



The Future's Electric!

The benefits of Midland Main Line Electrification

Midland Main Line Electrification

Why it's so important for the East Midlands and why it should be delivered as soon as possible

The decarbonisation mission

In 2008 the UK set its first decarbonisation targets in legislation¹, and in 2021 the Department for Transport published its Transport Decarbonisation Plan² which included a commitment to remove diesel-only trains from the network by 2040. Electrification is a vital tool for the rail sector to decarbonise, especially on main lines like the MML. The MML inter-city services currently produce over 48,000 tonnes of CO₂ per year using diesel-powered operation. Our analysis shows that approximately an additional 30,000 vehicle miles could be operated using lower carbon emitting electric power every year if full MML electrification was completed.

Urban regeneration, improving quality of life and attracting patronage

In the East Midlands and South Yorkshire, the MML's catchment area is one of the most densely populated main line railways in the country. The region's residents, workers, and visitors do not benefit from a modern and clean railway unlike other parts of the country. Improvements on the MML can promote regeneration in the areas surrounding the stations in some of our biggest towns and cities and attract more passengers out of cars and onto electric trains.

Data shows that over 9 million passengers³ who currently use MML inter-city services between London, Sheffield, and Nottingham stand to benefit from electrification.

Reducing operational costs

Infrastructure electrification will enable the full benefits of the planned MML rolling stock modernisation programme, which in turn further enables the potential for a flow of benefits to other routes and regions through a rolling stock cascade. The introduction of new electric trains will trigger improvements to depots and staff training, enabling the overall operation of MML services to be stronger. Electrification can reduce the ongoing operational costs of rolling stock, fuel, track access, and maintenance. Over time it will lead to a lower cost and more effective railway.

Timescales and certainty – the future's electric

MML electrification has been discussed for decades and our region now needs certainty on how and when it will be delivered. The opportunity is now to make the most of the electric-capable Class 810 Aurora fleet which we expect to be fully in running on the MML from 2025. There are real costs to delays in delivery and of missed benefits. There should be a smooth continuous transition of the recently developed electrification skills to maximise efficiencies for the delivery of the route north of the planned termination point of current construction activity at South Wigston.

An efficient 'production' approach – affordably delivering electrification at scale

The rail industry has the opportunity to leverage recent MML and East Midlands rail project delivery success, and harness recent electrification innovations in order to showcase MML electrification as a template for affordable UK electrification. This can be achieved if there is Government support to provide the certainty major projects need. The UK's inconsistent rate of electrification has contributed to evidence of relatively high costs – so an efficient and sustained 'production' approach on MML is critical. This won't just benefit local jobs, and the East Midlands region, but will help build maturity and skills for electrification for the rest of the country and could act as an enabler for the UK to electrify more of the network confidently and efficiently.

Introduction and Context

Rail in the East Midlands

Rail plays an important role in how our economy functions, how people travel to visit relatives and friends, and how investment and business reach the East Midlands from the rest of the country. It has huge potential to help address some of the societal and economic challenges we face, including low productivity, low value employment, and some of the poorest social mobility in the country.

Our region is projected to be the fastest growing in terms of population growth to 2028⁴, but it has the lowest level of transport spend per head of any UK region or nation. If the region was funded to the UK average we would have an additional £1.29 billion to spend on transport every year⁵.

Our rail network has untapped potential in terms of what it can deliver for our region. Our stations are the least used, on a per capita basis, of all regions in England⁶ and reliance on car use is high.

Full electrification of the Midland Main Line (MML) is one of our key priorities as part of delivering a modern, 21st century railway for the East Midlands.

The Midland Main Line

The MML is the backbone of our region's rail network and is a nationally significant main line railway running between London St. Pancras and Sheffield, with a branch to Nottingham. It connects some of our biggest towns and cities including Leicester, Derby and Chesterfield and provides important connectivity to London and beyond.

The line supports a variety of both local commuter and inter-city services. Thameslink operate services to Bedford on the southern section of the route, East Midlands Railway operate intercity services between Sheffield/Nottingham and London, as well as 'EMR Connect' services between Corby and London via Kettering, and also a regional link from Leicester northwards to Nottingham and beyond. Other operators, including CrossCountry and freight services also use East Midlands sections of the MML.

Unlike the East and West Coast Main Lines, the MML is not fully electrified, and large sections of the route rely on diesel-powered trains.

The route is electrified between London and Bedford, Kettering, and Corby. Further electrification of the route to Wigston South Junction (south of Leicester) has recently been procured by Network Rail and is currently being delivered.

Strategically, the MML in the East Midlands is well placed for further full electrification. It is a relatively intensely used part of the railway, with services operating at speeds in excess of 100mph. It is already partially electrified in its southern section, and a modern bi-mode fleet of rolling stock is already under construction and due to come into service in the coming years⁷. It is not a candidate for battery, third rail, or hydrogen technologies, nor to endure continued diesel power running – there is no credible alternative to electrification when decarbonising rolling stock on the MML.

