunity that will create jobs and prosperity across every nation and region of the UK**

Andy Bagnall, Director General, Rail Delivery Group

The importance of low carbon transport has never been clearer. Getting people and goods from A to B is the single biggest cause of pollution in Britain. With the planet facing a climate emergency, the UK government is looking for solutions - a green industrial revolution. A 21st century interpretation of a classic Victorian invention offers the fastest route to a decarbonised transport system: the train.

Rail is already one of the greenest ways to travel and transport goods. It brings thousands of commuters from the suburbs into our cities every day and offers a low carbon way to bring the goods our economy depends on, to market.

While rail accounted for 10% of passenger miles travelled in 2019, it accounted for just 1% of transport-related emissions. Rail's greatest contribution to the climate fightback will be coaxing travellers and freight off the roads, out of the skies, and onto rails.

Rail already means green, and we want to go even further to make all trains zero carbon to run. Through electrification and the use of hydrogen, batteries, and the latest green technologies, we can further decarbonise train travel, contributing to the national and global effort to cut greenhouse gas emissions and improve air quality. Harnessing the railway's proud history in Britain's industrial past will unlock new, greener, high-skilled jobs for the industrial revolution of the future.

This report shows that, far from being simply a cost to be borne, decarbonising the rail network is a once-in-a-generation opportunity that will create jobs and prosperity across every nation and region of the UK, while building cutting-edge skills and innovations to export globally. We cannot afford to miss out on the substantial benefits from decarbonising the railway which include:

- Around 6,000 jobs - with opportunities to level-up, enhance the diversity of the rail workforce, and upskill our people.
- Economic benefits of £2.2 billion generated by the roles needed to deliver a decarbonised railway.
- 33 million tonnes of carbon not emitted into the atmosphere between now and 2050.
- Air quality improvements valued at a further £2.2 billion.

To make this a reality, government needs to fund a long-term programme of electrification, alongside investment in hydrogen and battery technologies. It's an investment not just for the railway, but for British jobs and enterprise. A greener railway that drives a sustainable economic recovery and growth, delivering a better future for all.

With COP26, the winds of change have begun to blow. As world leaders look to the future, the right investment here in the UK can see rail become the backbone of a decarbonised transport network, delivering job opportunities across the country, reducing emissions and positioning British businesses to succeed in delivering new low carbon technologies both here and abroad.

Benefits of decarbonising the railway

Around

6,000

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£2.2bn

of economic benefits generated by the roles needed to deliver a decarbonised railway

33m tonnes

of carbon emissions saved between now and 2050

Harnessing Britain's industrial heritage to build a greener future

How might decarbonising rail benefit the nation's economy? Given the wide-ranging demands on public finances as government looks to achieve its ambitious target of a net zero economy by 2050, this important question sits at the heart of our report.

Through this document, we make a compelling case for meaningful investment in making the railway even greener. In doing so, this would unlock:

- Around 6,000 jobs lasting to 2050, boosting the economy by £2.2 billion;
- most jobs created outside London and the South East, including over 2,600 across the East Midlands, Yorkshire and the Humber and the South West;
- approximately one-third of jobs created at advanced apprenticeship level and a further third at graduate level;
- carbon emission reductions over the period valued at c.£5.8bn[1];
- a further £2.2 billion of value from improved health as a result of cleaner air.

The Rail Delivery Group (RDG) asked Oxera, IPEX and the National Skills Academy for Rail to offer their economic and industry insights to establish what a programme of investment to decarbonise the nation's railway could achieve. This report sets out the results of their novel research.

This research sits against the backdrop of the UK's commitments to decarbonise the economy by 2050. RDG will seize the opportunity at COP26 to set out an ambitious vision for rail as the backbone of a sustainable transport network, and to champion British technology before a global audience. As one of the greenest modes of transport and the only mode with a credible plan for moving large volumes of passengers and freight[2] in a net zero way, rail will play a central role in the decarbonised transport network of the future[3].

Working together with government, which holds the key levers to make the railway greener and encourage more journeys to be made by train, the rail industry will play a vital role in achieving net zero for Britain. Travelling by train produces just a third of the emissions of car travel.[4] Each freight train removes 76 lorries from our roads.[5] Trains already reduce UK carbon emissions by 7.7 million tonnes every year (compared to a scenario where those journeys were made on the road),[6] with reduced congestion feeding through to improved air quality.

1 Based on carbon values published by BEIS in 2021: BEIS (2021), 'Valuation of greenhouse gas emissions: for policy appraisal and evaluation', September.

2 We note that the technical challenges for freight are greater than that for passenger rail due primarily to the weight of freight trains and the size of the batteries (based on today's technology) that would be required to move these when they are off of the electrified network.

3 The Rail Delivery Group (RDG) represents the rail industry in Great Britain, and so we only refer to Great Britain in this report. Rail in Northern Ireland is not within RDG's remit.

