

1. Overview

Angel Trains welcomes the Economy, Infrastructure and Skills Committee's inquiry into decarbonisation of transport. We support the Committee's consideration of the important issue of decarbonising rail as the Welsh Government develops the next Wales Transport Strategy (WTS) and are grateful for the opportunity to contribute to this inquiry.

Angel Trains is the largest of the UK's Rolling Stock Owning Companies (ROSCOs). We own and maintain 4,450 passenger vehicles, and have a further 785 on order, which we lease to 18 franchised (including Transport for Wales Rail Services) and two open access train operators. Based in London and Derby, we employ 135 professional, technical and administrative staff, graduates and apprentices.

Angel Trains plays an integral role in the UK's rail industry. We are owned by a consortium of infrastructure and pension funds, and act as a bridge between the operational railway and investors by attracting and securing the necessary private finance to procure, refurbish and enhance UK passenger rolling stock. Over the past 25 years we have invested over £5 billion in new rolling stock.

Rail is one of the lowest carbon modes of transport in Wales – and across the UK – and we encourage greater use of the network by travellers to reduce carbon emissions and improve air quality¹. Our submission sets out the actions needed to support the delivery of the Welsh Government's vision and priorities in the transport sector pathway. There is a clear economic opportunity for the sector to become a world-leader in developing and delivering low carbon rail solutions, as well as significant potential passenger benefits to be derived from the transition to alternative fuelled rolling stock, which our submission outlines.

We are committed to decarbonisation and have worked closely with the Rail Industry Decarbonisation Taskforce, including supporting the Decarbonisation of Traction Energy project. While much of the debate to date has focussed on the role of hydrogen, including in the Wales and Borders franchise, a wide range of low carbon rolling stock solutions will be needed to

¹ Emissions data in *Prosperity for All: A Low Carbon Wales* is sourced from the Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2016

accelerate the decarbonisation of different parts of the GB rail network and support the target of net zero carbon by 2050.

We are already investing in innovation, research and development (R&D) and pioneering alternative fuel technologies, including our Class 165 HyDrive pilot. There are significant opportunities to further decarbonise rail and we look forward to working in partnership with industry and the Welsh Government to deliver new innovations across the network.

2. Decarbonising rolling stock

“Decarbonisation of transport presents a serious challenge but also significant opportunities”, Prosperity for All: A Low Carbon Wales

Angel Trains is stepping up to the challenge of finding solutions for a low carbon rail future. In recognition of the Welsh and UK Governments’ ambitions, as an industry we are working to adapt and upgrade our fleet and to provide new rolling stock in the future. We are delivering significant investment in innovation to find efficient technology solutions that work for our customers and their passengers, and which improve the performance of traction units to reduce or remove emissions.

Given the diverse landscape and requirements of the Wales and wider GB rail network, we believe it is important that the industry pursues a range of solutions for future rolling stock – including hybrid drives, hydrogen technology and Electric Multiple Units (EMUs). We are pleased to see the development of technologies to support a low carbon rail future being promoted across the whole of the rail industry and its supply chain, including SMEs.

At Angel Trains, we are proud to be working in partnership with Chiltern Railways and Sheffield-based Magtec to deliver the **industry's first hybrid technology using a diesel train with the conversion of a Diesel Multiple Unit (DMU) to battery hybrid drive**. The pilot unit, Class 165HyDrive, is due for completion in H1 2020 and will serve passengers on Chiltern Railways' routes. Key environmental and passenger benefits include a reduction in diesel engine exhaust emissions, switching off engines in stations and other

How we will retrofit the first DMU

The conversion will remove entail the removal of the existing diesel engine and transmission, together with hydrostatic auxiliary systems, alternator and static converter, which are no longer needed. They will be replaced by a 180kWh Lithium Ion battery, which will deliver power to a new body-mounted permanent magnet traction motor rated at 400kW, and to the vehicle's auxiliary systems. Small diesel generators will be arranged in a modular Series Hybrid configuration to maintain an optimum charge to the battery, with the modular design allowing these generators to be upgraded to even lower carbon alternatives in future. The existing cardan shaft and bogie final drive architecture will be retained.

The permanent magnet traction motor and generators, as well as the IGBT controllers, will be liquid cooled via a dedicated low temperature cooling circuit. Clean, dry compressed air will be delivered by a stop – start electric drive compressor. The vehicle will be able to regeneratively brake, storing the recovered energy in the traction battery. The hybrid drive will give the ability to improve acceleration compared to the existing drivetrain.



Scan this QR code with an iPhone or iPad camera to view Angel Trains' video on our Class 165 HyDrive. Hover your camera over the code and a link will appear, which when clicked on will automatically load the video.

sensitive areas and significant improvements in fuel economy. Once proven through the pilot, we see the potential to roll-out this technology on other modern DMU fleets, for example the Class 175s fleet that operates throughout Wales.

