International High Speed Rail **Voices**

March 2021

HIGH SPEED RAIL GROUP

About High Speed Rail Group

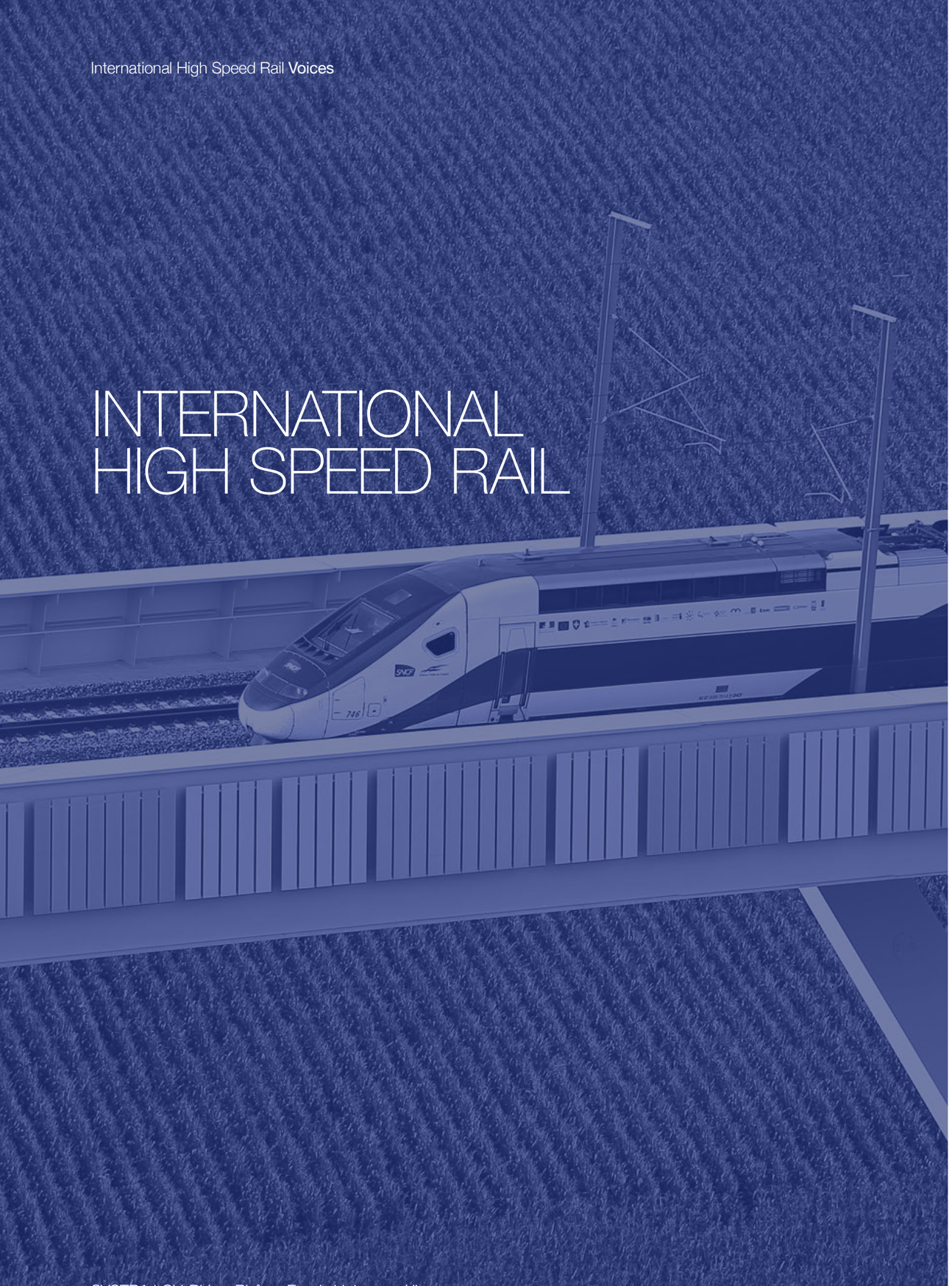
High Speed Rail Group (HSRG) is committed to supporting the successful delivery of a world-class high speed rail network in Britain. Our members have helped deliver major infrastructure projects in the UK and around the world, including creating entirely new high speed networks and improving the UK's existing rail network. This gives us a unique insight into both the shortcomings of the current network and the transformative capacity, connectivity and carbon benefits that high speed rail brings. We support a national high speed rail network which includes the delivery of HS2, high speed rail's integration with the existing network and investment to maximise the released capacity benefits HS2 brings on and off route, along with other rail investments such as Northern Powerhouse Rail and Midlands Engine Rail.

Find out more at **www.rail-leaders.com**

International High Speed Rail **Voices**

CONTENTS

INTERNATIONAL HIGH SPEED RAIL



SYSTRA LGV, Rhine–Rhône–Essais high speed line

International High Speed Rail **Voices**

From its inception in Japan during the 1960s, the high speed rail journey has been revolutionising rail and long-distance travel. Europe got on board in 1981 with Paris-Lyon, the continent's first high speed line. The UK commenced High Speed 1 (HS1) services in 2003 and along its entire route in 2007, connecting the UK with France and Belgium. China took on the mantle in the 2000s and 2010s with the exponential growth of its national network, which now accounts for more than two thirds of global high speed rail. Many other countries have followed track too with a high speed rail network globally that today stands at 52,484km in length. Broken down by continent, there is currently 39,930km of operational high speed rail in Asia Pacific, 10,576km in Europe, 1,043km in the Middle East, 735km in North America and 200km in Africa.[1]

A further 11,960km of high speed lines are under construction and in just five to six years' time, the global high speed network is expected to grow by almost 25 per cent.[2] This growth has been supported by an expert industry—undertaking scheme blueprints and project management through to enabling works and construction, rolling stock construction, signalling and designing out carbon to maintenance and operation. The rail industry and its supply chain have taken the opportunity to undertake extensive knowledge transfer which has been essential to the expansion of the high speed rail network, and the creation of an international high speed rail industry that spans continents.

The utilisation of high speed rail across the globe has seen countries recognising the many transport benefits that it brings, with fast, regular, efficient, safe, secure and reliable services. High speed rail also continues to play an important economic and nation-building role for many countries. Critically, high speed rail is now playing a crucial part in transport decarbonisation through a combination of increasingly eco-conscious travellers and desire at a governmental level to reduce carbon emissions in line with net zero goals. New high speed networks and expanded services are taking shape to help drive this change. Most recently another driver has been COVID-19, with many countries investing in and bringing forward plans for high speed rail as part of their economic response packages.

This report, the latest in High Speed Rail Group's (HSRG) *Voices* series, examines the benefits, opportunities and extent of international high speed rail, with contributions drawn from across the high speed rail industry. We provide an overview of the international high speed rail landscape and look at the role of nation building and bringing communities together; the development of new international links; innovation in delivery and operation; the impact of COVID-19 on the future landscape; export opportunities and how high speed rail helps meet net zero—critical in the year of the COP26 climate conference. This report also serves as a reminder that while the UK's High Speed 2 (HS2) is a significant project, it is not alone and sits amongst a global push for more and expanded high speed rail networks.

1. https://uic.org/IMG/pdf/20200227_high_speed_lines_in_the_world.pdf
2. Ibid.

Bringing countries together

Since railways were first laid, they have connected countries, regions, peoples and economies. High speed rail is taking this to a new level, providing transport spines for countries and in so doing reshaping economic geographies and helping build and rebuild regions and national cohesion. For some countries like Japan, high speed rail has been an integral part of its modern national identity.

HS2 too is very much about reshaping the economic geography of Britain, connecting eight of its largest cities, shrinking journey times, providing a new railway spine which unlocks economic development and regional rail schemes, whilst 'levelling up' the country. HS2 is about rebalancing economic growth and productivity away from London towards the Midlands and the North, and the project is a significant part of the economic plans of regions served by the route.

By effectively linking up cities and regions, the new HS2 railway, the first new north–south railway for 100 years, offers an opportunity to connect communities and bridge divides. Birmingham to Leeds will take only 49 minutes rather than 1 hour 58 minutes. Manchester to London becomes just over an hour rather than two-and-a-half.[3] Journeys become easier. This is particularly important as the purpose of travel is changing, with a significant uptick in leisure travel as the HSRG report *High Speed Rail Group's Response to Decarbonising Transport: Setting the Challenge* outlines. Leisure travel represents more than half of trips above 80km. It is often erroneously said that HS2 is for businesspeople, but in reality, the majority of HS2 passengers are likely to be travelling for leisure. HS2 offers an opportunity for citizens and tourists alike to connect with the country.

HS2 also improves connections between Scotland and England, and in particular northern cities, further joining up these economies. The Government's Union Connectivity Review is seeking to establish how to better join up the nations of the United Kingdom and high speed rail can play an important role.[4] HS2 already improves travel times between the nations, but a series of interventions would enable journeys between London and Glasgow to reduce to around three hours. Equally, interventions could also facilitate high speed services to run to South Wales and Bristol through to Scotland, creating an 'X' shaped network.

The UK follows nations such as China, Spain and France that have used high speed rail to connect their regions and bring economies closer together.

With 35,388km in operation and a further 5,250km under construction, China is by some way the leading high speed nation.[5] For a country that spans over 20% of the Asian continent and is 39 times the size of the UK, as described by Mott MacDonald in its contribution to this collection, high speed rail shrinks vast distances and lines crisscross to connect cultures and diverse regions. Shanghai to Beijing, a distance of some 1,100km, is a little under 4 hours 20 minutes through the high speed Jinghu railway. The goal ahead is to have an even faster high speed rail line resulting in a journey time of little over two hours.

In August 2020, the China State Railway Group Company published its plans for further developing the high speed rail network, effectively doubling it to 70,000km by 2035.[6] With almost all major cities in China already linked by high speed rail, the additional track will stretch further into lesser served areas of the country. China's network is a source of national pride, a symbol of investment and nation-building, albeit one in which political goals are entwined too. Conventional rail network links to the furthest reaches of the country, including autonomous regions, have not only provided improved transport connections, but have helped strengthen ties to Beijing too. Similarly, the 'Belt and Road' initiative seeks to build stronger transport links with many countries China trades with, all the way to Europe, and in turn build political and economic links.

Spain, like China, is a country with strong regional identities including Catalonia, the Basque region and Andalusia, with autonomous devolved administrations. Spain decided in the 1980s to harness the opportunity of high speed rail, starting with the Madrid, Seville, Cordoba, Puertollano and Ciudad Real route. AVE (Alta Velocidad Española) trains now offer a reasonably priced means of joining up most of Spain's major cities with speeds of up to 299km/h[7]. Spain boasts the longest high speed network in Europe, and second in the world only to China. Madrid is joined to Barcelona in under three hours, and as such the political hearts of Castilian Spain and Catalonia are joined rapidly and efficiently. The wider network incorporates places such as Seville, Malaga and Valencia. As Thales outlines in its contribution to this publication, as well as joining up the country, high speed rail has very much been an economic connectivity programme, benefiting not only the cities it passes through, but many of the Spanish regions.