4 DfT (2021), 'Great British Railways, The Williams-Shapps Plan for Rail', p. 16.

5 RDG (2015), 'Freight Britain: continuity and certainty for rail freight'.

6 Network Rail (2021), 'Sustainability'.

But more can and must be done: every element of the UK economy and society will need to play its part in this transition to a net zero economy, and the rail industry is committed to further reducing its carbon emissions. The technology to do this - powering trains directly with electricity, or with battery and hydrogen-powered trains where electrification is not practical - is proven.[7] Investors in rail are prepared to fund a new generation of zero-emissions rolling stock using private capital; but what is needed is a commitment from government to fund the infrastructure for this ambitious programme. The analysis in this report is based on the Traction Decarbonisation Network Strategy (TDNS)[8] , with underpinning assumptions discussed directly with the team responsible for TDNS.

This programme would save approximately 33 million tonnes of carbon emissions from the rail industry between now and 2050 - around the same amount of CO2 as is emitted when heating every home in Birmingham over the same period[9]. The avoidance of these emissions is valued at nearly £5.8bn,[10] delivering significant value to the UK, and the environment.

As one of the greenest modes of transport and the only mode with a credible plan for moving large volumes of passengers and freight in a zero carbon way, rail will have a central role in the decarbonised transport network of the future.

To maximise efficiency, a decarbonised railway would be delivered through a rolling programme of investment taking place between now and 2050. It would have many benefits beyond the reduction in carbon, including faster journey times, greater reliability,[11] and increased capacity which will support further modal shift to rail.

However, there is a wider story. As well as the benefits of jobs, skills and exports resulting from a rail decarbonisation programme, rail would also become a key customer for the UK hydrogen industry due to the use of hydrogen-powered trains wherever electrification and batteries are not practical or economical.

Finally, the rail industry aims to source all of the electricity used to run trains from renewable sources by the mid-2030s, using the industry's considerable purchasing power to bring additional renewable generation to the UK. This would be one of the largest Power Purchase Agreements in the UK and would support the UK's world-leading offshore wind industry in the process.

Therefore, this investment programme would support UK industry across the country, and across a number of sectors.

This report has benefited from support and input from across the rail industry, and we are grateful to all of those who have given their time to participate.

7 Although there is further research to be done around first- and last-mile solutions for freight, where battery and hydrogen solutions need further development.
8 Network Rail (2020), 'Traction Decarbonisation'.
Network Strategy - Interim Programme Business Case', July.
9 Oxera analysis using household numbers published by the ONS (2021), 'Annual population survey - households by combined economic activity status', and average household level of CO2 emissions from heating from the Energy Saving Trust (2021).
10 Based on carbon trading prices.
11 Principally better on-time performance.

Driving a new era of green jobs

Every project requires people to deliver it. Decarbonising our rail network is no exception: the associated investment programme would both support existing employment in the rail industry and its supply chain, and lead to new employment opportunities in the sector.

These jobs can be considered as being either 'protected' or 'unprotected'. A 'protected' job is one filled by someone who would otherwise be employed in the rail industry or another sector of the economy, while an 'unprotected' job is one filled by someone who would otherwise be unemployed or economically inactive (e.g. a student or not actively looking for work).

Analysis conducted for the RDG suggests that this programme could support an average of 6,000 jobs per year across the programme between 2024 and 2050. These are jobs both directly involved in delivering the work (e.g. delivering electrification of the network or assembling new trains) and in the supply chain (e.g. manufacturing components or managerial roles).

This employment would be sustained over a near 30-year period, providing job security for those involved, and a basis on which employers can be confident in investing in training and upskilling - for instance, through on-the-job training and apprenticeships.

Our analysis indicates that these jobs would be across many disciplines and so would benefit many suppliers - both inside the rail industry and more broadly throughout the UK. This programme would provide a long-term market for suppliers across the UK's industrial sector. If managed in the right way, this should enable those suppliers to invest in UK-based capacity to take advantage of the commercial opportunities presented by this programme, thus building the UK's industrial base in a way that could support a range of industrial sectors.

Around two-thirds of the jobs generated would be infrastructure-based, but substantial employment would also be associated with assembling new electric, battery and hydrogen trains.

As discussed later in the report, this will support the UK's nascent hydrogen industry by providing a stable source of demand for hydrogen and the development of UK industrial capacity in technology such as batteries, which will be important for the decarbonisation of other sectors.