As another example, we would also highlight innovations in dual-fuelling. Grand Central, an open access operator, is currently converting one of Angel Trains' Class 180 diesel-hydraulic multiple units to run on a combination of diesel and liquefied natural gas in a dual-fuel technology demonstration project. The vehicle will be fitted with G-volution's Optimiser System in a trial being funded by the Rail Safety and Standards Board (RSSB). A previous study undertaken by the RSSB has shown that dual-fuel operation can cut fuel costs by 30%, as well as reducing CO₂ emissions and Particulate matter (Pm).

3. The passenger benefits

The next WTS should reflect the significant passenger benefits which alternative fuel rolling stock provide – from higher air quality standards at

stations and a quieter on-board environment, to shorter journey times. Angel Trains is committed to putting passengers at the heart of our technology innovations and the upgrades to our rolling stock. The roll-out of our HyDrive vehicles will deliver the following improvements for passengers:

- **Customer:** An improved customer experience as a result of reduced noise and vibration within the vehicle compared to diesel trains, as well as being quieter and cleaner in stations.
- **Carbon:** Reduced carbon and cleaner air by reduced emissions of CO₂, NO_x and particulates giving a smaller carbon footprint and much cleaner air.
- **Capacity:** Improved capacity and shorter journey times achieved by increased acceleration, improved by up to 10%, from the new traction motors.
- **Cost:** Reduced operating cost resulting from the improved fuel economy and an overall reduction in maintenance costs aided using remote condition monitoring.

Further additional benefits include:

- **Reduced environmental impact** by significantly reducing the use and disposal of transmission oils.
- **Running primarily on batteries**, with only intermittent use of modern engines, as well as regenerative braking, delivers **increased fuel efficiency**.
- **Significant increase in reliability** predicted using new, modern, reliable components and optimised maintenance. This means that there is less chance of trains breaking down causing inconvenience to rail passengers.
- **Potential to increase unit range**, with better fuel efficiency allowing the train to run for longer between trips to the depot for refuelling.

Finally, an additional benefit of upgrading existing vehicles to HyDrive, rather than replacing early-life fleets with new rolling stock, is the avoidance of the embodied energy used in the construction of new vehicles. Conservatively, this alone would save at least 1.3GWh per vehicle, which is equivalent to over half a million miles of operation. Upgrading and enhancing rolling stock so it can serve passengers throughout its intended 30+ year life cycle is therefore a key part of the shift to low carbon rail.

4. Delivering a low carbon railway in Wales

Below we have outlined the actions needed to support Wales' transition to a low carbon railway, to meet and the targets and policies set out in *Prosperity for All: A Low Carbon Vision for Wales*.

The transition could be supported and low carbon rail available to passengers in Wales, through the continued lease of Class 175s which as described above, are suitable for conversion to hybrid technology.

Support for a mix of rolling stock solutions

A wide range of low carbon rolling stock solutions will be needed to accelerate the decarbonisation of different parts of the GB rail network.

Hydrogen

On parts of the rail network, hydrogen fuelled trains have the potential to play an important role in the medium-term. However, there are significant barriers to their commercial roll-out. Given the energy density of hydrogen, this alternative fuel cannot currently be used to power fast intercity-type trains or heavy vehicles, including freight. We have provided further background on key challenges below:

STANDARDS | Current regulations restrict gas-powered trains from passing through a tunnel longer than one kilometre, which would significantly limit their use across the rail network. To ensure hydrogen trains can support the shift to a low carbon railway, we recommend that the industry standards on gaseous fuels in tunnels are reviewed, with appropriate safety measures built into any new regulations.

LOADING GAUGES | A further challenge for hydrogen-powered trains is the volume of fuel storage required on-board to enable the train to be in service for one day without refuelling. For example, a three-car train formation would provide two cars of passenger space, with the remaining vehicle being given over to hydrogen storage. This cannibalises space which otherwise would have been allocated for passenger seating, luggage and bike storage and accessible toilets. A potential solution is to lengthen train formations; however, in many cases platforms across the network would also need to be extended with new capital investment. Current fuel cell technology, coupled with the space needed, also limits the use of hydrogen-fuels to services which operate at a maximum of 75mph. These capacity and speed restrictions means hydrogen-powered rolling stock will need to be deployed in a targeted way across the network.

Batteries and hybrids

At this stage, battery-only trains are not a viable replacement for diesel or electric trains. Based on the current technology available, they would require batteries of 40 times the physical volume of diesel ones to provide the same amount of energy. However, under hybrid technology, batteries can enable trains powered by electrification, a diesel engine or even a hydrogen fuel cell to make short journeys up to a few tens of km without another power source.