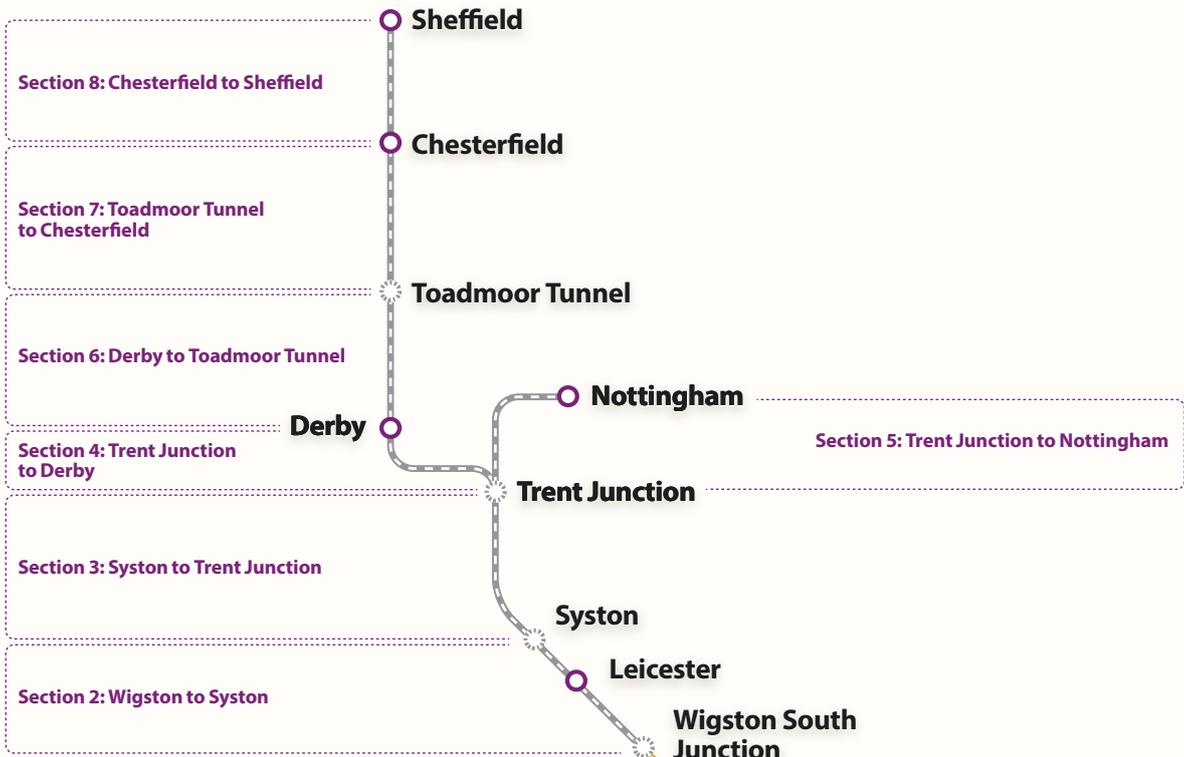
Previous plans for full electrification of the MML were paused in 2015 and then cancelled in 2017. The Government's 2021 Integrated Rail Plan put full electrification of the MML to Nottingham and Sheffield back on the table, an approximately 139km stretch of the line with approximately 67 structures. In terms of specific outputs of the project, these are assumed to include:

- Progressive delivery of overhead electrification to Nottingham and Sheffield (via Derby)
- Route clearance to accommodate the delivery of overhead line equipment
- Increase in power supply
- Immunisation of existing assets
- Pantograph transitioning sites as electrification is progressively commissioned

The section between London St Pancras and Bedford was electrified in the 1980s, and to enable electric operation of the new fleet at up to 125mph in that area will mean an enhanced renewal of the existing overhead wires.

These aged assets will be asked to perform with a more intense and faster electric service demand than today - so this complexity must be recognised and designed in order to prioritise resilience for the future performance of the MML.

Figure 1 MML electrification status by section



MML Electrification Status:

- Electrified
- - - Not electrified – currently under construction
- - - Not electrified – included in IRP

The Sections 2 to 8 are the anticipated delivery phases for MML electrification to Sheffield/Nottingham via Derby.

London St. Pancras

Why is the Midland Main Line important?

Adding value to our economy by supporting fast and reliable long-distance journeys

MML services already deliver a huge amount of economic, social, and environmental value to the East Midlands. When people choose to travel by rail they do so because they find it beneficial compared to the alternatives. For example, over long-distances a trip on the MML can provide a substantially faster and more comfortable journey than by car:

- Driving from Nottingham to central London would take at least two and a half hours, but takes an hour and 45 minutes on the train;
- Travelling between Derby and Sheffield by car takes around an hour, but only 30 minutes by train.

If we assume that all journeys currently made by train were instead by car then it is possible to estimate the direct benefit that MML inter-city services currently provide to our economy. Our analysis shows this figure to be over £450 million per annum. The table below shows how this benefit is delivered across different MML journeys.

Journey between	Annual user journey time benefit (£m)*
London and Nottingham	53.6
London and Leicester	51.8
London and Kettering	49.7
Derby and Sheffield	28.5
Leicester and Nottingham	25.5
Nottingham and Sheffield	23.3
Chesterfield and Sheffield	17.4
London and Derby	32
London and Market Harborough	21.1
Derby and Leicester	15.9
Other flows	137.7
Total	456.5

Table 1 Annual user benefit of MML inter-city services

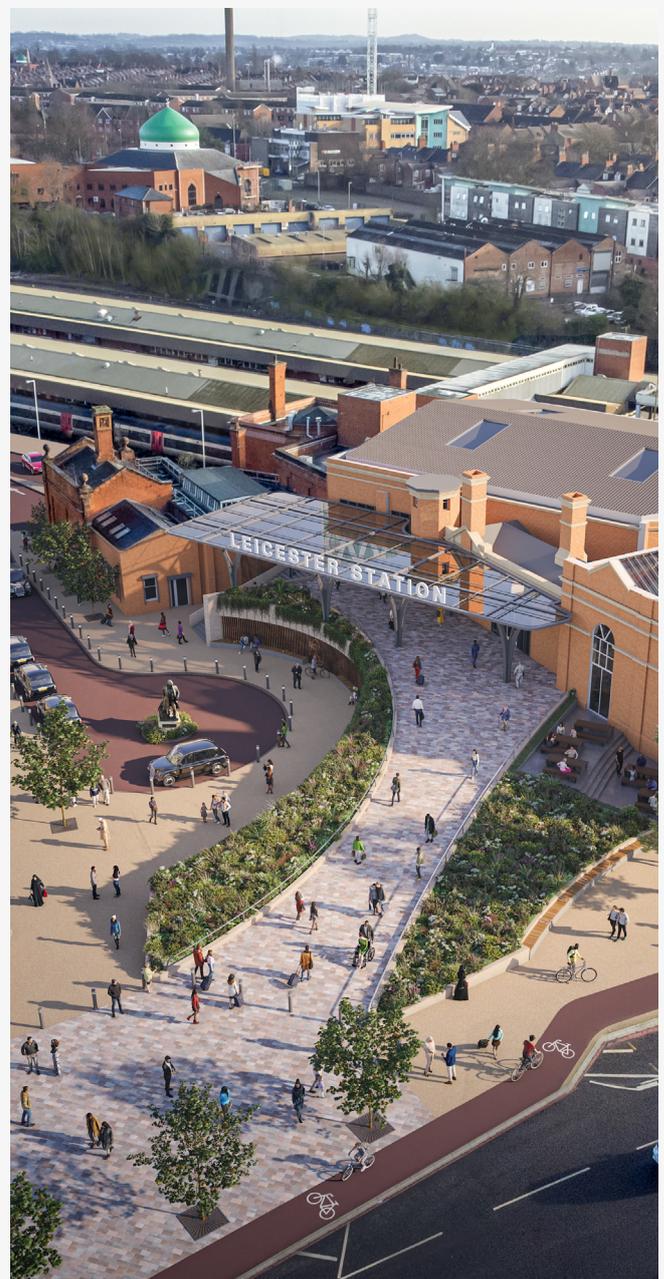
*these values use the DfT's Values of Time to convert time savings and user benefits into monetised values

