# Written Evidence Submitted by Alstom UK
# (HNZ0018)

**Introduction**

- The following is our response to the Science and Technology Select Committee's inquiry into the role of hydrogen in achieving Net Zero inquiry. It is submitted by Alstom UK & Ireland.
- In anticipation of the Committee's meeting to discuss the findings of the inquiry, we would welcome the opportunity to present to the committee at any further evidence sessions that the committee might hold, particularly to discuss our major advancement in the development of hydrogen train technology that could see hydrogen trains running on regional routes in the UK as early as 2024. We are also happy to provide any further information that may assist with this inquiry, and would be delighted to welcome committee members to our factory in Widnes where the UK's first passenger-ready hydrogen train is currently being developed.

**About Alstom**

- Alstom is a global leader in sustainable and smart mobility. Alstom develops and markets integrated mass transit systems that provide the sustainable foundations for the future of transportation. Alstom provides a range of solutions, such as rolling stock, ranging from trams and light rail through to very high speed trains, signalling, components and turnkey system solutions.
- In February 2020 Alstom announced that it had come to an agreement to acquire Bombardier Transportation. Upon completion, Alstom will become the largest rail manufacturer in the UK: significantly increasing its scale and industrial footprint and playing an even more pivotal role in delivering sustainable transport systems designed and built in the North of England – which will be crucial for the Prime Minister's levelling up agenda. As part of this, Alstom will also be taking over the UK's oldest and largest rail manufacturing hub in Derby for which we have ambitious plans.
- Alstom's heritage in the UK goes back over a century and its plan is the only 'shovel-ready' hydrogen train programme. Alstom is ready to move fast to help the Government meet its net zero objectives.

**Submission response**

1. **The suitability of the Government's announced plans for "Driving the Growth of Low Carbon Hydrogen", including:**

    - **the focus, scale and timescales of the proposed measures;**
    - **how the proposed measures—and any other recommended measures—could best be co-ordinated;**
    - **the dependency of the Government's proposed plans on carbon capture and storage, any risks associated with this and how any risks should be mitigated; and**
    - **potential business models that could attract private investment and stimulate widespread adoption of hydrogen as a Net Zero fuel;**

Alstom welcomes the inclusion of low-carbon hydrogen as the second priority in the Prime Minister's Ten Point Plan for a Green Industrial Revolution, and we look forward to the publication of the national hydrogen strategy in early 2021.

We stand ready to work with the Government to deliver on its decarbonisation objectives. Hydrogen technology will be key to achieving a low-carbon future. This is most pertinent in the transport sector where diesel vehicles are still the biggest polluters. As the backbone of our public transport network, decarbonising rail must be the priority.Over 60% of the network remains unelectrified and is operated by over 1,000 aging diesel trains. For this reason, Alstom's work on hydrogen trains is critical.

In order to drive the growth of low carbon hydrogen we must also drive the growth in demand for such hydrogen. The deployment of fleets of hydrogen powered trains is an ideal means of creating highly predictable, long term demand which is exactly what investors need to secure production capacity. Each train fleet will require tonnes of hydrogen a day, 364 days per year. Hydrogen production launched on the back of this demand can then be further expoited to create a network of supply hubs that can be multi-modal, supporting other forms of transport or hydrogen usage wherever they are.

Hydrogen vehicles, trains included, create zero emissions as they operate. Their only emissions are generated in the production of the hydrogen and so green (produced from electrolysis using renewable energy), or blue (produced from fossil gas with carbon capture and storage) hydrogen is key to the full elimination of carbon emissions. The benefits of operating zero emission vehicles, particularly the clean air benefits, can be made with any type of hydrogen and then emissions improved over time with cleaner hydrogen production. This would merely be the same situation as we currently have for all grid charged electric vehicles whereby they only become "zero emission" once the grid itself is fully net zero. This means that the adoption of hydrogen powered vehicles need not necessarily be hindered by a delay in the introduction of cleaner hydrogen production. Indeed, it can be made in advance in order to ensure that there is secure demand for the cleaner production output as it comes on stream.

**2. The progress of recent and ongoing trials of hydrogen in the UK and abroad, and the next steps to most effectively build on this progress;**

Other countries are pressing ahead with national hydrogen strategies and there is a risk of the UK falling behind. Technology cycles are being compressed and innovation is happening faster than ever before. In Germany, our Coradia iLint trains operated in full passenger service for over 180,000km over a 20 month period and since then have run successful trials in the Netherlands before entering passenger service in Austria. Two fleets of 14 and 27 trains have been ordered in Germany and will enter service in 2022 respectively. Wherever they are deployed they demonstrate the viability of hydrogen trains to provide a suitable alternative to longer range diesel trains on non-electrified regional railways. As well as being environmentally friendly, hydrogen trains are also proven to be much smoother and quieter, with improved reliability, for passengers.