France has had a similarly expansive programme with regard to high speed rail, seeking to connect all parts of the country, and allowing cities and towns to benefit economically. Lille is perhaps the most noticeable example. The city has grown significantly both economically and culturally through its international high speed links, driven by former Mayor Pierre Mauroy, who saw the huge potential the connections would bring to an economically depressed part of France.

The advent of European high speed rail networks is taking continental connectivity to a new level, redrawing maps, reducing journey times, opening up possibilities and connections and cementing economic links.

Travelling through the continent by train after school or university has been a rite of passage for many, and the European Commission has in recent years offered free interrail passes to 18-year-olds across the EU through the DiscoverEU scheme.[8] By exploring cities and countries throughout the EU by rail (and high speed rail), befriending other young people off on their own adventures and broadening horizons beyond their home countries,

3. https://www.hs2.org.uk/where/journey-planner/

4. https://www.gov.uk/government/consultations/union-connectivity-review-call-for-evidence

5. https://uic.org/IMG/pdf/20200227_high_speed_lines_in_the_world.pdf

6. https://www.chinadaily.com.cn/a/202008/13/WS5f34ddfaa3108348172601d0.html

7. https://www.eurail.com/en/get-inspired/trains-europe/high-speed-trains/ave

8. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_54

young Europeans receive the chance to experience other cultures and build shared understanding, which the EU hopes will build a sense of togetherness and cooperation.

Eastern European countries have also come together through the Visegrad Group of Poland, Hungry, the Czech Republic and Slovakia, to create a high speed network to connect their nations, cement economic and political ties and build a commonality of approach.

It isn't just Europe. As Hitachi Rail describe, Japan has used high speed rail as a national transport project designed to drive economic development, and it has been important in South Korea and Taiwan too. Morocco opened the first high speed rail line in Africa in 2018, a sign that high speed rail is reaching all parts of the globe. For Morocco, its development is emblematic of the image it wants to project of a modern country that it is an attractive place for investment. The line is already popular among its population and is used by the country as a demonstration of Moroccan leadership in this sphere and as a leading nation in Africa.

All of these examples show that high speed rail is much more than a transport network, it is about strengthening connections, bringing cultures and countries together. Leading high speed rail countries have used the railway as an economic driver, but also as a foundation for national ties. More countries are now seeking out these benefits with some, for example the USA, seeing high speed rail as a way of reconnecting the country—most noticeably by new President Joe Biden, known as 'Amtrak Joe' for his patronage of the high speed line between Washington and his home state of Delaware, who has pledged to 'spark the second great railroad revolution.'

High speed rail as a means of delivering modal shift and net zero

Decarbonisation is a global endeavour, with all sectors and all countries needing to play their part. Transport accounts for around a fifth of global carbon emissions, and as such decarbonisation of the sector is critical to net zero goals.[9] To achieve this, there must be modal shift from road and aviation to electrified railways. Indeed, the UK Government has put forward this goal in its consultation on the Transport Decarbonisation Plan.

High speed rail already has a record in displacing carbon-emitting flights in and out of the UK through High Speed 1 (HS1). The London to Paris Eurostar service, connecting the capitals in just over two hours, is one example of the success that high speed rail has had in providing a clean and green transport solution, cutting the equivalent of 60,000 short-haul flights and saving 750,000 tonnes of CO_2.[10] Similar benefits have been demonstrated with the London to Brussels service at under two hours. The more recent introduction of the London to Amsterdam route in 2018 has also made a dramatic impact. In 2019, with just three services a day, the Eurostar made up 23% of journeys (air and rail) between the capitals. More services and simplification of journey border checks will further increase passenger share and reflects the fact that high speed rail shifts people from air to rail, delivering big carbon benefits within two years of operation. In their contribution to this collection,

9. https://ourworldindata.org/co2-emissions-from-transport#:~:text=Transport%20accounts%20for%20around%20one,CO2%20emissions%20from%20energy%5D

10. HS1, 'Delivering for Britain and beyond: The economic impact of HS1', (2020).

International High Speed Rail **Voices**

HS1 outlines these significant benefits in more detail, and how the cross-Channel high speed rail market offers significant untapped potential that is ready to be seized upon post COVID-19.

COVID-19 though, has had a dramatic effect on transport usage which has in turn had a significant financial impact. It has led business leaders and the rail industry to raise the issue of the potential collapse of Eurostar. The service has not received UK Government financial support like airlines, or as rail companies have for domestic services. If Eurostar services collapse, the benefits of these high speed rail services will be lost and with them the significant strides made in attracting passengers from aviation. At a time when even more progress is needed on modal shift to meet net zero, and as the UK hosts the COP26 climate talks later this year, Eurostar must be supported ahead in order to maintain the greenest way to travel between Europe and the UK.

Germany and France are examples of countries that have taken a decision to invest much more in rail and high speed services as part of their COVID-19 recovery responses and to accelerate the move to net zero. As noted by SYSTRA in their contribution to this collection, the French Government's financial support for Air France was predicated on the premise that domestic journeys would be undertaken by rail (and high speed rail) not planes. We look at COVID-19 and its implications in more detail later in this report.

Returning to high speed rail's role in achieving net zero, other examples demonstrate that where high speed rail is a viable alternative, air travel decreases. In Sweden, the high speed MTR Express runs between the country's two largest cities, Stockholm and Gothenburg. Domestic air travel dropped by nine per cent in Sweden in 2019 whilst at Gothenburg Airport, domestic air travel was down 14 per cent.[11] This drop in flights and use of high speed rail also corresponds with a shift in public opinion that discourages flying, known as 'Flygskam.'

In the United States, traditionally a car-based society, Amtrak high speed rail has been helping to counter this. In the 20 years since high speed rail began operating on the country's Northeast corridor, the market for air travel on the same route has significantly diminished. Amtrak has taken more than a 90% share of the shuttle flight route that used to run frequently between New York City and Washington DC. According to the 2019 US Department of Energy Data Book, Amtrak is 36% more energy efficient than domestic air travel.[12] Since 2010 Amtrak has reduced greenhouse gas emissions by 22%, the equivalent of removing over 51,000 passenger vehicles from the road.[13] Under the new Biden administration high speed rail is viewed as a key tenet of the climate agenda, with newly appointed Secretary of Transportation Pete Buttigieg declaring 'I want the US to be leading the world when it comes to access to high speed rail.'

11. https://www.globalrailwayreview.com/article/97530/modal-shift-more-rail-fewer-carbon-emissions/

12. https://www.amtrak.com/travel-green#:~:text=Since%202010%2C%20we%20have%20reduced,at%20the%20Amtrak%20Sustainability%20Report

13. https://www.amtrak.com/travel-green#:~:text=Since%202010%2C%20we%20have%20reduced,at%20the%20Amtrak%20Sustainability%20Report

High speed rail is making inroads on the west coast of the US too. Brightline is building the XpressWest line from southern California to Las Vegas, Nevada, a route on which 85% of trips made are currently by bus or car. The trains are scheduled to begin running in 2023 and will operate at 322km/h, making the 274km trip from Victorville, California, to Las Vegas in 85 minutes. This is a trip that takes about three hours by car under ideal traffic conditions.[14] The new rail line will lead to 100,000 tonnes of CO_2 removed annually compared to car travel and is the equivalent of up to three million cars removed from the roads annually.[15]

The impact high speed rail can have on moving freight to rail is also significant, both through released capacity and new services. In the UK, it is expected that the capacity created by HS2 on the traditional rail network will make space for 144 extra freight trains per day, which could carry over 2.5 million lorries' worth of cargo each year. Transporting freight by rail rather than on roads produces 76 per cent less CO_2.[16] International air cargo can also be reduced by increased high speed rail freight services. In 2018, Italian state-owned operator Ferrovie dello Stato Italiane Group's Mercitalia Logistics launched the world's first high speed rail service dedicated to freight. Running on the existing high speed infrastructure, the service connects the southern terminal of Maddaloni-Marcianise to Bologna, one of the country's most important logistics hubs, in three hours and 30 minutes overnight. This is intended to open the door to many other high speed rail freight services across the continent.

Some countries are also using ticket pricing as a means to further encourage travellers onto high speed rail. In 2020, Germany saw fares decrease by 10% on trips of more than 50km on Deutsche Bahn's Intercity Express trains as part of the country's climate protection measures. Deutsche Bahn said it believed the price drop would bring in another five million passengers per year. Whilst in January 2021, Spain's state-run rail operator Renfe launched a budget high speed service, AVLO, with tickets costing only €5 (£4.43) for journeys of over 600km to encourage users onto its services. This was in part spurred on by the arrival of rival provider Ouigo in Spain, backed by French state operator SNCF, which will start operations later this year with a service between Madrid and Barcelona and the intention 'to offer high speed lines with the highest number of travellers possible and with a service which has the lowest carbon footprint possible.'

High speed rail is a critical element in helping reach a net zero economy and cutting greenhouse gas emissions. The many examples from around the world demonstrate that a decarbonised rail system, which includes a high speed rail network, can successfully help deliver modal shift by taking passengers and freight off roads and out of planes onto green rail.

14. https://eu.usatoday.com/story/travel/2020/07/30/acela-brightline-us-fastest-trains-high-speed-rail-coming/5535529002/

15. https://www.gobrightline.com/xpresswest

16. https://www.midlandsconnect.uk/media/1600/midlands-connect-hs2-oakervee-review-submission-letter-online-docx.pdf

International services

With the growth of national high speed networks, international connections are expanding too as high speed rail continues to make rail more attractive and provides an alternative to flying for long distances and intercountry travel. Some projects and services are at present more aspirational, while other programmes are being developed in earnest.

The example of HS1 services from the UK to Paris, Brussels and Amsterdam has already been highlighted. A range of new routes from the UK to European destinations are now being considered, including to Germany as well as services from Malmo to Cologne with an onward change to London.

Within Europe, high speed rail's environmental performance and socio-economic benefits are widely viewed as supporting the European Union's transport and cohesion policy objectives. The EU's Trans-European Transport Network (TEN-T) policy, seeks the development of a Europe-wide network with interconnection and interoperability and the efficient use of infrastructure. Within this policy sits the Trans-European Rail network, and within this the Trans-European High Speed Rail Network (TEN-R) which aims to achieve the interoperability of the European high speed train network at the various stages of its design, construction and operation. The aim is an important one, as intercountry high speed services are currently not as connected nor extensive as they could be.

The policy promotes the construction of high speed rail lines across the following European corridors:

- **Corridor 1**: Berlin–Palermo
- **Corridor 2**: London, Paris, Amsterdam and Cologne to Brussels
- **Corridor 3**: Lisbon–Madrid
- **Corridor 4**: LGV Est (Eastern Europe)
- **Corridor 5**: Lyon–Budapest
- **Corridor 6**: Paris–Bratislava

Individual member states have been laying foundations for the TEN-R.[17] A number of cross border routes are already in construction or planned. Construction is underway on the Brenner Base Tunnel to connect Austria and Italy—made up of a railway tunnel through the base of the Eastern Alps and is part of the Berlin-Palermo route. Whilst the Karlsruhe-Basel high speed railway, which will form part of the Paris-Bratislava route, known as the 'Mainline for Europe,' is also progressing.