We estimate that approximately 50% of the roles created by this programme would be filled by people who are already active in the rail industry or in other sectors of the economy. This represents a significant opportunity for people to continue their employment within the sector (rather than to move sectors or become unemployed) when other large rail projects (such as HS2) reduce their construction requirements. It also provides a substantial opportunity for employees in other sectors of the economy to upskill for work in rail. Having a genuinely long-term programme such as this should enable the supply chain to confidently invest in their workforce, against the backdrop of a stable and long-term GB rail market. This will add to skills and productivity across the workforce. Germany offers a relevant example of how this type of long-term rolling programme of electrification can deliver benefits, including significantly lower costs.[12]

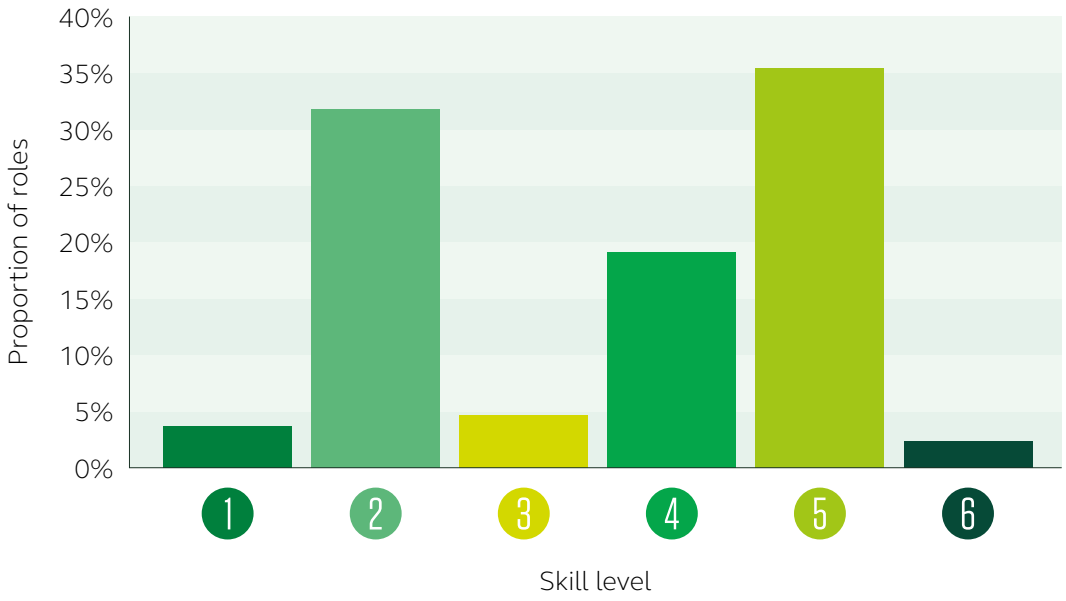
The remaining roles would benefit new entrants to the job market. These roles could be filled by a range of people - for instance, school leavers, recently graduated students or the long-term unemployed.

This new and supported employment would be a mixture of highly skilled (graduate-level) and more manual/vocational level jobs. This will provide opportunities for new graduates to enter the rail industry and for existing employees to upskill. These roles should be open to people from every walk of life-including people from disadvantaged groups, school leavers, ex-forces and ex-offenders and there should be a range of employment and pre-employment initiatives in place to offer training and support, including Routes into Rail.

[12] House of Commons Transport Select Committee (2021), 'Trains fit for the future', section 3, para. 43.

The figure below illustrates the split of roles by skill level (i.e. the level of education or training required for a role).

New roles by skill levels



Source: NSAR. analysis.[13]

The programme to decarbonise the GB rail industry would therefore support a wide range of high-quality jobs - giving the supply chain long-term confidence to invest in people.

Of course, the work required to transform the rail network and manufacture the new rolling stock is only part of the impact. The UK government has aspirations for 5GW of low carbon hydrogen production capacity by 2030,[14] and continued growth in the longer term. Our analysis suggests that the rail industry may need 2–5GWh of energy from hydrogen per year to fuel a fleet of hydrogen trains. This will support employment in the energy industry and enable the railway to be an 'anchor tenant' for the emerging hydrogen industry, supporting the industry to invest and scale-up (and therefore reduce costs) to a greater extent than would otherwise be possible.

The rail industry aims to run trains on 100% renewable electricity. This would require additional renewable energy generation capacity in the UK. The UK has a world-leading offshore wind sector and, while the precise details are yet to be agreed, it is likely that a significant proportion of the 4–6TWh of electricity needed to power the electric trains will come from UK-based wind farms, providing further support to UK-based manufacturing and energy sector employment. In addition, the consistent demand from rail may help to stimulate investment in energy storage that would help to manage the volatility in supply from renewable sources that depend on intermittent forces of nature (e.g. wind or solar).

[13] Skill level 2 is equivalent to GCSE or L2 Diploma; level 3 to A-level or L3 Diploma; level 4 to a foundation degree or HNC (Higher National Certificate); level 5 to an HND (Higher National Diploma); level 6 to a university degree (bachelors); and level 7 to a Master's degree.

[14] HM Government (2021), 'UK hydrogen strategy', p. 2.

Supporting economic growth

The UK economy will benefit from the changes in job roles and labour force growth that our decarbonisation plan brings about.

Individuals moving to new roles will often result in greater productivity and pay as people use skills and attributes that their existing job does not involve, or they up-skill. Our analysis indicates that this increase in productivity could be worth £3,900 per supported job per year.