As well as the passengers travelling on the trains themselves, when people choose to travel by rail all of society benefits. By removing fossil-fuelled car trips from the road network and onto MML rail services there are fewer accidents on roads, reduced greenhouse gas emissions, and improved local air quality. Our analysis of these 'non-user' benefits shows that as a result of MML passengers choosing to travel by train:

- Over £30 million of time savings for road users are generated through congestion relief;
- Approximately 45 accidents, valued at over £4 million in total, are avoided on the road;
- Local air quality improves, with a monetised value of over £1.5 million per annum; and
- Approximately 30,000 fewer tonnes of CO₂ are emitted, worth nearly £8 million per annum in monetised benefit.

However, it is important to note that these greenhouse gas emission savings are to a large degree offset by the emissions from the diesel-powered sections of the MML rail services until electrification is introduced.

Image source Leicester City Council



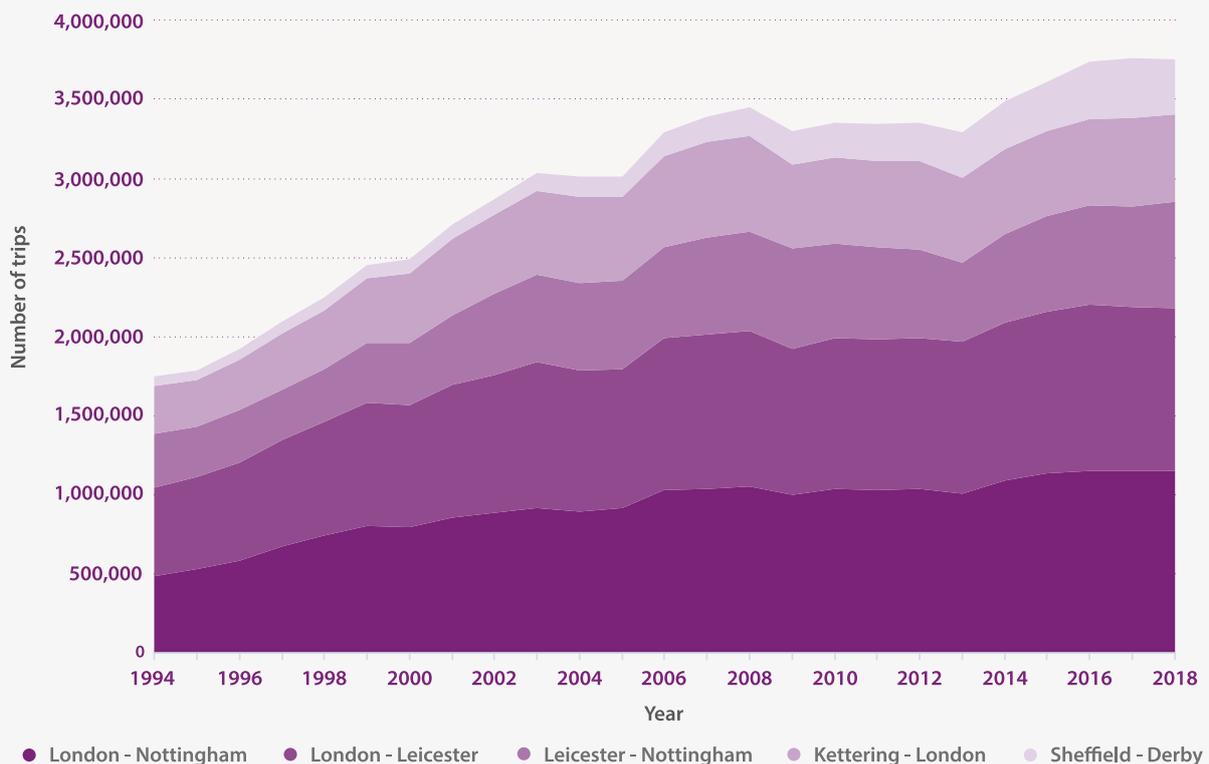
Supporting growing demand for inter-city connections

Historical data shows that MML services are more important now than ever before. The number of trips on the five busiest MML flows in the East Midlands has grown from 1.75 million in the mid-1990s to over 3.75 million in 2018⁸.

As well as this strong growth prior to the COVID-19 pandemic, data from the Office of Rail and Road shows that the number of trips made using East Midlands Railway services are now back to above pre-pandemic levels, with the number of journeys made between January and March 2023 101% of the same period in 2019⁹.

Vehicle miles on the MML are the highest they've ever been. Delivery of the 'Key Output 1' timetable enhancements in 2021 from the Midland Main Line upgrade programme mean East Midlands Railway now operate up to six trains per hour in each direction, four of which still require additional electrification to decarbonise.