Building on this proven innovation, Alstom and Eversholt Rail have developed the "Breeze" hydrogen train conversion in the North West of England, in order to adapt hydrogen technology to the challenges of the unique UK rail environment. The design work has taken place over the last two years and together this summer we committed a further £1M of investment to the development programme in order to undertake a programme of 'Advance Works' to develop further the key areas of the train design, progress the safety and approvals activities associated with fleet introduction and thereby maintain programme momentum in anticipation of receiving the first fleet order. As part of this process, the trains have been registered as Class 600 Breeze Hydrogen Multiple Units (HMUs), the first in the "6xx" series of trains, a class for future alternative energy trains.

The reason we have carried on with this work, and continued to invest without any external support, is because of our belief that this technology will be crucial to achieving the objectives that have been set for the railways of the future. The benefits of hydrogen should be brought forward to the UK network as soon as possible which is why we have moved quickly to ensure our programme is "shovel ready". We stand ready to deliver the UK's first hydrogen train fleet as soon as we have the green light from Government – creating hundreds of jobs in Widnes and the Tees Valley, where the first project is proposed to be deployed, with more to follow elsewhere with additional fleets.

The UK has a real opportunity to lead the world in the development of hydrogen train technology, technology suitable for many heavy transport applications: creating thousands of green jobs and reducing harmful emissions. If we act swiftly, Alstom will play a key role in establishing the UK as a technology led, industrial centre for the supply of hydrogen equipment.

**3. The engineering and commercial challenges associated with using hydrogen as a fuel, including production, storage, distribution and metrology, and how the Government could best address these;**

Government investment is urgently needed to stimulate demand for the trains that would consume the hydrogen: reducing harmful emissions and creating jobs, growth and exports. The demand created for the equipment fitted to the trains (and other heavy vehicles in due course) would allow the supply chain in the UK to grow and set down roots meeting this domestic demand. Based on that demand, they could reach out to export to meet demand around the world. Here in the UK, hundreds of hydrogen trains would be required to replace just half of the existing UK regional diesel fleet consisting of around 2,400 carriages typically formed into one, two and three car trains. In Europe, around a further 6,000 diesel powered trains will require replacement, and globally many more, generating potential markets measured in billions of pounds.

Alstom and Eversholt Rail Group have already invested over £2.5 million in the Breeze hydrogen train project, which will stimulate demand for hydrogen production and hydrogen technologies.

4. **The infrastructure that hydrogen as a Net Zero fuel will require in the short- and longer-term, and any associated risks and opportunities;**

The biggest challenge to the deployment of alternative fuelled rolling stock is the provision of the fuel. By definition, the fuel is "alternative" and therefore a supply chain and delivery infrastructure is lacking. While the specific infrastructure may not be particularly complicated, whether the requirement is for hydrogen or for charging points for batteries, neither currently exists. Over 70 years a supply network has been developed for diesel in the rail sector which is further reinforced by its widespread use in other sectors.

It therefore follows that with each deployment of an alternative fuelled train fleet, a dedicated fuelling facility(ies) is required. This adds cost and complexity to a deployment (but not to successive replacement fleets in future) and necessitates closer sectoral integration with the energy sector. For example, the scale of hydrogen production needed for rail and wider transport is significant. As a train fleet is a large-scale consumer of hydrogen, it can help catalyse the wider hydrogen economy in the region it is deployed. As more train fleets are deployed, hydrogen facilities can be created specifically for them and the problem eases, creating a network that would eventually replace the existing network of diesel storage and dispensing facilities around the country with the additional environmental benefits to the storage sites.

However, in the longer term, dedicated facilities may not prove to be the most cost effective or necessary if some of the visionary schemes to replace hydrogen in the gas mains such as Hynet or H21 come to fruition. Other planned projects, creating off-grid green hydrogen production capacity could also be harnessed to feed into transport hubs using road or rail tanker supplied hydrogen.

Despite some potential short-term difficulties when creating the infrastructure needed for hydrogen production and distribution, we believe that in order for the UK to become a world leader in this sector and generate billions of pounds worth of investment, it is well worthwhile.

5. **Cost-benefit analysis of using hydrogen to meet Net Zero as well as the potential environmental impact of technologies required for its widespread use;**

The Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) and Shift2Rail's 2019 report compared predicted comparative costs of diesel, hydrogen and catenary powered trains. They concluded that in Total Cost of Ownership terms over the life of the trains, costs were comparable for all three types. Their analysis was based on a range of assumptions more directly applicable in Europe than in the UK (not least duty paid diesel prices and European costs for electrification) but it illustrates how, even at today's prices, hydrogen can be competitive with other, existing modes. Electrification works best for mainline, high speed routes or where very high capacity commuter trains require significant amounts of energy, but it is much less attractive on less trafficked regional routes. In these areas it is expensive and disruptive to install and maintain compared to the cost of a hydrogen powered fleet. Therefore, we believe that as a fuel to power regional rail routes, hydrogen is cost-effective fuel alternative.