In addition, bringing new people into the labour force has even greater economic benefits, estimated at £42,500 per role per year. These benefits include the value of the salary to the individual, incremental benefits to the Treasury from tax and National Insurance, and reductions in welfare payments claimed, as well as reflecting the well-established link from increased employment to reduced expenditure on health.

The economic benefits from employment resulting from the decarbonisation programme are estimated to be worth

£2.2bn[15]

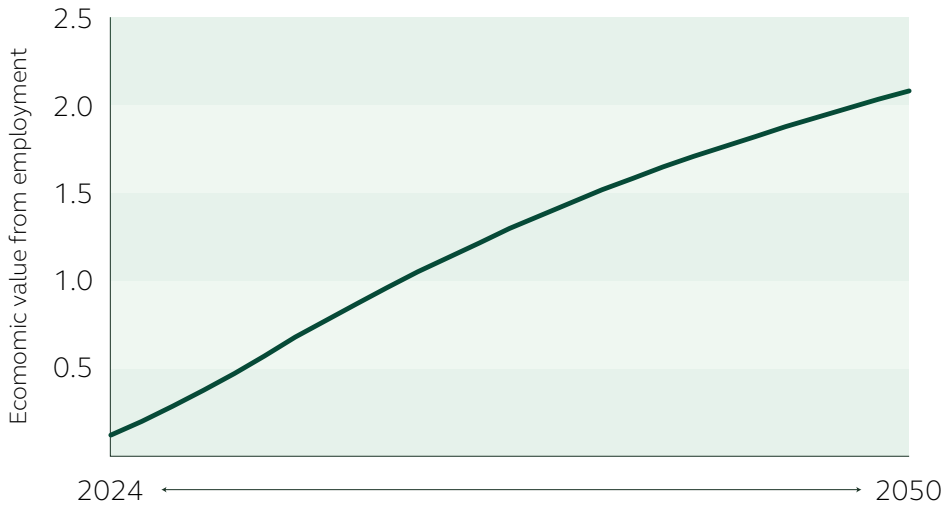
These are the 'hidden' economic benefits of this investment. They are not typically included in the economic business cases for government spending on transport, which do not consider the workforce or supply chain effects of an investment. Instead, typical economic business cases focus on the impact of investment on passengers and the wider economy (e.g. reductions in congestion) arising from changes in passenger and freight volumes or modal shift.

The economic benefits outlined in this report reflect changes in the labour market arising from the investment programme, relative to a situation where the programme is not undertaken.

These figures only account for the impacts felt within the rail industry and are therefore conservative - for example, they do not take into account any employment supported in the hydrogen or offshore wind sectors - so the total impacts will be even greater.

[15] In 2019/20 prices, and discounted at 3.5% a year in line with Green Book guidelines.

Cumulative economic benefit from employment over the programme (£bn)



Note: 2019/20 prices, discounted using standard Green Book assumptions.
Source: NSAR.

Hannah Wiles, 28, is a graduate in Mechanical Engineering from Loughborough University. She is a Project Engineer in the Asset Protection team for Porterbrook, the Derby-based rolling stock company that is developing the HydroFLEX train. Part of her role involves overseeing component and materials recovery from trains when they come to the end of their working life. She said:

I'm working on an exciting project to upcycle one of our existing trains to run on hydrogen so we can showcase how this green fuel can be used to power passenger trains. I'm very proud that my work on HydroFLEX will support making trains even more environmentally-friendly and I'm really keen to see the railway adopt further green technologies that have been developed successfully in other sectors.

Distributing opportunities across Great Britain

Decarbonisation of the GB rail industry would deliver benefits across Great Britain, contributing positively to the government's 'levelling-up' agenda. Specifically, jobs would be created across Great Britain, as thousands of people will be needed to electrify the network and build new electric (or alternative traction) trains.

The following figure illustrates a regional estimate of where we would expect these jobs to be, based on the geographical location of infrastructure works and existing rolling stock manufacturing/assembly plants.