Figure 2 Patronage growth on busiest MML inter-urban flows



MML has a greater need for electrification than other lines

The MML travels through some of the most densely populated parts of our region and the country as a whole. Our analysis shows that approximately an additional 30,000 vehicle miles could be operated using electric traction every year, benefiting over 9 million passengers¹⁰ who currently use MML intercity services.

Our analysis also shows that the population density in the area immediately surrounding the MML between London and Sheffield is

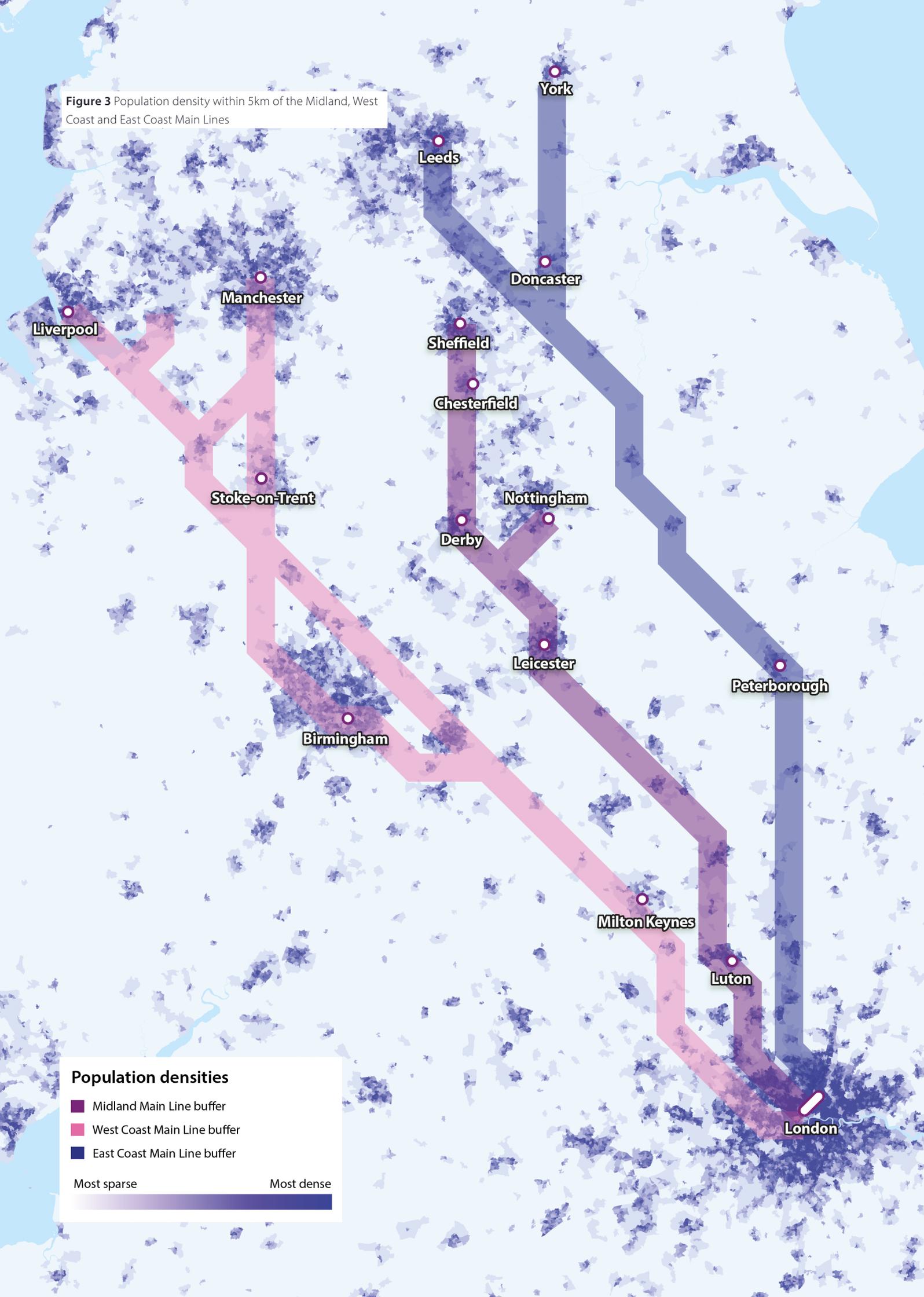
approximately 1,200 people per square km. This is higher than the West Coast Main Line between London and Liverpool/Manchester (1,100 per square km) and much higher than the East Coast Main Line between London and Leeds/York (650 square km). Both of which are already electrified.

People living and working close to the West and East Coast Main Lines benefit from cleaner air and less noise, whereas those living along the central and northern sections of the MML have to live with the pollution and decibels of diesel engines.

Image source Network Rail East Midlands @NetworkRailEM



Figure 3 Population density within 5km of the Midland, West Coast and East Coast Main Lines