Alstom believes that Government investment into the Breeze hydrogen train project, and in hydrogen production more widely, will help the UK to become a world-leader in the hydrogen sector.

With that in mind, Alstom encourages the Government to initiate a ten-year hydrogen train programme to deploy 300 to 400 hydrogen trains on the network with more to follow. A 300–400 train deployment, including supporting infrastructure, could be a financed solution with no significant initial government capital cost. Trains can be leased through the familiar system in place. The fuelling infrastructure can then be similarly financed. Such a commitment would link to the forthcoming UK Hydrogen Strategy and focus the sector on a green recovery. Hydrogen provides a ready source of skilled, green jobs, the majority of which will be in the North of England in locations including Derby, Widnes and Manchester.

As has been seen before, Capex works well to incentivise R&D, but when applied to projects without additional OpEx support, it encourages the building of white elephants. It is better that government encourages private capital investment in the trains and infrastructure through OpEx subsidy in the form of market support mechanisms in a similar fashion to that seen in the renewables energy sector where incentives such as ROCs (Renewables Obligations Certificates) to build capacity followed by CfDs (Contracts for Difference) have been used to encourage cost reduction. This is a more effective use of public funds and would help to grow what must ultimately become a privately funded industry, at least to a similar extent to which regional railways currently achieve cost effectiveness with diesel traction. Proposed changes to the evaluation of business cases by HMTreasury should also be evaluated and adapted to ensure that carbon efficiency and long term modal transport and energy shift are suitably valued when making funding decisions.

**6. The relative advantages and disadvantages of hydrogen compared to other low-carbon options (such as electrification or heat networks), the applications for which hydrogen should be prioritised and why, and how any uncertainty in the optimal technology should be managed.**

At Alstom, we believe that transport is an ideal sector in which to invest into low-carbon fuel solutions. In rail terms, it is our expectation that trains fit for the future will be electric trains powered from overhead wires, batteries or hydrogen as appropriate to each route. We fully support an ambitious rolling programme of electrification, but expect it will be deployed to a less ambitious extent than forecast in Network Rail's recent Traction Decarbonisation Network Strategy Interim Business Case (TDNS) and passenger deployment of hydrogen in particular will be significantly greater than initially forecast. These trains will all be clean, safe and efficient means of transport developed to attract passengers and serve their needs in a manner that almost passes unnoticed and unquestioned. We are ready and able to provide such trains and to support each with the relevant infrastructure that they require, starting now.

Around 29% of the UK rail fleet is powered by diesel, less than 40% of the network is electrified, and 2,500 aging diesel powered carriages, with no emission controls, need to be replaced over the next decade. While diesels contribute to toxic air, hydrogen trains emit just pure water and Hyundai has even demonstrated how air filtered for supply to the fuel cells in their cars actually emerges cleaner than when taken in - effectively cleaning the atmosphere. Hydrogen trains also have wider passenger benefits including a quieter and smoother ride than a diesel. To all intents and purposes a hydrogen train is an electric train from a passenger experience perspective.

Other alternative fuels may emerge in the future but at the present time, hydrogen is the only viable path for a zero emission, mid to long range, self-powered, alternative to diesel on the regional railway. Batteries, despite the huge investment in their development in recent years, are limited to short range extension duties of up to around 50 miles due to their low energy density, heavy weight and large size. Alstom calculated that a battery that could provide equivalent performance to the hydrogen drive on its German trains would have weighed about 33 tonnes, eliminating the capacity to carry passengers.

Electrification is the other, obvious solution to decarbonise rail. Electrification works very well on mainline, high speed routes or very high capacity commuter trains requiring significant amounts of energy, but it is less attractive on the less trafficked regional routes.

Electrification, plus the new trains needed to run with it, is expensive compared to the cost of a hydrogen powered fleet. Hydrogen fuel cell power offers significant benefits over batteries for fuelling times. Filling time is comparable to diesel whereas battery charging takes considerably longer – even for a 50 mile range. Hydrogen trains have lower range than diesels and so require refuelling daily, hence the need to integrate hydrogen production and refuelling. So, hydrogen performance comparators are diesel, cost comparators are electrification plus trains.

Given the success of hydrogen trains in Europe, we believe the Government should prioritise investment in UK hydrogen train technology. In so doing, the UK can become a world leader in that market, stimulating more investment and jobs, particularly in the North of England, Scotland and Wales, which will in turn support the Prime Minister's levelling up agenda.

***(January 2021)***