There is considerable interest in accelerating, making good and shaping these plans. European think tank, The Vienna Institute for International Economic Studies, has proposed a 10 year €2 trillion investment programme in transport, infrastructure and energy decarbonisation in response to the European Commission's post-COVID recovery programme. Recommendations include a dedicated green high speed rail network, called the Ultra-Rapid-Train, to be established during the 2020s. The proposed network would complement existing high speed rail networks on the continent, allowing passengers to halve current rail travel times and thus making air travel for a large part of intra-European passenger

17. https://www.eca.europa.eu/Lists/ECADocuments/SR18_19/SR_HIGH_SPEED_RAIL_EN.pdf

transport obsolete, whilst increasing rail freight capacity and reducing lorry traffic. Consisting of four major railway lines, the proposed network would connect all the capital cities of the EU and those of the Western Balkans that are potential EU candidate countries. The plans seek to foster European integration and cohesion and bridge the technological gap with China in the development of high speed train technology.[18] The proposed corridors are:

- **Dublin–Paris** via a ferry-based sea link between Cork and Brest, taking on an additional significance following the UK's departure from the EU
- **Lisbon–Helsinki** including a loop around the Baltic Sea meeting in the Ruhr area
- **Brussels–Valletta**
- **Berlin–Nicosia**, with a ferry-based sea link between Piraeus and Paphos and a loop between Vienna and Sofia

Existing high speed rail links are also set to be improved. The St Petersburg to Helsinki high speed route which opened ten years ago is one such example, currently taking 3 hours 30 minutes and through upgrades set to drop to 3 hours.

One development over the last year that has sparked considerable interest is the revival of continental sleeper services across Europe. In December 2020, it was announced that France, Germany, Austria and Switzerland are planning four new sleeper services combining high speed trains and night trains that will ultimately link 13 western European cities.[19] The first two routes, from Amsterdam to Zurich, and from Vienna to Paris via Munich, will begin operating in a year's time. By 2024 two further lines will connect Berlin to Barcelona and Amsterdam to Rome, with offshoots stretching to Warsaw and Graz. German Transport Minister Andreas Scheuer, a proponent of the new scheme, has said that it could be possible to board a train in Warsaw in the evening and arrive in Paris in time for breakfast the following morning, 13 hours later.

Asia has also seen an increasing drive to build international high speed rail connections and is now showing global leadership in this area. Much of this has been led by China—sometimes termed 'high speed rail diplomacy'—as they seek closer ties with Southeast Asian neighbours. Recently, this has seen China negotiating with Thailand to agree a new high speed link that could connect the two countries. The proposed line would make up a central portion of a transnational railway from Kunming, in the southwestern Chinese province of Yunnan, to the Gulf of Thailand, using Chinese technology.

China has also discussed working with Russia to build a high speed rail line on the renowned Trans-Siberian rail route. The project would be over 7,000km long and more than three times the length of the world's current longest high speed rail line, which runs from Beijing to the southern Chinese city of Guangzhou, some 2,000km. Such a line would cut the current train travel time from six days to under two, a huge difference in traversing these vast countries.

18. https://wiiw.ac.at/how-to-spend-it-a-proposal-for-a-european-covid-19-recovery-programme-dlp-5352.pdf

19. https://www.thetimes.co.uk/edition/world/eu-nations-all-on-board-for-revival-of-the-trans-europ-express-0dxrjf2zn

Across the Atlantic, another potential North American high speed rail link has been mooted. Though different options have been proposed, the current route being discussed is one that crosses from Portland and Seattle in the US through to Vancouver in Canada. Authorities in the relevant states of Washington, Oregon and British Columbia are studying how such a line might serve the Pacific Northwest. A 2020 report on the 'Cascadia ultra-high speed ground transportation' (UHSGT) says that the project would connect people and communities, increase economic competitiveness and improve quality of life—'with equity as its guiding principle, the UHSGT project could help connect local workers to family wage jobs, increase access to affordable housing choices, and offer greater mobility for almost 9 million people', all while mitigating the impacts of climate change.[20] Next steps for the proposed project include building support for the coordinating entity, developing an enabling agreement between the three jurisdictions and establishing funding.

These examples all serve to highlight the increasing move towards high speed rail as a means of transnational mobility, which looks set to grow significantly in the years ahead.

Innovation in the high speed rail market

New technologies are being deployed to bring forward new high speed rail routes, extend and upgrade existing networks and improve the passenger experience.

In October 2020, Chinese state-owned rolling stock manufacturer CRRC Changchun Railway Vehicles unveiled a prototype gauge-changing high speed train intended for international operation. It has been developed for cross-border operation between China's 1435mm gauge network and the 1520mm gauge used in neighbouring Russia and the Commonwealth of Independent States (ex-Soviet Union) countries. A multi-system traction package will allow the train to run on different power supplies. The train set will be suitable for operation in temperatures from -50C to +50C and has been designed to run at a maximum speed of 400km/h. As well as the gauge-changing bogies, the company has developed a matching changer track installation. Technology such as this will make the previously mentioned Trans-Siberian high speed rail route feasible. Manufacturers also cite Beijing–Moscow (the Trans-Mongolian railway) as a potential route for application of the technology.

In their contribution to this collection, Italferr detail how they overcame the twin challenges of Italy's mountainous terrain and many hydrological features through the use of innovative design and technology. This included the cable-stayed bridge installed over the Po River on the Milan-Bologna section of the Italian high speed rail network, and the 22km Valico tunnel within the 'Third Pass' high speed rail project currently under construction to connect Tortona to Genoa.

20. https://wsdot.wa.gov/sites/default/files/2017/08/28/CascadiaUHSGT-FrameworkForFutue-ExecutiveSummary.pdf

Improving the passenger experience on high speed rail is also an important aspect of continued innovation. As Siemens Mobility outlines in its contribution to this collection, the new Velaro MS trains they are delivering for the German market will offer passengers greater comfort and convenience with features like frequency transparent windows for stable mobile phone reception. Whilst passengers will also benefit from a quieter environment and an advanced passenger information system with video screens in all carriages which are clearly visible from every seat and provide route information.

Elsewhere, high speed rail is being used for more than passenger travel. One of the more inventive ideas is from the Italian Angel Group in the development of an Intensive Care Unit (ICU) train, which is equipped with outpatient and intensive care clinics. The goal is to offer quick medical support in emergency situations throughout Europe. The hospital train project was selected from a total of 130 submissions in response to an international call from the European Space Agency (ESA) to support European countries in the COVID-19 pandemic. Indeed, during the initial outbreak of the virus, 'hospital trains' were also used by SNCF, who utilised their high speed TGVs to transport patients from hard-hit intensive care units in Paris and eastern France to hospitals with more capacity in Brittany and the region around Bordeaux.

For innovation to thrive, exporting and sharing new technologies is required. The UK Government has a target of increasing exports to 35% of GDP, up from 30%. In its contribution, the Railway Industry Association (RIA) highlights the importance of having trade policies in place to support the development of new rail and high speed rail capabilities and innovation in areas like decarbonisation and digitalisation. Whilst as the University of Birmingham highlight, exporting British educational expertise via partnerships between our universities and international rail projects is a key of ensuring innovative thinking forms an essential part of the global rail matrix.

As rail networks continue to expand across the globe, innovation will be at the heart of maximising the many benefits that high speed rail can bring.

High speed rail and COVID-19

The COVID-19 pandemic has had a significant impact on high speed rail, with the sector adapting to provide socially distanced and safe travel. Mandatory mask wearing is one measure adopted in numerous countries, whilst in China and South Korea temperature checks take place. In China, there have also been health questionnaires for non-stop high speed rail services and night trains. France, Italy and China are among the countries with 'smart' reservation systems which limit capacity and allow passengers to guarantee a safe minimum distance. On the Japanese Shinkansen, supplementary to regular disinfection of trains, train conductors disinfect surfaces whilst they are patrolling the train. The Shinkansen also increases air renewal of the onboard air-conditioning and ventilation systems by constantly replacing the entire air inside the train every six to eight minutes.

The public also recognises the benefit of trains ahead. Polling by international rail pass company Eurail found 82% of respondents would choose the train as the most or second-most comfortable method of transport to use when travel will be possible again.

There is though, a question as to how the pandemic will shape future travel ahead and COVID-19 has undoubtedly impacted current passenger numbers. However, as the HRSG and Rail Delivery Group (RDG) report *Building Back Better: The green case for rail investment after the pandemic* outlines, historical trends in rail travel show that passengers have more or less increased continuously over the last two centuries. Rail travel demand has more than doubled since 1994, and has recovered following previous pandemics such as the Spanish flu in the 1918-20s and SARS in 2003.

Investment bank UBS has suggested that the COVID-19 pandemic could actually accelerate the shift of passengers from air to high speed rail, supercharging growth across the industry. Surveying 4,000 people in France, Germany, Italy and China—all countries with well-established high speed networks—they found that the majority of business travellers surveyed were willing to accept travel times of two to three hours on trains—journey times that high speed rail serve. This time was much higher for leisure travellers, with the majority prepared to go on rail journeys five to six hours or longer. They also estimate that there will be approximately 800 more high speed trains in operation in Europe within the next decade, while 196 fewer planes will be required globally. If people opt to use trains instead of flying or driving, they believe this could save as much as five million tonnes in CO_2 emissions during the next ten years.[21]

With trains already among the safest ways to travel, new steps entrenching that safety and rail's increasing popularity, high speed rail schemes and services are set to be accelerated and expanded.

The next section will look at these benefits and opportunities in more detail. Drawn from the High Speed Rail Group membership, which has experience delivering major high speed rail projects around the world, our contributions cover European networks including France, Germany and the Channel tunnel crossing, to the expansion of high speed rail in the United States and the leading role being played by Asia with the extensive networks of Japan and China. Contributions also speak to the economic and international export potential of high speed rail, and the important role of global knowledge transfer in the development of the international high speed rail market.