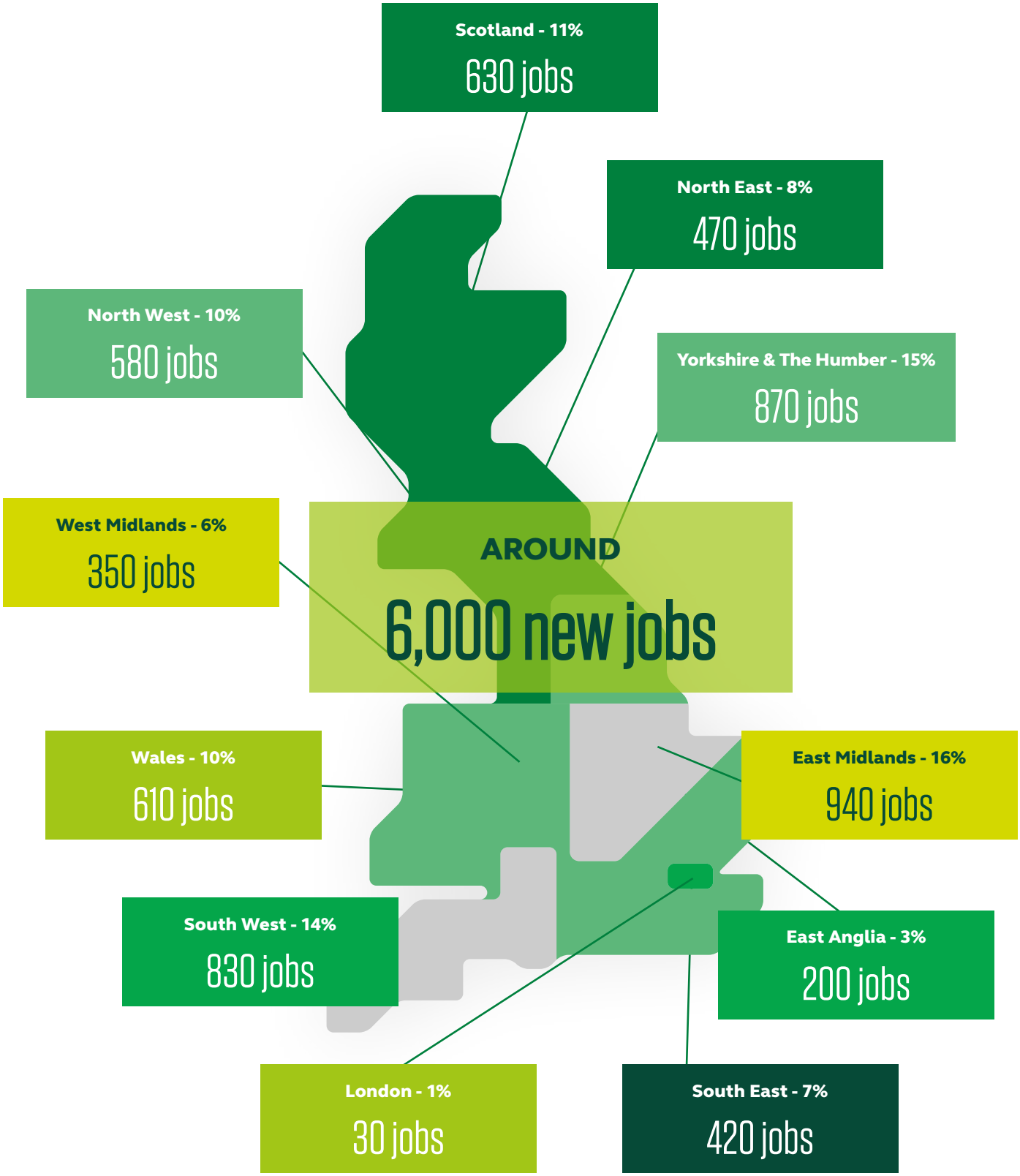
There will be significant employment opportunities arising from the electrification of the network, particularly in Scotland and the South West of England, where much of the infrastructure work will take place. This is driven by the fact that much of the rail network in these regions is diesel-based and requires more infrastructure to decarbonise.

There will also be substantial levels of activity in the East Midlands, the North East, Yorkshire and Humber, and Wales from the assembly of the thousands of electric, battery and hydrogen-powered passenger vehicles required to take advantage of the new infrastructure: the existing or planned assembly plants at Newton Aycliffe, Goole, Derby and Newport provide the UK with significant train-assembly capabilities.

A long-term programme of rail decarbonisation also presents an opportunity for UK-based suppliers to plan to provide a substantial level of the components for these trains. Freight locomotives are currently imported, but with sufficient visibility of the pipeline, the manufacturers of these vehicles may choose to invest in UK facilities.

The creation of thousands of skilled jobs across the country would leave a lasting legacy. Of course, this employment is only one part of the story; for many years electrification programmes have been pursued on the strength of their positive impact on the operation of the railway and the improved passenger experience that they can support (for example, reduced journey times and improved reliability).

The distribution of jobs across GB supported by a decarbonisation programme



Note: The distribution of jobs is based on the geographical location of infrastructure works and rolling stock manufacturing/assembly plants.

Source: NSAR.

Catalysing green investment across the wider economy

The UK government wants to be a catalyst for private investment in green tech. This programme supports that objective.

The rail industry in Great Britain is already a significant user of electricity, every year consuming 4TWh of electricity to power trains which are already electrified and more for stations and property. This is expected to increase to 6TWh by 2050 as more trains run on electricity and batteries. To put this into context, this is approximately 1% of all electricity consumed in the UK.

The rail industry has an ambition for 100% of its electricity to be produced from renewable sources by the mid-2030s. The intention is for this to be achieved by Power Purchase Agreements (PPAs) with renewable wind and solar farms and also increasing the extent of local generation of renewable sources on, or close to, rail property (for example, building on the Riding Sunbeams project, and increasing the use of station and depot property for local renewable generation).