Population densities

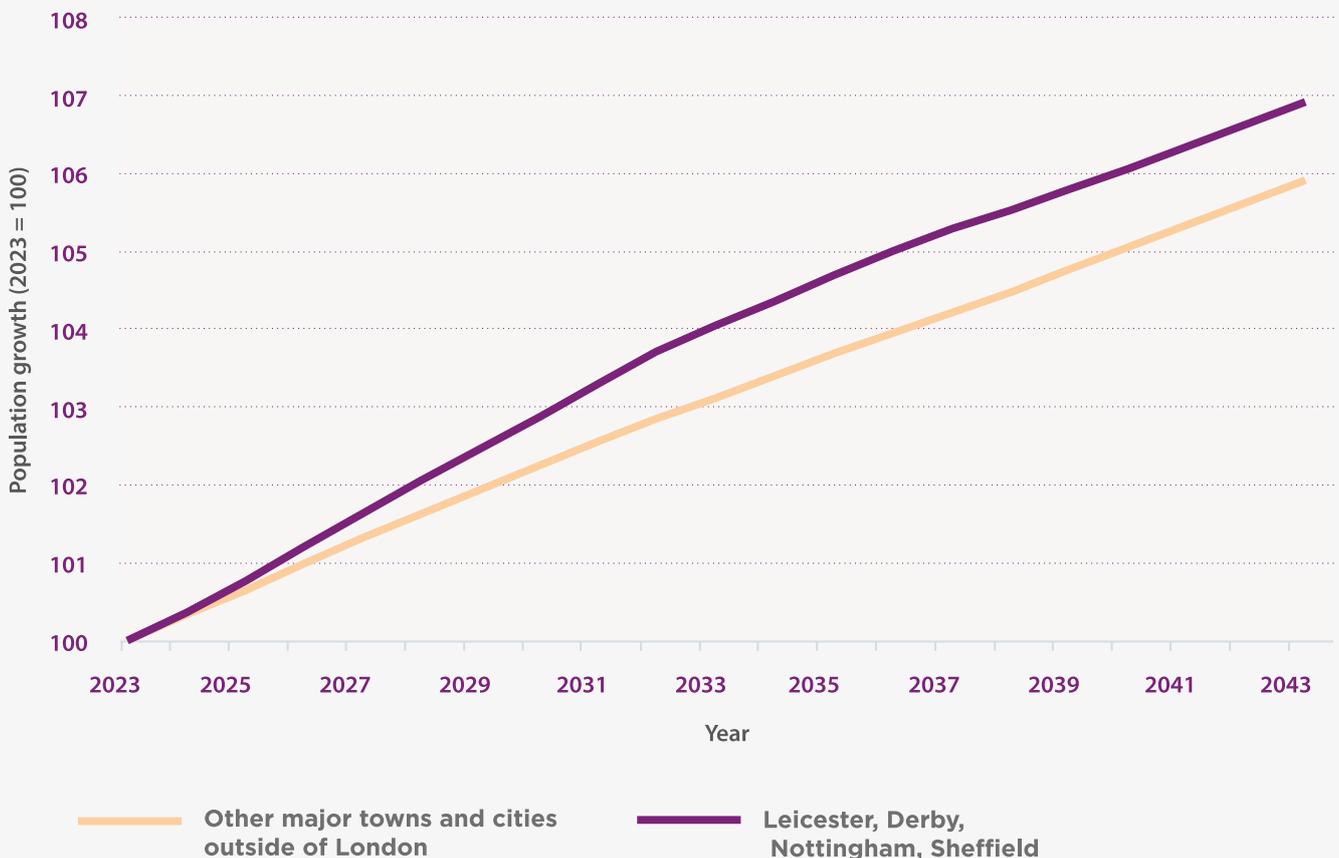
- Midland Main Line buffer
- West Coast Main Line buffer
- East Coast Main Line buffer

Most sparse Most dense

The towns and cities that the Midland Main Line serves are also amongst some of the fastest growing in the UK, emphasising the long term importance of this key urban corridor being served by a modern and fit-for-purpose rail network.

Along with population growth, in recent years we have also seen relatively high comparative rates of growth of new businesses (higher than any other region in 2019 and 2021). We believe electrification can act to attract further inward investment, and act to support an improvement of rail industry sustainability through the "sparks effect" to increase patronage, and to deliver even more decarbonisation benefits from increasing modal shift over time.

Figure 4 Forecast population growth for select cities and UK average



What are the benefits of electrification?

Direct and local economic impacts

The Commons Transport Select Committee¹² have recommended a rolling programme of electrification that would enable the UK to retain a skilled workforce and develop efficiencies to deliver electrification at lower costs than previously seen in recent UK programmes.

When commitments to electrification are made certain it is local firms and jobs that often benefit first, such as on the TransPennine Route Upgrade (TRU), which includes full electrification of the route between Manchester and York. The project employs 80% of its staff from the local area immediately surrounding the route, and over 170 apprentices have been recruited as part of the project¹³.

Our region already has strong ties to the rail industry and a proud railway heritage. We have the skills and workforce here ready to help deliver full electrification.

Contributing to our national net-zero carbon commitments

With regard to the Climate Change Act 2008 targets, several of the Local Transport Authorities in the East Midlands have declared climate emergencies in recent years¹⁴. The role that transport must play in national decarbonisation efforts cannot be underestimated, with transport currently being the single largest contributor to UK domestic greenhouse gas emissions. Prior to the Covid-19 pandemic, carbon emissions¹⁵ from rail in UK were amongst the world's highest, with rail passenger emissions double the global average¹⁶.