21. https://www.ubs.com/global/en/investment-bank/in-focus/covid-19/2020/by-train-or-by-plane.html

International High Speed Rail **Voices**

HIGH SPEED RAIL INTERNATIONAL MAPS

Source: International Union of Railways (UIC)

Europe

Commercial operation over 250km/h
Under construction or planned over 250km/h
Commercial operation less 250km/h
Under construction or planned less 250km/h
Others

Oslo
Stockholm
Helsinki
St Petersburgh
Tallinn
Gothenburg
Jönköping
Riga
Copenhagen
Malmo
Vilnius
Gdansk
Minsk
Glasgow
Edinburgh
Leeds
Manchester
Birmingham
London
Hamburg
Berlin
Poznan
Warsaw
Amsterdam
Hannover
Antwerp
Brussels
Koln
Leipzig
Wroclaw
Krakow
Kiev
Prague
Luxembourg
Nuremberg
Brno
Paris
Rennes
Munich
Bratislava
Vienna
Basel
Budapest
Bern
Ljubijana
Zagreb
Lyon
Milan
Venice
Bordeaux
Turin
Genoa
Bologna
Belgrade
Bucharest
La Coruna
San Sebastian
Toulouse
Florence
Marseille
Sofia
Zaragoza
Rome
Skopje
Edirne
Oporto
Barcelona
Bari
Madrid
Naples
Valencia
Lisbon
Murcia
Alicante
Sevilla
Almeria
Cadiz
Malaga

West Coast USA

Sacramento
San Fransico
Fresno
Bakersfield
Los Angeles

East Coast USA

New York
Philadelphia
Washington

Africa
Morocco

Tangier
Kenitra
Taza
Oujda
Rabat
Fes
Marrakech

SUMMARY OF **HIGH SPEED RAIL LINES** AROUND THE WORLD

Area	Country/ Region	Length (km)				
		1. In operation	2. Under construction	3. Planned	4. Long–term planning	Total
Africa	Egypt	–	–	910	300	**1,210**
Africa	Morocco	200	–	139	975	**1,314**
Africa	South Africa	–	–	–	2,390	**2,390**
Asia Pacific	Australia	–	–	–	1,749	**1,749**
Asia Pacific	China	35,388	5,250	1,071	257	**41,966**
Asia Pacific	Taiwan	354	–	–	–	**354**
Asia Pacific	India	–	–	508	4,126	**4,634**
Asia Pacific	Indonesia	–	–	712	–	**712**
Asia Pacific	Japan	3,041	402	194	–	**3,637**
Asia Pacific	Kazakhstan	–	–	–	1,011	**1,011**
Asia Pacific	Malaysia	–	–	–	335	**335**
Asia Pacific	Singapore	–	–	–	15	**15**
Asia Pacific	South Korea	893	–	49	–	**942**
Asia Pacific	Thailand	–	253	431	1,958	**2,642**
Asia Pacific	Vietnam	–	–	–	1,600	**1,600**
Asia Pacific	Austria	254	281	71	–	**606**
Europe	Belgium	209	–	–	–	**209**
Europe	Czech Republic	64	–	666	318	**1,048**
Europe	Denmark	56	–	–	–	**56**
Europe	Estonia	–	–	213	–	**213**
Europe	Finland	1,120	–	–	–	**1,120**
Europe	France	2,734	–	–	1,725	**4,459**
Europe	Germany	1,571	147	81	210	**2,009**
Europe	Italy	921	327	–	–	**1,248**
Europe	Latvia	–	–	265	–	**265**
Europe	Lithuania	–	–	392	–	**392**
Europe	Norway	–	–	–	333	**333**
Europe	Poland	224	–	805	875	**1,904**
Europe	Portugal	–	–	–	596	**596**
Europe	Russia	–	–	1,080	1,549	**2,629**
Europe	Spain	3,330	1,293	676	–	**5,299**
Europe	Sweden	–	11	150	589	**750**
Europe	Switzerland	144	15	–	–	**159**
Europe	The Netherlands	90	–	–	–	**90**
Europe	UK	113	230	320	–	**663**
Latin America	Brazil	–	–	–	511	**511**
Middle–East	Bahrain and Qatar	–	–	–	180	**180**
Middle–East	Iran	–	1,336	117	1,651	**3,104**
Middle–East	Israel	–	–	85	–	**85**
Middle–East	Saudi Arabia	449	–	–	–	**449**
Middle–East	Turkey	594	1,652	789	4,384	**7,419**
North America	Canada	–	–	–	290	**290**
North America	Mexico	–	–	–	210	**210**
North America	USA	735	763	1,659	449	**3,606**

Africa (3)	200	–	1,049	3,665	4,914
Asia Pacific (13)	39,930	6,186	3,036	11,051	60,203
Europe (19)	10,576	2,023	4,648	6,195	23,442
Latin America (1)	–	–	–	511	511
Middle–East (6)	1,043	2,988	991	6,215	11,237
North America(3)	735	763	1,659	949	4,106
Total (45)	**52,484**	**11,960**	**11,383**	**28,586**	**104,413**

Source: International Union of Railways (UIC).
Editor's Note: This list was compiled in 2020 and as such some of the numbers quoted in the following articles are different to those above, reflective of progress made in the proceeding year.

JAPAN—THE ORIGINAL HIGH SPEED INNOVATOR

Say 'Japan' and for many people the first thing to come to mind is the bullet train, or Shinkansen, which has become a defining symbol of the country and its post-war development. These revolutionary trains were introduced in time for the Tokyo Olympics in 1964.The first-generation Series 0, built by Hitachi, hit the heady heights of 210 km/h along the newly built Tokaido Line, just one year after the publication of Dr Beeching's infamous report which closed a third of the UK's rail network.

It was a time of high economic growth in Japan, fuelled in part by major infrastructure investment, with a particular focus on the development of a national high speed and high capacity rail network. As the public flocked to use the new services, and development began to expand out from around the new rail hubs, public pressure increased to continue expanding the Shinkansen network. The development of new lines was led by Japan National Railways, a state-owned public corporation, which was responsible for financing the construction of new lines.

Private capital was the source of much investment, with developers in many cases funding the building of new stations with multiple levels overhead. The involvement of private sector developers is an approach being taken at Euston Station, and examined for other stations along the future UK high speed network. A question to be considered is could more be done to intensify such development in and over new stations, helping finance the roll-out of a national network connecting all parts of Great Britain?

The development of fast connections between Tokyo and Japan's regions spurred economic growth both in the capital and along the line, as commuting using the Shinkansen became possible, and the resultant increase in available labour pool. There are now nine Shinkansen lines running from Kagoshima in the south to Hakodate in the north. 1988 saw the opening of the world's longest undersea tunnel which by 2030 will enable bullet trains to reach Hokkaido's capital, Sapporo from Hakodate, the current terminus. Nowadays central and local governments contribute the majority of funding to develop new Shinkansen lines.

A key factor in public acceptance and support for the high speed network was the detailed planning and research that went into the project. One issue was noise—as generally the faster a train goes the more noise it makes. This was especially problematic for Japan, where bullet trains regularly pass through residential neighbourhoods at high speed. By considering aerodynamics in the design, as well as developing advanced low-noise pantographs, noise levels were significantly reduced, allowing development space to be maximised close to the new lines.

Interestingly, several engineering problems related to the introduction of increased speed and the resulting noise issues were solved by biomimicry—observing how animals had evolved and implementing design changes. The nose of the Shinkansen train was reshaped in the form of a kingfisher's curved beak – this allowed elimination of the sudden pressure increase, with the result there was no more sonic boom as the train entered tunnels at speed. Its pantograph was reshaped based on an owl's wing incorporating small serrations, resulting in a marked drop in vibrations and much less disturbance for residents near the tracks.

Such detailed focus on advanced aerodynamical design—along with the use of lightweight materials including aluminium for rolling stock–allowed engineers to utilise smaller diameter tunnels than other high speed rail systems overseas, reducing construction and maintenance costs.

International High Speed Rail **Voices**

HITACHI
Inspire the Next

"Several engineering problems related to the introduction of increased speed and the resulting noise issues were solved by biomimicry—observing how animals had evolved and implementing design changes. The nose of the Shinkansen train was reshaped in the form of a kingfisher's curved beak—this allowed elimination of the sudden pressure increase, with the result there was no more sonic boom as the train entered tunnels at speed."

Furthermore, the vertical set-up of the Japanese network, with an integrated system of tracks, control systems and rolling stock, has bred a culture of reliability. This isn't calculated in minutes or hours. It is calculated in seconds.

Technology of course plays a role. The pioneering Shinkansen is designed to cope with the rigours of Japan's regular earth tremors and typhoons. Automatic Train Operation is standard across the Shinkansen network; combined with full digital signalling and advanced Train Maintenance Systems (provided by Hitachi). This allows network operators the ability to quickly recover from weather and other natural occurrences. Indeed, in its over 50 year history, carrying over 10 billion passengers, there has not been a single passenger fatality or injury due to train accidents.

Hitachi is also particularly proud of its role in developing and running the MARS seat reservation system for JNR (today, Japan Railways); the booking system, still in use today, has never gone down.

The high value placed on reliability in Japan is born from a business culture that values not only innovation, but also transparency and partnerships. A culture of customer care and respect is also key—JR's smartly uniformed staff with white gloves are seen across the network—but changes and innovations based on positive psychology have also been introduced. The jarring whistle and buzzer that once accompanied Shinkansen departures was replaced with the 'hassha' melodies—short, ear-pleasing melodies, intended to de-stress passengers alongside the main aim of keeping the train departure on time. The adoption of active suspension prevents the transmission of vibrations through the floor, further increasing ride comfort for passengers.

Accessibility is another area where Japan was ahead of its time. Shinkansen stations were built with level access, meaning people with reduced mobility didn't need to step up or down to access a carriage. It is only now, with the development of a new high speed lines in the UK, that level-boarding will be designed in as standard in new high speed stations—a move that that will be welcomed by the travelling public.

Japan is still looking to the future, with development of the 'ALFA-X' Shinkansen well underway, which can run at up to 400 km/h. Yet even this will be superseded when the Chūō Shinkansen, based on maglev technology, starts running. The line will connect Tokyo and Nagoya in 40 minutes, with further extensions to eventually link Tokyo and Osaka in just over an hour, running at a maximum speed of 500 km/h.

By continuing to innovate and improve Shinkansen services, Japan's railways continue to build on the original vision of a national transport project designed to drive economic development by increasing capacity and decreasing journey times between the major population centres.

International High Speed Rail Voices

SEIZING THE **UK'S** INTERNATIONAL HIGH SPEED RAIL OPPORTUNITY

COVID-19 has caused an unprecedented shock to rail passenger demand and we are not out of the woods yet. It has left rail bosses around the world scratching their heads over how to shape the recovery of their companies.

In response to the pandemic, it should be said that the UK Government has skewed too far the wrong way on transport modes and missed the opportunity on high speed rail. Aviation has received hundreds of millions of pounds in credit backing from the UK Government, whilst international high speed rail only a fraction. Building back better requires international rail be given an equal footing, so when it is safe to do so, operators can come out of the traps running.

There are lessons too from previous crises which show that seeking out opportunities rather than hibernating or trying to wait for the storm to pass is the best response. This means looking to replace lost markets and grow new ones. With only three of the eight key direct destinations from London being utilised to date, the cross-Channel high speed rail market offers a large untapped market ready to seize. HS1, together with our partner infrastructure managers, have done much to prepare the ground to ensure this opportunity can be taken as quickly as possible and help speed operators' paths to recovery.

Travel sectors around the world have previously suffered multiple catastrophic demand shocks where lessons may be drawn. One that will loom large in the memory of anyone old enough to remember is 11 September 2001. The terrorist attacks shook to the core consumer confidence in global aviation. It took five years for the industry to recover to pre-attack passenger volumes. But it did return and grow further. During that time, the aviation industry was upended. Older and established carriers preciously guarded their established routes and grappled with cost savings, effectively hunkering down and waiting for passengers to come back. In the process, they lost market share to nimble and inventive low-cost operators. On top of their innovative business model, key to low-cost operators' success was a willingness to seek out new markets that established carriers had dismissed and overlooked.