A PPA is a well-established approach whereby a user of electricity, such as the rail industry, agrees with a producer, like a wind farm or solar operator, to purchase power at an agreed price for a particular period of time - often ten years or more.

[16] See: https://www.ridingsunbeams.org/ for more information.

In this way, the rail industry can support the development of more renewable generation capacity in the UK than would otherwise be the case. In particular, if the rail sector's future energy demand was to be met entirely by wind power, the rail industry could support an additional 200–250 offshore wind turbines and 75–300 onshore wind turbines (depending on the energy mix used to meet the rail industry's power needs).

The rail industry has an ambition for

100%

of its electricity to be produced from renewable sources by the mid-2030s

In this scenario, between 2024 and 2050, the rail industry could be the catalyst for approximately £1bn of investment in increasing the UK's capacity to generate green energy.

> This report is a really important contribution to the case for decarbonising our railway network as it goes beyond the traditional 'business case'. Not only will electrification, alongside hydrogen and battery trains, be essential to reaching Net Zero by 2050, but – as this report shows – it can in addition create green, highly skilled jobs and provide a vast economic benefit to the UK. As the Government looks to generate an economic recovery post-Coronavirus, decarbonising our railway network is a clear, high value-for-money investment that can support the country's bounceback.
>
> **Darren Caplan, Chief Executive, Railway Industry Association**

The UK government is aiming for 5GW of low carbon hydrogen production capacity in the UK by 2030.[17] While the uses of hydrogen are expected to be widespread across transport, heating and industry, our analysis suggests that by 2050, the rail industry might expect to use 2–5GWh of hydrogen generated energy per year to power hydrogen trains. Therefore, the rail industry could be a key customer and early adopter of hydrogen. This would provide a catalyst for the nascent hydrogen industry in the UK by providing a reliable early customer, enabling investors to commit funding to hydrogen production capability with confidence that there is a stable and reliable demand for their product.

Hydrogen train

[17] HM Government (2021), 'UK hydrogen strategy', p. 2.

Supporting high value manufacturing

Our plan for decarbonising rail is a plan for boosting the UK manufacturing industry. High value manufacturing is a highly productive part of the UK economy, and boosting high value manufacturing is at the centre of the government policy to 'build back better'.

The long-term, stable pipeline of investment provided by a comprehensive rail decarbonisation programme would enable the UK's innovative manufacturing supply chain, and particularly SMEs, to plan and invest.

With a requirement for £7bn of private investment in new rolling stock, including 4,000 passenger and 700 freight vehicles, and requirements for new renewable technology, the entire programme for decarbonising the GB rail network will support high value manufacturing across the UK in four areas.

1. Supporting the supply chain for batteries - which is evolving rapidly with innovative SMEs, new entrants and established suppliers all developing capabilities. There are also links across supply chains, with firms active in supplying battery and related technology to both rail and automotive manufacturers. A clear and predictable demand for new rail supplies and energy storage solutions would stimulate the development of this industrial capacity, including across the North of England and the cluster of automotive manufacturing in the Midlands.

2. Enabling the development of a hydrogen generation and distribution industry - by providing a clear and stable source of demand for hydrogen to power trains where electrification is not economically viable, the rail industry will contribute to the development of this strategically important industry that the government estimates will be the source of 9,000 jobs.[18]

3. Boosting the manufacture of wind turbines - the industry's strategy for using renewable energy to power trains is being worked through in detail. However, there is the potential for much of that electricity to come from UK sources; in this way, the rail industry would support the UK's world-leading wind power and energy storage industries and the manufacturing jobs in those sectors.

4. Manufacturing of rolling stock components - approximately 25% (by value) of train components assembled in the UK come from UK-based supply chains and there is potential for this to be increased further. This programme of decarbonisation would deliver a long-term pipeline of potential demand for UK train component manufacturers, enabling the supply chain to invest in developing industrial capability within the UK, facilitating import substitution. This would support the existing clusters of train component manufacturers in the East Midlands and the North.

[18] HM Government (2021), 'UK hydrogen strategy', August, p. 8.

Much of this manufacturing activity will be located in the Midlands and North of the UK, building on existing clusters of economic activity across different types of manufacturing.

In addition to this domestic market, there is expected to be a substantial international market for electrification, battery technology and hydrogen trains. A long-term programme that stimulates the development of industrial capacity in those areas, based in the UK, would position UK-based firms well to compete for those contracts.

The distribution of manufacturing jobs

Source: Office for National Statistics.