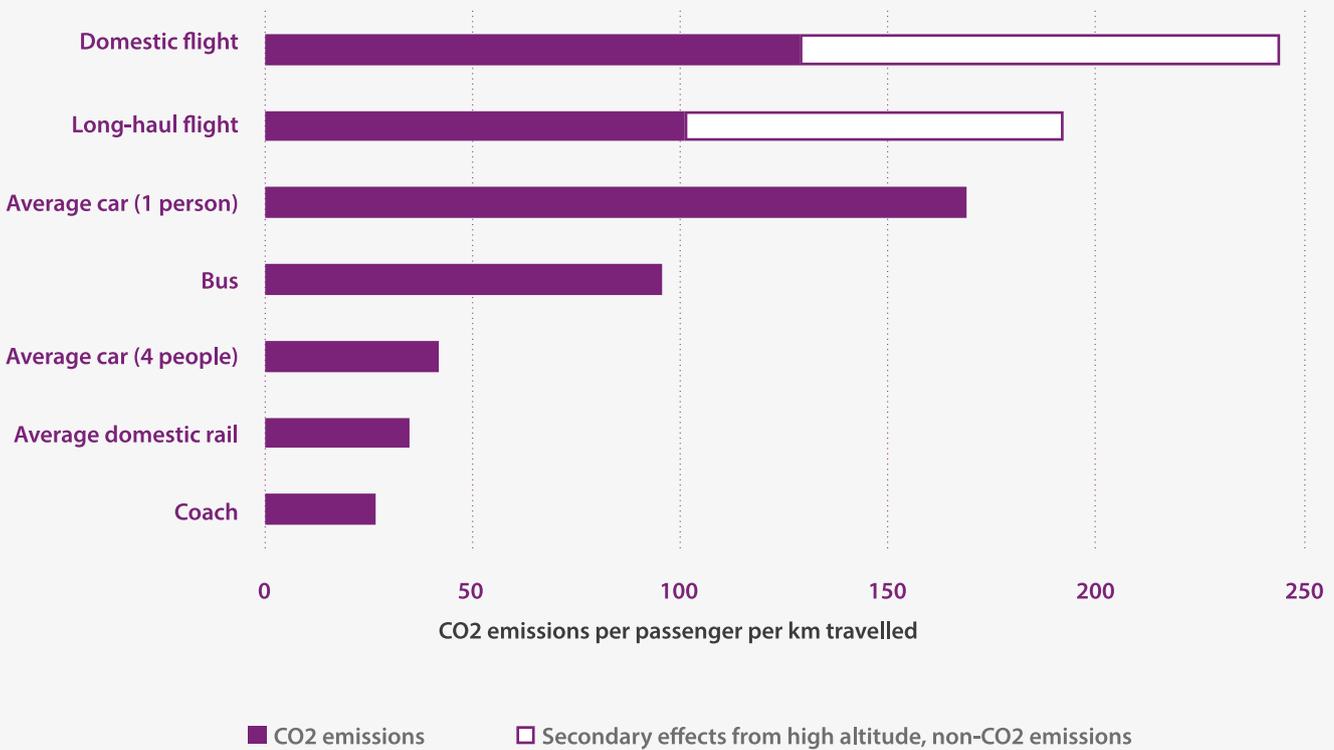
The Rail Delivery Group and Thrust Carbon¹⁷ have calculated that travelling by electric powered train between London and Edinburgh produced 10 times fewer carbon emissions than making the same journey by car, and we would expect a similar scale of benefit to be delivered by fully electric-powered MML journeys in the future. Electric trains are as efficient, in terms of greenhouse gas emissions, as they have ever been. Evidence from the Railway Industry Association shows that electric passenger trains have reduced their emissions by 30% since 2005¹⁸.

The diesel-powered sections of the MML services are costly in terms of the greenhouse gas emissions they produce, both in terms of tonnes of carbon and monetised value. Our analysis shows that the services between London St. Pancras and Nottingham/Sheffield generate over 48,000 tonnes of CO² every year, which have a value of over £13 million using the Department for Transport's carbon emission values.

If we compare this to our earlier analysis, which looked at the carbon emissions savings from people using rail rather than road, this shows that the emissions of the diesel-powered trains 'cancel out' approximately 80% of the emissions that are saved by passengers using MML services instead of driving.

Electrically powered trains are the most energy efficient form of traction (80% compared to 26% of the diesel car)¹⁹ and have the potential of being delivered with zero carbon emissions if the electricity is generated through sustainable sources including wind, hydro, or solar.

Figure 5 Emissions by mode of transport



Improving local air quality

Air quality within rail stations and on-board trains is increasingly becoming a concern, including in our region. Recent evidence²⁰ shows that levels of nitrogen dioxide on board trains powered by diesel can be higher than the level recorded on a busy road in central London. As well as for passengers travelling on trains and moving around stations, full electrification of the MML has the potential to improve air quality for the people living in or near to the MML corridor.

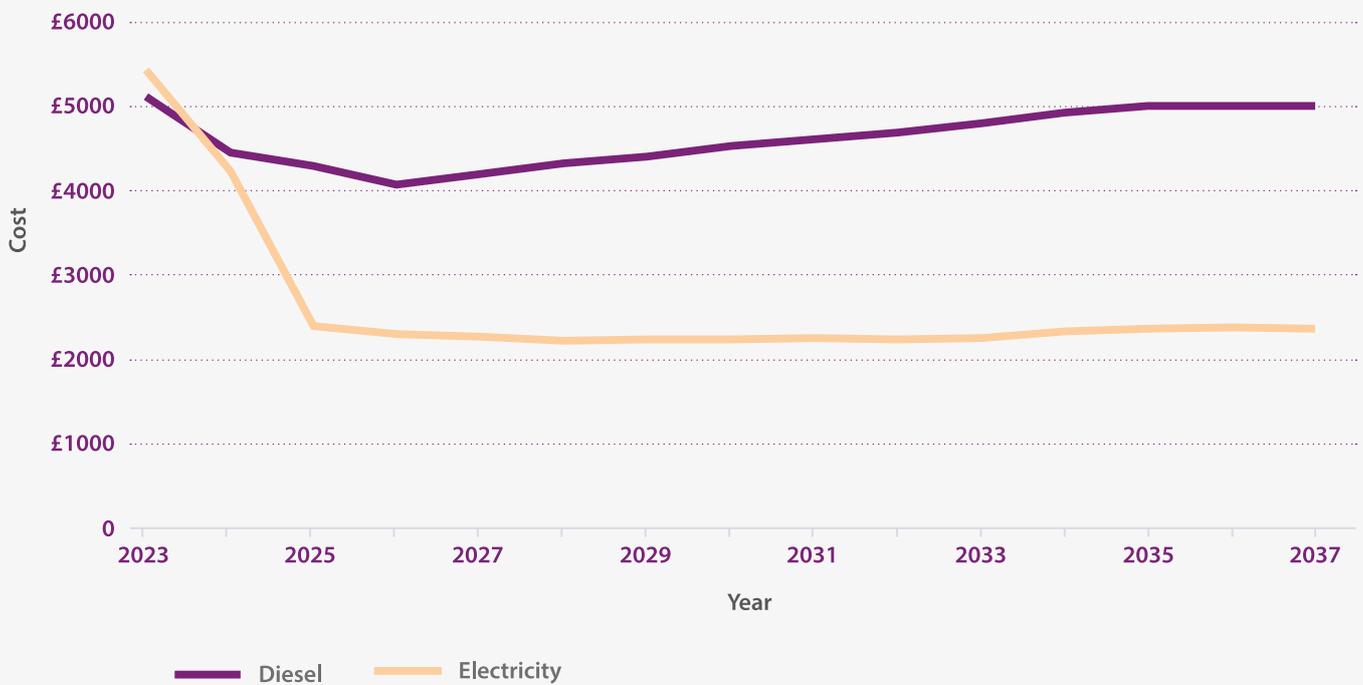
In the East Midlands, the MML passes through Air Quality Management Areas (AQMAs) in Leicester, Mountsorrel, Loughborough, Nottingham, Derby, and Sheffield. These AQMAs are where there have been high levels of air pollution measured and where the area is unlikely to meet national air quality objectives without intervention. Whilst there are many contributors to poor air quality, continuing to operate diesel powered trains will have a clear impact.