Untapped cross-channel rail markets will be sizable when travel opens up again. Official British Civil Aviation Authority (CAA) statistics show in 2019 that there were 16.4m air journeys from London to near-continental destinations where high speed rail can offer a competitive journey time. As rail infrastructure managers serving the cross-Channel market, we have long been aware of the potential of these markets and so have already been busy paving the way. Working with SNCF-Réseau, Eurotunnel and LISEA, we selected London-Bordeaux as our first additional route. The region is home to one in four British citizens living in France, in part contributing to the almost one million air journeys between the London and Bordeaux regions in 2019. Together, we have taken a practical problem-solving approach, putting ourselves in the position of an operator and pre-empting and overcoming the challenges they may face. We have made concrete steps to unlocking this market—from preparing the ground with regulators to detailed costing for border facilities. Perfect for a nimble-footed rail operator looking to replace or gain market share.

We have not been alone in seeing opportunity. The cross-Channel high speed rail network is expanding through the current operator, Eurostar, on the HS1 network. In 2020 Eurostar launched its direct service between London and Amsterdam (the initial service between the cities launched in 2018 required a change). This expansion has paved the way for more destinations. The treaty that governs how new border controls are created is now 'oven-ready' to add new countries, meaning Germany or Switzerland could be added with relatively little difficulty. This will make developing London-Frankfurt and London-Geneva easier and quicker.

International High Speed Rail **Voices**

"With HS1 in 2020 becoming the world's first carbon neutral railway, the footprint of cross-Channel rail travel is set to shrink further. Resulting from ever-increasing availability of green electricity, the potential exists to banish carbon emissions completely from near-Europe travel in the not-too-distant future."

As wider society contemplates what comes after COVID-19, one thing seems clear; whatever comes next, we want it to be greener. Like the beleaguered nations that emerged from the Second World War determined to build a better future, the 'build back better' frame we have today taps into a similar zeitgeist and is now echoing across Europe.

What is more, faced with the aftermath of one crisis, we want to avoid greater calamities that seem certain to be unleashed by catastrophic climate change. Here, high speed rail has a significant contribution to make to prevent this. International high speed rail journeys can emit up to 80% less CO_2 than their air equivalent. They are effectively switching passengers from one of the most polluting forms of transport to one of the most carbon efficient.

With HS1 in 2020 becoming the world's first carbon neutral railway, the footprint of cross-Channel rail travel is set to shrink further. Resulting from ever-increasing availability of green electricity, the potential exists to banish carbon emissions completely from near-Europe travel in the not-too-distant future. When it comes to arguing which transport modes governments should favour in the recovery, pitting aviation against high speed rail is not quite right. Greener planes will be needed for very long distances, although high speed rail can cater for some of these journeys. Where high speed rail has a significant opportunity is the many nearer Europe destinations.

The desire for greener travel has likely been the catalyst for a more general seismic shift in consumer attitudes to longer train journeys. Primary research by UBS, questioning over 4,000 people internationally released in June 2020, showed that roughly 80% were now willing to spend five to six hours longer on a train. This comfortably puts Cologne, Frankfurt, Lyon, Bordeaux and Geneva as prospective destinations for the St Pancras departure board. Whether it is consumer driven, market or environmentally led, we are on the cusp of a massive step change in transport. Through happenstance the international high speed rail network is already prepared to help train operators diversify to replace passengers they have lost and respond to the increasing desire of their customers for greener transport. As infrastructure managers, we stand ready to hasten this step change and help operators make it a reality.

THE **SPANISH** HIGH SPEED RAIL NETWORK SUCCESS STORY

The first high speed rail journey in Spain departed Madrid for Seville on 21 April 1992. In the three decades since, Spain has developed one of the most advanced rail networks in the world, thanks to its leading network length, level of modernity, commercial speed, the versatility of its fleet and punctuality. As of today, the Spanish high speed network spans 3,402km, which is the longest high performing network in operation in Europe and second in the world after China. This puts the network ahead of those in other countries that have a great tradition in this mode of transport.

Since the first journey on the Spanish network, more than 400 million people have travelled using the high speed infrastructure across a wide range of distances, carrying more than 100,000 passengers a day and connecting 47 cities. The number of passengers using the high speed network in Spain has seen steady growth year after year, reaching 22.4 million in 2019, a 5% increase year on year.

The expansion of the high speed rail network planned by the Spanish Government will continue to see the development of the network in the medium-term. New lines, such as the Northern corridors, are under construction and others are also expected to be developed. Today, two out of three of the Spanish population has access to high speed transport in their province. The goal is to grow this proportion to the largest possible number of citizens, meaning that nine out of ten citizens are within 30km of a high speed station.

In Spain, Thales has equipped more than 2,800km of high speed lines with either signalling and/or communications systems. A recent example was the deployment of ERTMS L2 signalling technology in October 2020 on passenger services operating on the section between Madrid-Chamartín and Olmedo, the Madrid-Valladolid line and also the section between Olmedo and Pedralba on the Madrid-Galicia line. The impact was a reduction in travel times and distances that covered an area containing more than 30% of the national population. This is the first section to become operational with ERTMS L2 of the high speed Northwest corridor.

“Investment in high speed has helped position the railway sector as one of the main drivers of economic and social development in the countries where it is deployed. Increased investment drives job creation (both directly and indirectly), reinforces regional cohesion, and opens new markets, especially in the services sector.”

Investment in high speed has helped position the railway sector as one of the main drivers of economic and social development in the countries where it is deployed. Increased investment drives job creation (both directly and indirectly), reinforces regional cohesion, and opens new markets, especially in the services sector. High speed is the preferred option for mobility on medium and long-distance routes, and also provides an effective solution to existing road and air congestion problems. By reducing the numbers of cars on roads and planes in the air, their consequent pollution can be improved.

In today’s digitally connected world the value of time cannot be underestimated, and this is particularly true when it comes to high speed infrastructure. The average commercial speed of the Spanish high speed network is 222km/h, which is higher than in pioneering countries including Japan and France. This is one of the key technological factors of this transformation. Since the late 1980s, there has been an increase in speed of 160% highlighted by the high speed line between Barcelona and Madrid, where the average commercial speed on a journey without stops is 248km/h. The result is a connection between Spain’s two largest cities that takes just 2 hours and 30 minutes.

Commissioning of the high speed lines has benefitted not only the cities they pass through, but also many Spanish regions. The interoperability of conventional and high speed networks was made possible by gauge changing technology that allows adjustable-axle trains to circulate on both. The social impact of the high speed lines is also notable on roads, and in aspects such as fewer accidents and time saved in road travel because of less congestion.

The high speed transport activity between 1992 and 2016 has allowed society to save an estimated €4.286bn, if evaluated in terms of economic impact from climate change, pollution and the accident rate that other modes of transport would have caused.

Environmental integration is a key part of the philosophy inspiring all high speed rail networks. The railway is the most environmentally friendly means of transport—CO_2 emissions are much lower than those generated by other modes of transport, and it also leads to considerable savings in energy consumption. In the first 25 years of operation, it is estimated that savings of more than 12.9 million tonnes of CO_2 emissions and 2.6 million tonnes of oil have be made. Added to this, 100% of power consumed by high speed trains in Spain is generated by carbon-free, renewable sources.

Spain decided to strategically deploy the ERTMS system in order to build the high speed network as soon as it was available, and making a clear commitment to this new interoperable system. As a result, Spain now boasts the most kilometres of ERTMS in operation in the world. Major high speed railway investments in recent years have enabled ERTMS to be developed locally, which has meant that more than 3,000km of railway line have been equipped with the technology (in service or in construction/test). The system continues to be deployed on additional high speed lines that are under construction.

Spain has played a key role in the development, deployment, and success of ERTMS, and is an international leader in the efficient operation of the system. Spain has shown the rest of Europe that technical interoperability among all providers is possible, with high levels of punctuality and reliability, and boasts the longest interoperable route in Europe between Barcelona and Malaga. An additional benefit is the experience and technological knowledge gained which has boosted the competitiveness and internationalisation of Spanish railway industry companies worldwide.

International High Speed Rail **Voices**

A HIGH SPEED RESPONSE TO THE **GLOBAL** NEED FOR SUSTAINABLE GROWTH

The development of high speed rail systems is universally considered a stimulus for economic growth and a sustainable response to population growth, increased travel demand, and transport capacity constraints. This growth must be balanced with the urgent need to meet net zero carbon targets and develop more holistic business cases that enable us to value the long-term social outcomes that inclusive infrastructure can deliver. If we succeed in this, we will unlock the full potential of infrastructure to fulfil its ultimate purpose—to serve society and improve people's lives.

We're always considering how people will interconnect with and move through stations, about the opportunities for development around the station, and potential to enhance life for those living alongside the route. High speed rail offers an amazing opportunity for engineers to create something vitally important for the future set in a much wider context than most projects. Mott MacDonald is engaged on high speed rail around the world, having had key roles on major projects including Taiwan's Taipei to Kaohsiung system, China's expanding network, California's high speed rail project, North India's proposed Corridor 3, and HSL-Zuid in the Netherlands.

Supporting economic growth in Taiwan

In the second half of the twentieth century, Taiwan's economy grew so quickly that its western transport corridor, including highways, conventional rail, and air traffic systems, became saturated and an obstacle to further economic growth. A new high speed rail line was first suggested in the 1970s, with informal planning getting underway in the 1980s.

As part of an international joint venture, Mott MacDonald led an international railway engineering group through all stages of design and construction over a six-year schedule, as independent checking and site engineer, and was appointed to develop a comprehensive asset management strategy. At the time, this was among the world's largest privately funded transport projects. The route was 350km along the west coast of Taiwan, from the capital Taipei to the city of Kaohsiung, with 270kms of bridges and viaducts, 45km of tunnels, and 30kms of earthworks. The system operates using Shinkansen vehicles and has three depots and two maintenance bases.

Construction of the system took more than six years, drawing on the work of more than 2,000 engineers from 20 countries and more than 20,000 foreign and domestic workers. On the route, trains reach top speeds of 300km/h and are accessible to almost 90% of Taiwan's population. Because most of the intermediate stations are outside the cities served, transfer options such as free shuttle buses, conventional rail, and metros have been developed to integrate the railway. The rail line opened in 2007, and now more than 500 million passengers have used it.

The stations were developed as destinations, integrated with local communities where some stations became popular shopping or lunchtime destinations, with development areas and open public spaces that deliver sustainable wider economic benefits. The high speed rail system has contributed to people's wellbeing and productivity, and growth of the cities that it connects.

MOTT MACDONALD

"We're always considering how people will interconnect with and move through stations, about the opportunities for development around the station, and potential to enhance life for those living alongside the route. High speed rail offers an amazing opportunity for engineers to create something vitally important for the future set in a much wider context than most projects."

Keeping China at the forefront of high speed rail

For many years, high speed rail has been one of China's top infrastructure investment priorities. China's expansion of high speed rail is managed entirely by the Chinese Ministry of Railways, which since 2006 has embarked on an ambitious construction plan, reaching a network with a length of some 37,000km by the end of 2020. China published plans in 2020 to increase the country's high speed rail network from 36,000km to 70,000km over the next 15 years, and its total length of track from 141,400km to 200,000km.