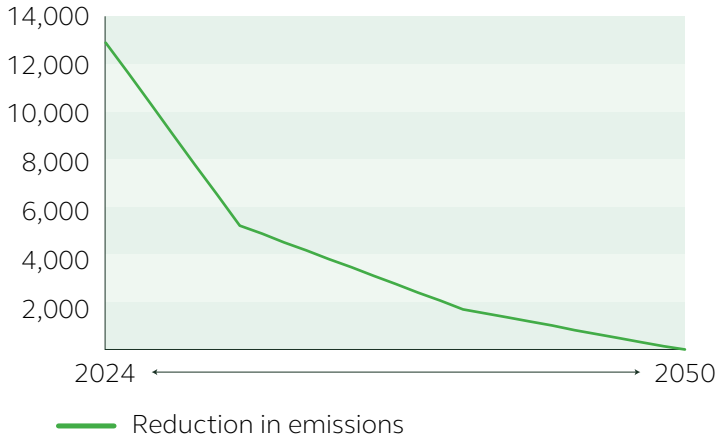
Improving air quality

In September 2021, the World Health Organisation issued new Global Air Quality Guidelines,[19] drastically reducing its advisory target for emissions from transport, fossil fuels and industry. Our plan for decarbonising rail can help the UK government move towards this target and protect communities.

As this report has already discussed, rail is one of the greenest forms of transport. Rail releases 90% less particulates (PM_{10}) and emits up to 15 times less nitrogen oxides (NO_2) than HGVs for a given journey.[20]

However, diesel train engines produce emissions that reduce local air quality, particularly in and around stations or other enclosed places where trains spend time moving slowly or idling. This can affect passengers, staff and others around the rail network. The industry is working on addressing this and, in 2020, the Rail Safety and Standards Board (RSSB) launched an Air Quality Strategy Framework to support the effort to reduce air quality impacts arising from the rail industry's activity.[21]

NO_2 emissions (tonnes)



Note: The annual emissions of NO_2 were calculated using emission factors published in the National Atmospheric Emissions Inventory (NAEI) and the estimated activity of diesel trains (based on the annual fuel usage).

Source: Oxera analysis based on data from IPEX and the NAEI. NAEI (2021), 'Emission factors detailed by source and fuel'.

[19] World Health Organization (2021), 'New WHO Global Air Quality Guidelines aim to save millions of lives from air pollution', News release, 22 September.

[20] Rail Delivery Group, 'Response to The Environment, Food and Rural Affairs, Environmental Audit Committee, Health and Transport Committees improving air quality inquiry'.

[21] RSSB (2020), 'Rail industry launches Air Quality Strategy Framework', https://www.rssb.co.uk/en/what-we-do/insights-and-news/news/Rail-industry-launches-Air-Quality-Strategy-Framework (last accessed 5 October 2021). June.

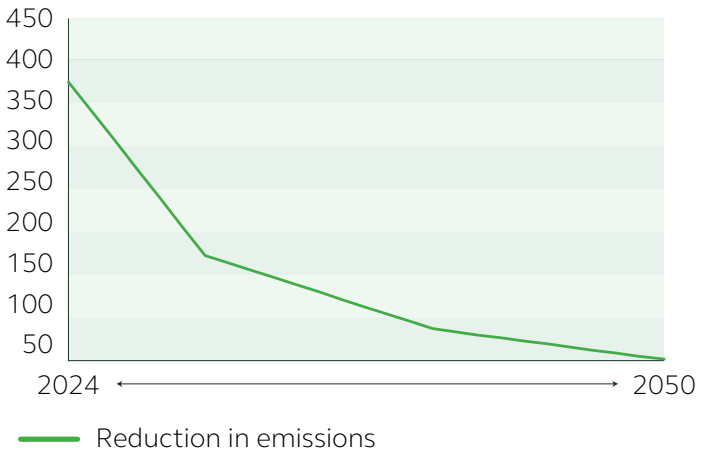
Decarbonisation of the network offers a solution to this problem - replacing polluting diesel engines with zero-emission alternatives, whether through the introduction of conventional electric trains or hydrogen or battery powered trains.

A rolling programme of decarbonisation would progressively remove the major source of emissions from the rail network and result in the saving of approximately 280,000 tonnes of NO_2 and 9,000 tonnes of PM_{10} emissions by 2050.

The two graphs presented show the trajectory of NO_2 and PM_{10} emissions respectively on the network between now and 2050, assuming a gradual programme of new rolling stock to take advantage of the new infrastructure.

Using values from the UK government representing the monetary value of improvements in health from lower exposure to air pollutants,[22] these reductions in local air pollution are valued at £2.2bn and would represent a material improvement in the air quality around the rail network, particularly in enclosed urban stations.[23]

PM_{10} emissions (tonnes)



Note: The annual emissions of PM_{10} were calculated using emission factors published by the NAEI and the estimated activity of diesel trains.

Source: Oxera analysis based on data from IPEX and the NAEI.

[22] Department for Transport (2021), 'TAG air quality valuation workbook'.