Cost savings and performance improvements

Full electrification of the MML has the potential to deliver the rail industry and the UK taxpayer operational cost savings in the future.

Our analysis shows that operating MML services using electricity is forecast to become significantly cheaper than diesel over the next 15 years, with cost savings of approximately £10 million possible over 15 years.

Figure 6 Forecast rail operating cost, diesel and electricity



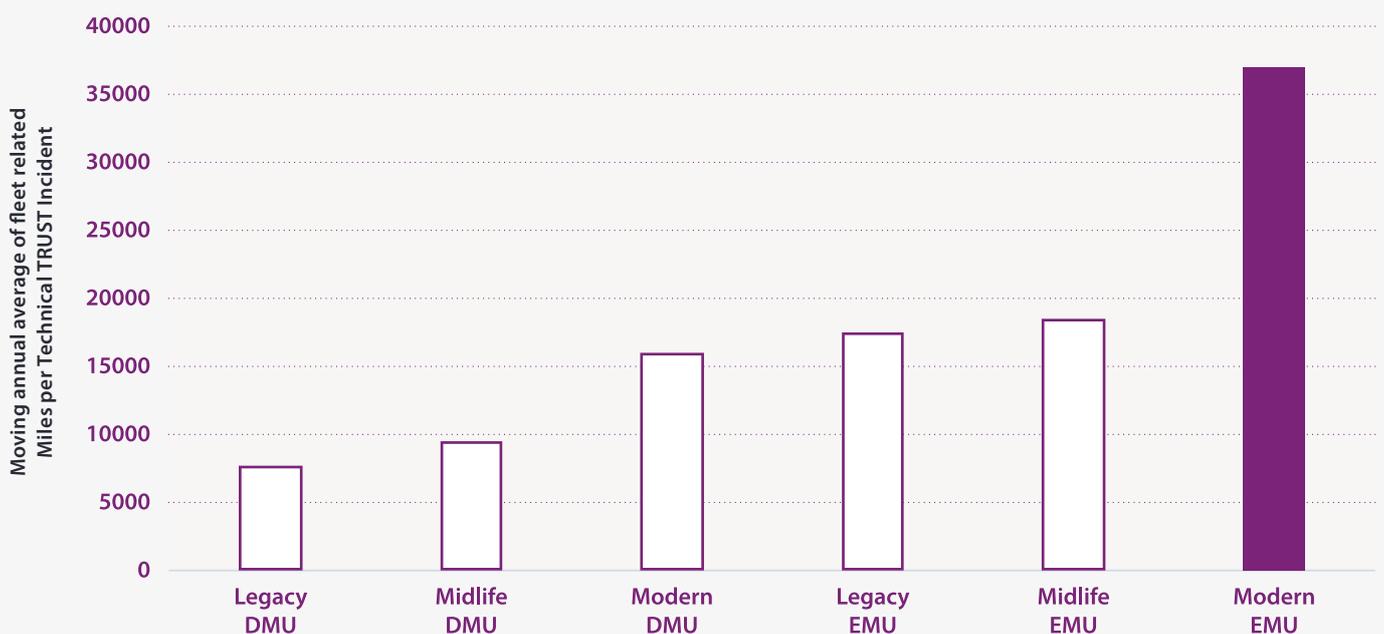
The class 810 'Aurora' fleet of bi-mode trains ordered to operate EMR's intercity services are stated to cost approximately £400 million. Evidence from the rail industry suggests that like-for-like electric-powered rolling stock can be up to 20% cheaper than bi-mode equivalents, with electric stock also being even cheaper to maintain.

The introduction of the Class 810 Auroras will offer a welcome boost to capacity at a time where other fleet stock has been retired and not replaced. The fleet size will have an additional six units, with each unit having an additional 59 seats for passengers²¹.

The new trains offer the potential for more journeys to be made by rail and so more benefit to be derived from the electrification.

Evidence also shows that electric-powered trains can be significantly more reliable than diesel equivalents, helping passengers reach their destination on time and helping to build a trust-worthy and reliable rail network. Evidence from the Rail Delivery Group²² shows that a modern 'electric multiple unit' (trains powered using electricity) on average travels over 36,000 miles without a technical incident, which is more than double the figure for modern diesel multiple units.

Figure 7 Technical reliability of different rolling stock



Benefits to the rest of the network

Delivering full electrification of the MML will not just benefit the route corridor, nor just the East Midlands region, but could act as a catalyst for benefits right across the UK rail network. By further developing electrification innovation on a large scale on the MML, the current UK electrification unit cost rate can decrease and improve the value for money and affordability case for a proposed future UK electrification roll out.

Innovative techniques and skills are developed every time major projects like electrification are delivered, for example voltage-controlled clearance used in the electrification of the route between London and Cardiff, which helped avoid the need to demolish and rebuild Victorian-era bridges and tunnels. But the potential to set a new benchmark for low-cost electrification will be hindered by any stop-start uncertainty and any plans that promote inefficient slow delivery.