Mott MacDonald has been operating in China for over 60 years and has been closely involved with the construction of four separate projects: the Daxi PDL section; Hefu PDL Anhui section; Hefu PDL Min'gan section; and Hukun PDL. Each of these has design speeds between 250km/h and 350km/h. Based on site, our staff provided quality management and site supervision services throughout the construction schedule and over a combined route length of 400km.

The social benefits of the development of high speed rail in China are vast. It will expedite the mass movement of population from rural areas to urban centres and will expand economic opportunities, free up existing lines for freight capacity, and increase employment. Construction of the Beijing-Shanghai line alone employed about 100,000 workers and engineers.

Cutting California's carbon emissions with high speed rail

California has long been considered as an ideal candidate for high speed rail. Notorious for traffic congestion and air pollution, the state could clearly benefit from a rail line that would move people, goods, and services more efficiently, and cut carbon emissions—a need magnified by a population projected to grow to 45 million by 2060. California high speed rail will fundamentally transform how people move around the state, drive economic growth, create a cleaner environment, preserve natural habitats, and create jobs.

The proposed high speed rail system will run from San Francisco to Los Angeles in under three hours at speeds exceeding 322km/h. It will operate over 1,287km of track and will serve as many as 24 stations at cities including Sacramento, San Francisco, San Jose, Fresno, Los Angeles, and San Diego.

International High Speed Rail **Voices**

Between 2007–2012 Mott MacDonald provided project management, engineering design, environmental, permitting, and right-of-way acquisition services for three segments of the system: Fresno to Bakersfield (177km); Bakersfield to Palmdale (153km); and Palmdale to Los Angeles (105km). This involved developing structural solutions for wide canyon and river crossings, tunnelling and ventilation solutions for complex tunnel alignments, mitigation for sensitive habitats and urban areas, and risk management and innovative engineering in seismic zones in Southern California.

The Central Valley segment is expected to go into service in 2027, and the San Francisco to Bakersfield section in 2029. When the project is complete, a passenger will be able to board an express train in San Francisco and step off the train in Los Angeles 2 hours and 40 minutes later. That's three hours less than driving — even without traffic— and, most crucially, the project will remove 400,000 vehicles a year from the roads.

From Building Information Modeling (BIM) and carbon management, lean construction processes to the integration of digital technologies and the creation of smart infrastructure, the challenge is there for all involved in delivering and managing high speed rail: to achieve improvement without compromise. That improvement must ultimately be focused on the people who will use high speed rail services.

Tianjin Railway Station for high speed trains

HIGH SPEED RAIL IN **ITALY**— A SUCCESSFUL JOURNEY

"The high speed rail system has brought about a dramatic and fundamental change in Italian railway infrastructure, both in terms of engineering transformation and the cultural approach to passenger travel."

Created in 1984 as the engineering consultancy arm of the Italian State Railways, Italferr has played and continues to play a leading role in the successful creation of the Italian high speed rail network. The network represents the largest and most prestigious rail investment programme ever delivered in Italy and has provided a huge opportunity for socio-economic development and enhanced the country's competitiveness in international markets.

The high speed rail system has brought about a dramatic and fundamental change in Italian railway infrastructure, both in terms of engineering transformation and the cultural approach to passenger travel. It has involved the creation of 1,000km of track at 300km/h throughout the length of Italy, from Turin to Salerno, including over 254km tracks for the Rome-Florence express line (Direttissima). One of the most impressive outcomes of this huge investment programme has been the drastic reduction in travel times between Italy's biggest cities. For example, the journey time from Rome to Milan is now less than three hours, down from seven hours by intercity train or six hours by car.

The twin challenges of Italy's mountainous terrain and many hydrological features has presented obstacles. But through utilising innovative technology, we have overcome these with the design and delivery of iconic works such as the cable-stayed bridge over the Po River on the Milan-Bologna section of the high speed rail network, with its 192m-long central span and its 60m-high towers, or the 22km-long Valico tunnel within the 'Third Pass' high speed rail project currently under construction to connect Milan to Genoa and crossing the Northern Apennine, among others.

In addition, the implementation of the high speed rail network has led to a massive upgrading programme of railway hubs in Turin, Milan, Bologna, Florence, Rome and Naples, in order to ease high speed train traffic within the urban areas and ensure full modal integration with the local public transport system. Aiming to transform high speed stations into iconic urban hubs, international competitions for the design of those stations were launched. This resulted in the delivery of iconic examples of modern architecture such as Turin Porta Susa high speed station, which received the 2012 European Solar Award for its solar panels on the vault roof, Zaha Hadid's Naples Afragola high speed station, and Calatrava's Mediopadana high speed station.

Crossing six regions containing some of the most populated metropolitan areas of Italy such as Turin, Milan, Bologna, Florence, Rome and Naples, the construction of such a huge infrastructure project has inevitably changed the environment and the lifestyle not just of local communities, but the whole country. Delivery would never have been achieved without early and carefully structured stakeholder management, which included widespread engagement with national agencies, regional and local authorities, contractors, suppliers and local communities. To fully integrate sustainability into the design of the high speed railway, we have developed process tools to plan, manage and enhance the dialogue with stakeholders throughout all phases of the infrastructure life cycle process, which allows us to map, select and quantify environmental, economic and social KPIs. We have also developed a third-party certified protocol for measuring and reporting on greenhouse gas emissions during construction, while setting specific regulations to drive contractors' strategies toward carbon reduction.

In addition to high speed rail projects, a system upgrades program has been carried out by RFI (the Italian Network Rail equivalent) throughout the whole network, with Italferr supporting on design and construction supervision. While most of the high speed rail network was already designed with the ERTMS L2 signalling integrated (being the first in Europe), in December 2020 the southern section of the oldest high speed line, which had not been upgraded, called 'Direttissima', connecting Florence to Rome, was upgraded with the implementation of ERTMS L2, allowing full train interoperability, enhancing safety standards and reducing maintenance costs.

In addition to those already in operation, there are a further 2,200km of high speed rail lines in the design stage or in construction. Amongst these projects, one of the most challenging is the high speed Naples-Bari route which crosses the Southern Apennine Mountain Ridge, connecting two strategic hubs to enhance the economic and social development of southern Italy. The design has been developed by Italferr using BIM (Building Information Modelling)— the first time in Italy on behalf of a public entity—and it was awarded Bentley's Year in Infrastructure Award in Singapore in 2019.

The development of the Italian high speed network has had a truly transformational effect on the country and continues to do so, not just in terms of the infrastructure, but in the way in which people view and use the railway. It has connected communities and increased business productivity. The creation of a world class railway is a journey that is well worth taking and is something to be proud of.

International High Speed Rail **Voices**

International High Speed Rail **Voices**

International High Speed Rail **Voices**

PUTTING INNOVATION AT THE HEART OF THE **GERMAN** HIGH SPEED NETWORK

Across the globe, Siemens Mobility delivers a range of rolling stock, signalling, control, electrification and communications solutions for high speed and intercity railways, providing highly developed solutions to enable urban population centres to be linked quickly, reliably and across borders.

In Germany, the company is delivering a range of systems to Deutsche Bahn (DB), with projects including the supply of a fleet of 30 new high speed trains beginning in 2022 and a signalling solution for the new high speed line between Munich and Berlin. In work closely linked to the advancement of high speed, Siemens is delivering Germany's first UNISIG (European consortium who develop technical specifications for signalling) compliant automatic train operation (ATO) over European Train Control System (ETCS) core signalling and train control system on the Hamburg S-Bahn line.

Digital signalling and control solutions for high speed DB applications

The largest recent rail project in Germany, the VDE8 project, involved the construction and extension of high speed lines between Munich and Berlin. The new line has been introduced to provide additional capacity on the network to meet increasing demand and provides the travelling public with a competitive and more sustainable alternative to road and air travel.

With a maximum line-speed of 300km/h (tested up to 330km/h) considerable journey time reductions have been achieved between all major destinations: for example, the journey time from Nuremberg to Berlin has reduced from 4 hours 45 minutes to just 2 hours 50 minutes.

Siemens Mobility equipped the entire line with its Trainguard 200 ETCS Level 2 system. This proven solution provides constant communication between track and train, with drivers no longer receiving commands (such as speed restrictions), via signals, but on a cab display using information from a radio block centre sent via the GSM-R digital railway radio system.

The train driver is continually updated with information about how far and how fast they can travel, using data transmitted from the radio block centre over the GSM-R radio. This means that the driver has up to date information all the time, not just when passing a trackside signal. This is particularly important on high speed trains where reading trackside signals can be a challenge to the driver.

The use of ETCS Level 2 not only significantly reduced infrastructure costs on this project as trackside signals were not required, but also enhanced line capacity through reduced headway and higher line speeds, all of which contributed to faster journey times.

As lead contractor for the project, Siemens Mobility delivered the programme in two stages. Stage 1 saw the installation of the interlockings and ETCS on the line between Halle/Leipzig and Erfurt, with Stage 2 covering the installation of new interlockings and the start of ETCS implementation. Following the successful completion of acceptance tests, train services began operating in 2017.

During 2021, the company will also be delivering Germany's first UNISIG-compliant ATO over ETCS system. Forming part of a collaborative digital demonstration project on the S-Bahn Hamburg lines, the project is being delivered by a partnership of Deutsche Bahn, S-Bahn Hamburg, and Siemens Mobility. The project covers a 23km long section of track between the Berliner Tor and Bergedorf/Aumuehle stations and will see the deployment of Siemens Mobility's new Trainguard 200 RBC solution, which will interface with the company's ATO trackside, interlocking and control systems.

For this pilot, four of the fleet's 23 trains will be retrofitted with the Trainguard 200 ATO onboard systems. The project will demonstrate a high degree of automation, with the driver only intervening if there are disturbances or irregularities. The technology to support this is the future European standard of ATO over ETCS; with ATO over the radio based ETCS Level 2. The four trains will be controlled by radio signals, and data will be transmitted between the trains and the block control centre.

ATO over ETCS provides a step change in rail network efficiency, increased network capacity and improved reliability. Information on the current traffic situation is continuously transmitted to the trains by radio, and by adapting to this information a train can travel more efficiently, with an optimal speed profile and fewer braking operations. The result is more punctual trains, a more stable timetable, and greater travel comfort. With improved energy consumption and reduced mechanical stress on the trains, the customer's operating costs will also be reduced.

The first of these highly automated trains will enter regular passenger service in October 2021.

New high speed train fleet for Deutsche Bahn

To date, Siemens Mobility trains in service have covered over three billion kilometres in passenger operation. The company's high speed Velaro fleets have achieved very high levels of reliability: less than one service affecting failure for each million kilometres in service.

One of the fastest operational high speed trains in the world, a fleet of 30 interoperable Velaro MS trains is to be delivered to DB from 2022. Initially running on routes between the state of North Rhine-Westphalia and Munich, the new trains will increase DB's daily passenger capacity on these main line routes by 13,000 seats and will have a top speed of 320km/h. They will offer passengers greater comfort and convenience with features like frequency transparent windows for stable mobile phone reception, and space for storing bicycles.