Angel Trains' hybrid technology provides a solution to this. Our Hydrive technology offers the battery as the primary driver of the train, which is topped up by an alternative power source, initially a diesel engine or in the future an alternative power source.

We believe the hybrid approach has a crucial role to play as a bridging technology that reduces the emissions from today's trains, with no infrastructure requirements, and without the carbon and energy cost of renewing a fleet before it is life expired.

Encouraging innovation

Where there is currently no business case for new initiatives, government support is likely to be needed to accelerate key schemes and secure industry investment. Recent conversations between the UK Government and industry around central support for a 'first of kind' demonstrator to address challenges such as lineside battery storage and hydrogen generation is very welcome, alongside support for the roll-out of required infrastructure.

We support the Rail Industry Decarbonisation Taskforce's calls for the rail sector's R&D funding allocation to at least match, if not exceed, the levels of support offered to the aviation and automotive sectors. A step-change in R&D co-funding will be required to incentivise change, building on the opportunities available through the UK Government, Rail Standards and Safety Board (RSSB) and Innovate UK.

We welcome the Welsh Government's commitment to establish a Task and Finish Group to explore innovation and decarbonisation. We would be delighted to support this Group and share our experiences and expertise.

Long-term policy certainty

We welcome the Welsh Government's emphasis on the importance of long-term thinking in its Methodological Approach². Working with industry and academic partners, ROSCOs are already investing in innovative, cost-effective ways to deliver alternative fuel rolling stock. However, policy and regulatory certainty, increased R&D funding and targeted government support and incentives are all required to take rolling stock solutions from trial to commercial production and, ultimately, accelerate the UK's transition to a low carbon railway.

Policy certainty is essential if we are to become a world-leader in low carbon rolling stock solutions. Given the 30+ year lifecycle of the trains we buy, rolling stock investment decisions we make now will directly impact upon the industry's ability to meet low carbon targets. New trains, procured in recent years that are now coming on to the network, will also require major

² Prosperity for All: A Low Carbon Wales

refurbishments and upgrades. To finance, deliver and enhance trains that are fit for the future, we need a long-term policy and funding framework, agreed by government and industry, which provides clarity of vision and deliverable timescales.

A long-term strategic approach to rail decarbonisation policy, coupled with a risk prospectus for the relevant infrastructure assets, could also help to unlock new low carbon investment opportunities. Based on our experience of working with the international investor community, we believe that there is significant appetite to invest and finance either new or existing rail infrastructure.

An integrated approach

We agree with the Welsh Government's emphasise on the need to work across emissions sectors and understand the interconnections. All policy discussions which take place should be cross-departmental – maintaining close alignment between the transport, energy and industrial strategies – to develop synergies in hub areas.

5. Improving air quality

Rail transport makes a relatively small contribution to poor air quality – with overall emissions per passenger mile less than other modes of transport³. Nationally, it accounts for 4% of NOx emissions and 1% of Particular matter (Pm) emissions. However, we are committed to playing our part in continuing to improve air quality at stations and across the network for the benefit of passengers and the rail workforce, as well as supporting the rollout of Clean Air Zones in Wales and across the country.

Through our partnership with Chiltern Railways and Magtec, we are proud to be introducing the first hybrid conversion of existing diesel rolling stock in the UK, allowing trains to run on battery power alone in stations and depots, bringing an improved environment on the busy commuter routes between London Marylebone and Aylesbury. As well as eliminating emissions from platforms and other sensitive areas, HyDrive will deliver a smaller carbon footprint and much cleaner air along the route. Overall fuel and CO₂ emissions across the route will be reduced by at least 25%, NOx will fall by a minimum of 87% and Pm by 97%. Last year, London Marylebone became London's first clean air station and we are delighted to support Chiltern Railways and Network Rail in the next stage of this journey with our industry-first solution⁴. Looking ahead, we see the potential to roll-out our technology on existing diesel fleets including the Class 175 fleet operating across Wales to deliver county-wide air quality benefits.

³ UK Government's Clean Air Strategy 2019, <https://www.gov.uk/government/publications/clean-air-strategy-2019>

⁴ <https://www.chilternrailways.co.uk/news/marylebone-station-becomes-londons-first-clean-air-station>

Angel Trains is supporting the RSSB's development of the rail air quality strategy, which is running in parallel to the Decarbonisation Taskforce. Given the overlap between technical rolling stock solutions to address air quality and decarbonisation challenges, we agree with the Decarbonisation Taskforce's emphasis on the need to consider these workstreams together. This will ensure that action taken on air quality now does not have adverse long-term carbon outcomes⁵.

⁵ <https://www.rssb.co.uk/Library/improving-industry-performance/Rail-Industry-Decarbonisation-Task-Force-Initial-Report-to-the-Rail-Minister-January%202019.pdf>