[23] The monetisation of the benefits from the change in NOx and PM_{10} emissions was done using special worksheets published by DfT, designed to calculate the monetised impacts of air quality changes in appraisal schemes. The workbook used the estimated emissions of NOx and PM_{10} with and without the decarbonisation plan as an input and monetised the benefits of the change in emissions using damage costs values published by the Department for Environment, Food and Rural Affairs (DEFRA). DfT (2021), 'TAG: environmental impacts worksheets – air quality valuation workbook', 30 July.

Conclusions

Decarbonisation is one of the most pressing issues of our time, and the eyes of the world will be on the UK when COP26 takes place in Glasgow this November.

Rail - as the greenest mode for moving people and freight over longer distances - has an essential part to play in the transition to a net zero UK by supporting the decarbonisation of transport as a whole. It is already a green option and making best use of the available infrastructure, through increased modal shift to rail, is a critical part of achieving net zero.

But more is needed, and rail wants to decarbonise even further through a rolling programme of electrification, infills using battery and hydrogen, new rolling stock to take advantage of this greener infrastructure, and by using 100% renewable electricity.

This programme is ambitious but achievable - it does not rely heavily on new technology: much of the technology required already exists. What is needed is the commitment to the plan that will enable the whole industry to come together in pursuit of this vision.

While the main focus of this programme is decarbonisation, it is underpinned by a rationale that has driven electrification for many decades - faster, more reliable journeys, increased capacity and quieter, smoother rides - all of which will further drive modal shift and support the transition to a lower-carbon economy.

But there is a wider story here too - the jobs that this programme would support across the country, for all skill levels and backgrounds, and across the UK's manufacturing base, providing the foundations for investment, upskilling and export growth. This report, based on independent analysis from Oxera, IPEX and NSAR, has set out these expected benefits.

This programme would therefore support a wide range of government objectives, including levelling up the UK and building a green industrial revolution. As world leaders and decision makers descend on Glasgow for COP26, now is the time to be bold and invest in the rail industry as the backbone of a green transport network: it will not only deliver a better environment but benefit users, taxpayers and the country as a whole.

> **As world leaders and decision makers descend on Glasgow for COP26, now is the time to be bold and invest in the rail industry as the backbone of a green transport network**

~~500~~ ~~Cars~~

We Mean Green.
A single train removes up to 500 cars off our roads.
Get on board.

Our analytical approach

Overview

The analysis presented in this report was undertaken by a team comprised of Oxera (an economics consultancy firm), IPEX (a technical consultancy firm) and the National Skills Academy for Rail (NSAR).

The decarbonisation programme used as the basis for the report's findings was drawn from the Traction Decarbonisation Network Strategy (TDNS) developed by Network Rail. The Interim Programme Business Case for the TDNS was published in July 2020[24]. Network Rail expects to publish further details of the programme in due course.

Our estimation of the economic benefit, skills profile and geographical distribution of the roles created by the programme is based on analysis undertaken by NSAR, using their Skills Intelligence Model. Further details are set out below.

Our approach to determining the quantum and valuation of air quality improvements is based on emission factors from the National Atmospheric Emissions Inventory (NAEI) that convert the energy used in rail activity to NO_2 and PM_{10} emissions. The energy associated with rail activity comes from the analysis undertaken by IPEX in designing the decarbonisation programme, based on the TDNS. Finally, we used DfT's air quality valuation workbooks to monetise the estimated change in air quality.[25]

The underlying programme

IPEX used its non-electrified network model as a starting point for the analysis. The model splits the non-electrified UK rail network into 241 sections between sensible locations of junctions, towns, and cities, and identifies the presence of nearby existing electrification to those locations.

The Network Rail TDNS team provided IPEX with information and assumptions relating to the electrification roll-out over the coming decades. This enabled the IPEX team to develop a detailed electrification programme for the UK network that aligned to the TDNS, broken down into short-term (from present day to 2030), medium-term (2030–40) and long-term (2040–50) plans.

IPEX applied the latest developments in alternative traction technology to its non-electrified network model. Taking the TDNS programme as a baseline, IPEX assessed the possible interim steps that could be taken in the short and medium term in advance of electrification rollout, including the use of battery and hydrogen rolling stock where appropriate for given off-wire range requirements, geographies, and route operating characteristics.

This work programme generated a CAPEX profile that fed into the NSAR analysis described below.

Modelling the roles and determining the economic benefit

The roles and economic values presented in this report are based on outputs from NSAR's Skills Intelligence Model (SIM). The flow diagram below sets out the key inputs, analysis and outputs.

[24] NAEI (2021), 'Emission factors detailed by source and fuel'. DfT (2021), 'TAG: environmental impacts worksheets', 30 July.

Current workforce from sector

- Job role
- Skill level
- Region

Investment profile for sector

- Programme
- Region
- Number of years
- Asset type allocation

INPUTS

Model calculations using workforce pyramid

- Labour percentage
- Cost of employment
- Work type / asset type proportions

OUTPUTS

Future workforce

- Job role
- Skill level
- Region
- Asset type

Gap analysis

- Job role
- Years of programme
- Region
- Capacity in the available workforce

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