Velaro MS is a multiple unit train set in which the traction and all the technical modules are distributed underfloor over the length of the train. The full length of the train is therefore available to passengers, offering 20% more seating capacity than other train concepts. This evenly distributed weight characteristic also improves ride performance and therefore passenger comfort.

Passengers also benefit from a quieter environment and an advanced passenger information system with video screens in all carriages which are clearly visible from every seat and provide route information. The interior of the Velaro MS has a modular design, such that its fixtures, fittings and equipment can be altered quickly and flexibly.

International High Speed Rail **Voices**

“ATO over ETCS provides a step change in rail network efficiency, increased network capacity and improved reliability. Information on the current traffic situation is continuously transmitted to the trains by radio, and by adapting to this information a train can travel more efficiently, with an optimal speed profile and fewer braking operations. The result is more punctual trains, a more stable timetable, and greater travel comfort.”

Featuring an intelligent energy management system, the Velaro MS operates extremely energy efficiently, with CO_2 emissions per passenger of just 14 grams (the average aircraft emission is 10 times higher). The braking system also functions energy efficiently, with electric brakes recovering braking energy into the power grid, saving about 10% of energy and reducing mechanical wear and tear.

The aerodynamic characteristics of the Velaro MS have also been optimised to reduce both noise and energy consumption, with a new front-end design, cladding for roof mounted equipment and optimisation measures in the bogie and inter coach gangway areas all contributing to a 20% reduction in air resistance, compared to the previous Velaro generation. The attention to design detail is evident throughout the train, with the fully enclosed base tray of the bogies a perfect example. These design enhancements not only significantly decrease aerodynamic drag, which in turn greatly reduces energy consumption, but also provide protection against ballast pickup.

For the cross-border operation, the train is equipped with a range of seven automatic train protection (ATP) systems. The train is therefore compatible with the signalling systems in France, Germany and Belgium and can be used in Germany and France on the new high speed Rhine-Rhône line.

The Velaro Novo is an evolutionary advancement of the Velaro platform with the focus to further improve Life Cycle Cost (LCC). To validate the innovations of the Velaro Novo, a prototype vehicle was manufactured and is currently being trialled with the support of Deutsche Bahn Systemtechnik.

The operational experience of more than three billion kilometres in passenger operation of the Velaro fleets, together with maintenance experience from Velaro service contracts, are key ingredients for major improvements and new innovations.

International High Speed Rail **Voices**

RAIL CAN PLAY A CENTRAL ROLE IN A NEW '**GLOBAL BRITAIN**'

2021 marks a new era for the UK's position in international trade. Having left the European Union at the end of 2020, the Government is now keen to encourage businesses to look to new markets and to boost trade across the world. The Government has a target of increasing exports to 35% of GDP, up from 30% currently, and it is eager to support the development of new capabilities and innovation in areas like decarbonisation and digitalisation. By developing expertise further in these and other areas (such as predictive maintenance), it is hoped that UK businesses will gain a competitive edge abroad.

The Railway Industry Association (RIA) and our members are clear that rail is not mentioned as much as it should be, when it comes to promoting international trade. The UK rail industry is already a significant exporter—selling £800 million in goods and services abroad each year. When you speak to industry counterparts overseas, they are often highly impressed by the UK's ability to run one of the most intensively-used rail networks in Europe—as well as one of the oldest in the world—whilst ensuring it is reliable and safe. They are often impressed too that improvements are made with minimal disruption to passengers and freight users, that we commit to major projects like Crossrail and HS2 (Europe's largest infrastructure scheme), and that our rail companies have vast expertise and knowledgeable professionals. Whether high speed rail, metro, light, or other forms of rail, the UK is rightfully seen abroad as a leader in railways.

Increasingly, the UK Government has begun to understand the power—and the potential—of rail for international trade. The Rail Sector Deal, an agreement between government and industry made as part of the Industrial Strategy agenda, commits to doubling exports by 2025. The Deal has already provided a significant amount of support to industry, including launching a scheme whereby Network Rail can give UK exporters references to be used with foreign buyers. The Exports Pillar of the Deal is also working on delivering a mentoring scheme for those new to exporting who are looking for advice and help, and there are plans to map out new markets for UK businesses, to support them in understanding the commercial environment of different rail sectors overseas.

The Rail Sector Deal also recently published its latest Exports Survey, revealing some useful insights into the priorities of rail companies for the coming year. Interestingly, more than half, 55%, of the survey respondents confirmed they are currently exporting, planning to export, or considering exporting goods or services for the railway sector from the UK—a positive start. The Deal also showed the priority markets for rail suppliers, which are well aligned with the Government's own targets for Free Trade Agreements—Australia, the US and Germany, which have also been identified as some of the top priority markets where companies believe their goods or services have potential to be exported with assistance from the rail industry and government. Respondents were also asked the most common reason they had for not exporting, with many saying that their products or services were often UK-specific.

Railway Industry Association
The voice of the UK rail supply community

Of course, whilst the industry has a good basis from which to start, it will be a significant challenge to meet the Government's 35% target, and the goal to double rail exports by 2050. So what do we believe can be done to support the industry in achieving these aims?

Firstly, Government must fully back the rail industry's presence overseas. Trade exhibitions, like InnoTrans in Berlin—the world's largest rail trade fair—are shop windows for the UK's rail industry. Support from Government in making the UK pavilions as impressive as possible can go a long way in enhancing our reputation abroad, leading to new business for those companies who exhibit under the Department for International Trade (DIT) 'GREAT' branding. Ministerial support can also be a major help—and whilst COVID-19 means exhibitions are not currently able to go ahead, the UK must be ready to return to these trade shows with greater energy and effort than ever before when they start up again.

Secondly, Government should support small businesses in exporting, by helping them attend these trade shows. The popular Tradeshow Access Programme (TAP) is an initiative by Government to support SMEs looking to export abroad, by providing them with grants that go toward the costs of exhibiting, such as purchasing stand space. These grants are often small in amount but can be vital in supporting small businesses who often do not have extra funds to market their wares on an international stage. They also come with added support from the trade association administering the grant on behalf of DIT and from DIT's regional International Trade Advisers. Yet, there have been a number of concerns about these grants in recent months, including that they have not been rolled over from one financial year to the next, following the postponement of overseas events due to COVID-19. This means that SMEs will have to compete for grants for this year's exhibitions, alongside any postponed exhibitions from last year. Making the TAP scheme more flexible, as well as increasing and allocating a rolling three year budget, would do much good for those SMEs who find these grants extremely helpful and cost effective, as they 'dip their toe' in exporting.

"When you speak to industry counterparts overseas, they are often highly impressed by the UK's ability to run one of the most intensively-used rail networks in Europe – as well as one of the oldest in the world – whilst ensuring it is reliable and safe. They are often impressed too that improvements are made with minimal disruption to passengers and freight users, that we commit to major projects like Crossrail and HS2 (Europe's largest infrastructure scheme), and that our rail companies have vast expertise and knowledgeable professionals."

Finally, the Government should ensure there is the right policy environment to allow UK rail businesses to succeed. In 2020, RIA called for Free Trade Agreements negotiated by the UK to meet key asks: that rail plays a role in trade deals; that the UK maintains access to a skilled workforce; that there is consistent application of standards with mutual recognition; that there be as smooth cross border trade as possible; and that there are reciprocal rules on market access and domestic content. It was positive to see the UK and EU reach a free trade deal at the end of the year, and to see there would be no quotas or tariffs between the two trading

partners. The impact of the deal is still being worked out by rail suppliers, but these key trade asks remain very much relevant to our future partnership with the EU and with other nations we continue to negotiate with. If the Government supports these asks, UK rail will have the means to flourish in a post-Brexit world.

How should rail exporters, including those working in high speed rail, view the international market? Well, there are many reasons to be positive. European rail trade body UNIFE's World Market Study predicts an annual rail market growth of between 1 and 2.3% until 2025, equating to a volume of approximately €240bn per year. With decarbonisation rising up the political agenda, many countries are looking to rail—and high speed rail—to reduce domestic emissions.

For those who have never exported before, help is at hand. The COVID-19 pandemic has meant Government and trade bodies have become creative in their approach to overseas engagement—for example, RIA held its first virtual trade mission to Canada in January, organised in partnership with the DIT and a further virtual rail trade mission is planned to Australia at the end of March. And our 'outreach' webinars have seen DIT officials and commercial officers from across the globe join us to talk about their respective rail markets (going virtual has perhaps meant even more access to international expertise).

Rail should play a central role in the Government's vision for a 'Global Britain'. Working together, it is something we can certainly achieve.

THE IMPORTANCE OF **GLOBAL KNOWLEDGE TRANSFER** TO INTERNATIONAL RAIL

The scale and reputation of the UK's railway research and education capability internationally is not as well-known as it ought to be. From pioneering design through to railway engineering and operations, we have become world leaders in providing high quality research and education to almost every railway network in operation around the world.

Ten years ago, we had one Original Equipment Manufacturer (OEM) resident train builder in the UK. Since then another four major international OEM train builders have been attracted to our shores, demonstrating the confidence that the international market has investing in the UK.

The intriguing mix of legacy and state-of-the-art digital signalling systems within the UK gives us the experience and credibility in developing capability and capacity for railway systems around the world. At BCRRE, our education programmes take this into account, encouraging all students to contribute their own national and regional knowledge to courses for the benefit of everybody's learning. This knowledge transfer is critical for improving the effectiveness of railway systems around the world, be they high speed rail systems or more modest (but no less important) metro systems.

As the largest specialist railway research, education and innovation centre in Europe, BCRRE's railway engineering education provision is on a significant scale and we aim to develop broad engineering skills into advanced knowledge and expertise designed to support the global rail industry and its future skills requirements.

"BCRRE's work in Singapore, and with other partners around the world, demonstrates the essential role that global knowledge transfer between academic institutions such as ours and industry will play in the years ahead."

Projects like HS2 create a clear pipeline of demand for talent, and institutions such as ours work closely with our industrial partners to design and deliver courses that take into account the latest technologies and practices in industry.

A case study: from Birmingham to Singapore

For the Singapore Metro (SMRT), we designed a Postgraduate Certification in Urban Railway Engineering aimed at contextualising broad engineering skills into the specific (in this case, metro) environment. The qualification was designed to be sufficient for the SMRT students (once graduated) to achieve professional accreditation from their in-country professional engineering institution. We worked closely with SMRT to specify the programme, combining BCRRE expertise in rail and rail systems education with the company's needs, and have continued to work with SMRT since to review it regularly and ensure the course's focus remains relevant. For example, the programme was originally three academic years long, but after discussions with our partner we were able to compress the teaching and learning pipeline so that students graduated after 18 months (i.e. after only three university semesters) of study and could therefore enter the industry more quickly.