Looking into the long-term for future improvement of rail operations, MML electrification is key if fully electric intercity units are aspired to be introduced. Or, if long-distance CrossCountry services that use the MML are to ever run using electricity. Additionally electric-powered rail freight would together with the passenger services unlock the fullest carbon emission savings and effective railway on the MML. Currently 96% of the energy used to power freight trains in the UK is diesel²³, but abstracting freight from road to rail has been shown to cut emissions by up to 76%²⁴.

Image source Network Rail East Midlands @NetworkRailEM



Journey time and performance improvements

In the future, there is potential for electrification of the MML to deliver journey time improvements for passengers. Electric trains, in some instances, can accelerate quicker out of stations and brake later. This is unlikely to be a key impact of MML electrification from 'day one', but could become important with future rolling stock fleets and complementary electrification of other routes. These quicker speeds can also improve performance by building extra time and resilience into timetables.

EMR services between London and Corby are one case example of services that stand to benefit. With enhanced renewals to existing electrification infrastructure south of Bedford these services will be able to operate at speeds of up to 110mph, compared to 100mph today.

Our vision of rail in the East Midlands includes a clean and modern fleet on all lines, making use of electrification on the MML and other routes in the future, and is supported with new technologies including battery on local lines where appropriate. We see passengers benefiting from journey time improvements from electric trains, and will be increasingly attracted by the reliable and clean services.

Image source Sarah-Louise @Railwaygirl2018



Interdependencies and next steps

Complementing Network North

Delivering full electrification will future proof integration of the MML with emerging options for new long distance connectivity services and the proposals for electrification of other routes as part of government's Network North plan. Network North includes electrification of the Hope Valley route between Manchester and Sheffield, electrification between Leeds and Sheffield, and enhancements between Nottingham and Newark for Nottingham – Leeds journeys. To make the most of these investments, it makes long-term strategic sense to make sure the MML is part of the region and nation's modern electrified rail network.

Certainty and timescales

MML electrification has been discussed, planned, postponed, and re-planned over the last ten years. We see electrification as the only viable traction technology that can deliver the vital decarbonisation of intercity rail the region, and the rest of the country, need.

Electrification of the MML is one of Network Rail's own recommendations in their Traction Decarbonisation Network Strategy²⁶ - we must ensure that bi-modes do not become a risk that mean that electrification is seen as a 'nice to have' on the MML 'one day', but used as an opportunity to do more sooner.

We are keen to ensure there is no construction downtime after electrification is delivered to Wigston, and we believe there would be cost escalation of labour and materials, and a loss to the monetised benefits of the scheme, if slow and inefficient delivery was preferred due to prioritising a short-term view. We see MML electrification as a 'no regrets' decision that requires urgency to confirm and progress as quickly as possible.

Our next steps and asks of government are to:

- Set out a clear timescale and delivery plan for full electrification of the Midland Main Line that unlocks the benefits of the new Aurora rolling stock sooner rather than later
- Actively engage with the local transport authorities in our region to plan the short periods of disruption collaboratively, and to ensure there is sympathetic consideration to the existing route assets such as the UNESCO World Heritage locations
- Work collaboratively with industry partners across passenger and freight markets on future rolling stock decarbonisation plans and additional complementary sections of future electrification.

Endnotes

- 1 <https://www.legislation.gov.uk/ukpga/2008/27/contents>
- 2 <https://www.gov.uk/government/publications/transport-decarbonisation-plan>
- 3 Source: Rail industry ticket sales data
- 4 <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2018based>
- 5 HM Treasury Public Expenditure Statistical Analysis 2022
- 6 Calculated using the office of Rail and Road's Estimates of station usage and ONS population estimates
- 7 <https://www.eastmidlandsrailway.co.uk/help-manage/about-us/news-press/a-new-dawn-east-midlands-railway-new-intercity-fleet-to-be-named>
- 8 Calculated using DfT patronage statistics
- 9 <https://dataportal.orr.gov.uk/statistics/usage/passenger-rail-usage/table-1223-passenger-journeys-by-operator/>
- 10 Source: Rail industry ticket sales data
- 11 <https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/bulletins/ukbusinessactivitysizeandlocation/2022>
- 12 Trains fit for the future? House of Commons Transport Select Committee, 2021
- 13 TransPennine Route Upgrade
- 14 <https://www.nottinghampost.com/news/local-news/climate-emergency-declared-nottinghamshire-council-5465433>
- 15 Transport Decarbonisation Plan, Department for Transport
- 16 <https://www.railengineer.co.uk/making-electrification-affordable/>
- 17 <https://thrustcarbon.com/insights/paving-the-way-for-green-travel-rail-beats-air>
- 18 Why Rail Electrification?, Railway Industry Association
- 19 Page 12 and page 22: https://riagb.org.uk/RIA/Newsroom/Publications%20Folder/Why_Rail_Electrification_Report.aspx/
- 20 <https://www.theguardian.com/uk-news/2021/sep/16/pollution-on-some-new-uk-trains-13-times-one-of-londons-busiest-roads> and <https://www.gov.uk/government/publications/air-quality-on-board-trains-a-response-to-the-rail-safety-and-standards-board-report>
- 21 <https://eversholtrail.co.uk/fleet/class-222/> and <https://economyclassandbeyond.boardingarea.com/2021/01/25/east-midlands-railway-reveals-the-seats-for-their-new-trains/>
- 22 https://www.raildeliverygroup.com/files/Publications/2018-03_long_term_passenger_rolling_stock_strategy_6th_ed.pdf
- 23 <https://www.railengineer.co.uk/making-electrification-affordable/>
- 24 <https://www.networkrail.co.uk/stories/railway-day-freight-cuts-emissions-across-britain/>
- 25 https://www.emcouncils.gov.uk/write/Documents/TfEM_v1.pdf
- 26 <https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Interim-Programme-Business-Case.pdf>

The Future's Electric! Midland Main Line Electrification