International High Speed Rail **Voices**

UNIVERSITY OF BIRMINGHAM | BCRRE

The programme combines the knowledge, skills and behaviours expected of a professional engineer. It starts with a portfolio-based module which follows the student's journey through the first year. SMRT uses a work based learning route, utilising naturally occurring tasks or competences as evidence for inclusion in the portfolio (not unlike a NVQ/competence based learning model). The second of the modules details technologies for digital futures, where students will learn about the principles of railway control, system interfaces, communication systems, automation, control systems (current and future) and software-based digital technologies relevant to the digital railway. Whilst the third module teaches the students in separate groups according to their individual disciplines (e.g. communications and control, signalling, track infrastructure, rolling stock, power or energy and buildings and facilities) but bringing all the disciplines together where possible to work collaboratively and help to break down or prevent a 'silo mentality'. For a number of the students this was the first time they had genuinely worked together in a cross-disciplinary manner and, as a consequence, they got to experience each other's pains and frustrations across interfaces.

Our teaching model had the lecturers fly out to Singapore as a 'flying faculty' twice a year (usually March and October) to run anything up to four cohorts during any one visit. More recently the course has, of course, had to adapt. Throughout 2020, it was swiftly converted to blended learning as a consequence of COVID-19. We are pleased to report that this has been judged a success by students and employer alike. Ideally, we would prefer a blend of remote learning and face-to-face learning. However, it depends on the learning journey, the challenge for the students and, of course, what the employer requires. This programme with SMRT had around 250 students at any one time and, over the course of the programme, educated a total of nearly 400 engineers to Postgraduate Certification level.

The programme was always due to finish after five years, with a view to BCRRE assisting SMRT to develop an organic delivery capability. We have already started discussions with local, Singaporean institutions to see how we can work with them to continue this postgraduate learning provision as a partner, but with SMRT and the local providers taking the lead.

This significant achievement means that we have the experience, the knowledge and the flexibility to offer this and equivalent programmes face-to-face (when the situation allows) and remotely, through blended/online provision using a mixture of pre-recorded lectures and live lectures. We can thus provide the right level of education to the right people, in the right manner, to achieve the skills and knowledge needed to serve the international rail sector.

Incidentally, this whole programme came off the back of a package of research carried out by the university for SMRT. Of course, the opposite could happen in that we could identify research opportunities off the back of an education programme. Our Centre Director Professor Clive Roberts (Professor of Railway Systems at University of Birmingham and Head of School of Engineering) is also on the SMRT Board as a Technical Advisor and we believe that this too has realised much in terms of benefit for the customer.

BCRRE's work in Singapore, and with other partners around the world, demonstrates the essential role that global knowledge transfer between academic institutions such as ours and industry will play in the years ahead. By working together at an international scale, we can ensure that today's rail networks and those of the future are served by the most rounded and best trained engineers in a generation.

Singapore students, October 2017

L'EXPÉRIENCE DU TRAIN À GRANDE VITESSE EN **FRANCE***

Sometimes the future arrives unexpectedly. The claim that rail could realistically replace domestic flights in developed countries has long been argued, but it took the sudden crisis of the COVID-19 pandemic to make it a reality in France. The French Government has made bailout plans for Air France-KLM dependent on a permanent reduction in domestic flights, stopping all air travel where the distance can be covered by a train journey of 2.5 hours or less. Already flights between Paris and major cities such as Bordeaux are grounded, routes which had previously averaged up to ten flights per day in each direction. The environmental benefits will be huge and swift. But it can only work if the infrastructure is there to absorb the sudden increase in capacity and to connect cities with enough speed.

Nobody would have wished for a COVID-19 shaped crystal ball, but this is a glimpse of the future that should be of interest to commuters and policy makers in the UK and elsewhere. The UK is committed to net zero carbon emissions by 2050, and the rail network is the greenest possible means of mass transit. If we are going to get people out of the air, let alone out of their cars, we need speed and comfort and, above all, seats. Achieving that without extensive high speed rail connections will be a challenge.

It is, perhaps, inevitable as well as unfortunate that the centre of controversy in the UK has been focused on the question of speed versus costs. Yes, there will be significant gains in journey times, and these will matter more than some commentators will allow when people are choosing between air and rail, but as we know from our work in France and around the world,

"The broader economic benefits associated with high speed rail are hotly contested and there is always a danger of wishful thinking, but French experience has been pretty unequivocal. The estimated wealth creation from the 340km Bordeaux–Tours high speed line is in the region of €760m."

it is the huge increase in capacity that comes from separating high speed inter-city travel from local stopping lines that will be most immediately felt by commuters and which will future-proof the network. In France, one of the key selling points of the Tours-Bordeaux high speed rail line was capacity gains—since the existing rail network would allow more room for rail freight, taking thousands of lorries off the road.

SYSTRA has worked on every part of the French network and many high speed projects elsewhere from Sweden to South Korea. We adapt proven methods and technologies developed over 30 years to meet local constraints and requirements. The high price of HS2 is not from a lack of cost planning or control, it is because HS2 is world-leading in its attention to environmental impact and protection of the countryside. These are benefits which will be felt long after the project is complete. Bringing the project up to those demanding standards is creating a workforce with the sort of skills that are likely to be in ever-more in demand at home and overseas. Concern over environmental impact is only going to grow—throughout the world. In France, the Government's commitment to the environment is evident, national operator SNCF launched the prototype for the new TGV train model which is planned to start service in 2024 and will be cheaper and require far less energy to run.

* 'The high speed train experience in France'.

SYSTRA

The indirect benefits of the HS2 project, such a specialised skilled workforce with exportable expertise, are easy to underestimate. The 22,000 jobs directly created by the project won't just fade away once it is complete. Many other jobs will be created indirectly through the positive economic impact that a revitalised rail network affords. It is estimated, for example, that the Bordeaux high speed rail extension led to the creation of nearly 14,000 local jobs. In the UK, the recruitment of local people is already happening on a huge scale and projects like HS2 have in our case, attracted skilled workers from other sectors and even pulled them back home to the UK from other countries.

The broader economic benefits associated with high speed rail are hotly contested and there is always a danger of wishful thinking, but French experience has been pretty unequivocal. The estimated wealth creation from the 340km Bordeaux–Tours high speed line is in the region of €760m, for example, with a big boost in property value and development. We have seen the creation of 15,000 new homes and more than 50,000m² of commercial space in the vicinity of new high speed rail stations, just for this one high speed line. It has also positively impacted France's ability to trade, given half of trade with Spain transits via the Atlantic coast on which the line sits.

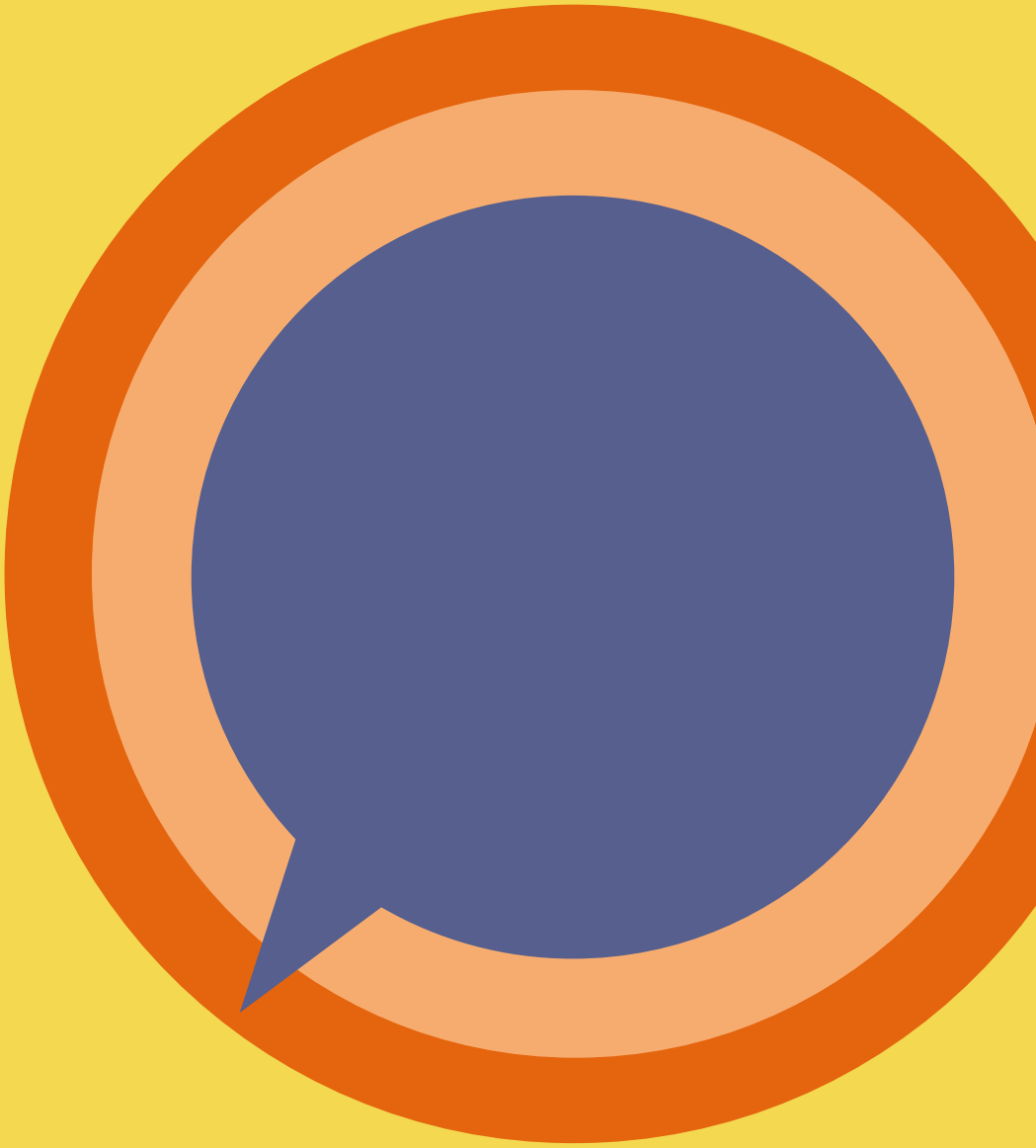
The British Government's Rail Sector Deal set out an ambitious investment plan designed to push the UK's rail sector forward and to help establish it as a world leader in modern rail design and delivery. These are laudable and achievable ambitions, but only if the sector does not neglect high speed, the only way that rail competes effectively with the airline industry on a domestic level. British engineers laid rail all over the world in the first great explosion of railways in the 19th century, exporting knowledge and expertise as well as engines. There is no reason why the UK should not be a global leader again in the second great age of rail demanded by an environmentally conscious population. Russia, East Asia and the Middle East are all areas that are underdeveloped in high speed rail technology and where an obvious need is apparent. When they come to invest, they will be looking for the best, and that can be British expertise.

When the Covid cloud clears, France will look to the skies and ask if we need to return to the old ways of doing things. The opportunity to embrace a cleaner, greener future right now is there because the investment and planning was done before the crisis hit. Another crisis, perhaps a greater one in the shape of climate change is looming, and the UK has the opportunity to meet it similarly prepared. Let's not miss this opportunity.

International High Speed Rail Voices

International High Speed Rail **Voices**

HIGH SPEED
RAIL GROUP



@HSRailGroup
www.rail-leaders.com