Written Evidence Submitted by Porterbrook

(HNZ0007)

1 Introduction

1.1 Porterbrook is pleased to respond to this important Science and Technology Committee Inquiry into hydrogen's role in achieving net zero by 2050

1.2 We recognise the aspiration to drive the growth of low carbon hydrogen in the government's 'ten-point plan for a green industrial revolution' through the £240 million allocated for a 'net zero hydrogen fund.' We welcome the recent acknowledgement from the government in the energy white paper that 'whole-life cost solution(s)' are the optimum approach to decarbonising rail as the country moves towards net zero by 2050

1.3 Porterbrook has been exploring alternative power sources for self-powered trains, which cover battery based and hydrogen fuel cell powered bi-mode units for a number of years

2 About Porterbrook

2.1 Porterbrook has been at the heart of the UK rail network for over 25 years and owns almost a third of the national passenger rail fleet. Our rolling stock supports around 1.5m passenger journeys and travels over a million miles a day when the railway operates at full capacity

2.2 We currently have over 4,500 vehicles on lease or on order. Since privatisation, we have invested £3bn in 2,500 new passenger and freight vehicles, and we are looking to invest c£1bn in UK rail in the coming years

2.3 Our role as a leading asset owner and manager goes well beyond financing. As a long-term custodian of Britain's rolling stock, we take a 30-year view of assets that optimise value to passengers, taxpayers and the environment

2.4 Innovation is at the heart of Porterbrook's whole life asset management approach. In collaboration with our industry partners, we are constantly looking ahead to anticipate future needs and proactively develop our rolling stock assets. Last year we introduced HydroFLEX, the UK's first hydrogen-powered train, in partnership with the University of Birmingham

2.5 We are committed to supporting and developing the UK rail supply chain. We trust 100+ UK-based companies to maintain and upgrade our assets, investing over £100m each year and supporting c.7,000 jobs

2.6 Porterbrook employs 150 people of which three quarters are engineers and project managers. In addition, over a third of Porterbrook's workforce is female including a number of our executive team which compares favourably to the UK rail industry average of 16%

3 Key points in response to the consultation

3.1 UK government policy is for the country to be net carbon zero by 2050. It's widely accepted that rail is a low-carbon form of transport with passenger and freight services responsible for just 1.4% of the UK's domestic transport emissions in 2018. The Westminster government has set a target of 2040 for diesel trains to be removed from the network

3.2 Carbon emissions from rail are reducing both from new trains coming into service and longevity benefits arising from existing fleets being more sustainability maintained and refurbished. Emissions from both diesel trains and electricity generation per rail passenger kilometre in 2018-2019 fell by more than 10% from the same period in 2017-2018

3.3 In March 2020, the government published a draft transport decarbonisation plan in which it recognised that electrification is the optimum high-level strategy for decarbonising the network. Rail electrification delivers better performance, lowers fuel costs and can reduce carbon dioxide and nitrogen dioxide emissions which provide improvements for both the environment and air quality

3.4 This view was reaffirmed in the government's Energy White Paper which was published in December 2020 which states that 'for areas of the rail network with significant freight flows or long-distance high-speed services, electrification is a proven technology that is able to support these service types. Analysis suggests that electrification may also be the best whole-life cost solution for more intensively used areas of the network. Away from these areas of operation the deployment of emerging technologies such as battery traction and hydrogen rolling stock on both an interim and permanent basis may offer alternative solutions to help in achieving decarbonisation of rail at a lower cost'

3.5 We note that the Committee on Climate Change's 6th Carbon Budget and path to Net Zero were also published in December 2020 which quantify rail's contribution to achieving the UK's long-term decarbonisation objectives particularly reaching net zero in surface transport. The CCC asserts that total passenger rail traffic should grow to 58% above today's levels by 2050 ("today" being understood as pre-covid) and that total rail freight hauled should grow to 9% above today's levels by 2050

3.6 The Committee also sets out an assumption that the rail network is steadily electrified at a rate of 200 km/year which would take the electrified proportion of the network to 55% by 2050. The CCC also projects that all diesel trains are removed from category A passenger routes by 2035 and from all passenger routes by 2040. By 2040, most new passenger trains are electric (68%) or battery-electric (26%) with smaller roles for diesel-electric and hydrogen

3.7 It is therefore clear that future rail energy requirements will be determined both by the electrification strategy and the profile of individual routes. Network Rail plans to electrify long-distance, inter-city, high-speed passenger and freight services. Such a rolling and incremental approach to electrification can be supported and enhanced by alternative traction and self-powered trains which will bring passenger benefits forward more quickly

3.8 Network Rail's Traction Decarbonisation Network Strategy (TDNS) has estimated that to achieve traction decarbonisation of the more than 15,000 single track kilometres (STKs) of unelectrified network the following is necessary:

- an additional c. 11,300 STKs of electrification is required for long-distance high-speed passenger and freight services;
- hydrogen train deployment over c. 900 STKs of infrastructure;
- battery train deployment over c. 400 STKs of infrastructure; and
- there are 2,400 STKs where a single technology choice is not immediately clear.

3.9 In addition Network Rail has identified the North of Scotland, Teesside and East Anglia as areas where hydrogen traction could be rolled out

3.10 Many private sector businesses including Porterbrook want to support the government's ambition for the UK to be a leader in low carbon rail and green jobs while aiding the post-Covid-19 economic recovery

3.11 We have long recognised the potential for hydrogen power to significantly extend clean operation on long-distance, non-electrified routes which led us to develop and launch HydroFLEX, the UK's first hydrogen-powered train

4 Background to HydroFLEX

4.1 To tackle the decarbonisation challenge, Porterbrook has been exploring alternative power sources for self-powered trains, which cover battery based and hydrogen fuel cell powered bi-mode units. These are currently being designed as retrofits to existing fleets, to ensure utilisation over full asset life, thereby reducing the carbon impact of producing new fleets to replace non-life expired rolling stock. Elsewhere, the University of Birmingham has led research into how fuel-cells and hydrogen can act as a source of power for rolling stock

4.2 In 2018, Porterbrook and the University of Birmingham entered into a partnership to develop and deliver HydroFLEX. The project has been a powerful and effective collaboration between the private sector and academia to deliver innovation

4.3 Porterbrook provided the train, fuel cell and engineering staff while the University of Birmingham supplied staff and specialist research skills. With a challenging timescale to achieve, joint project directors from both the University and Porterbrook were appointed and integrated teams of management, engineering, research and supply chain contacts were put together

4.4 Work on HydroFLEX commenced in November 2018 and initial concepts led to detailed design and manufacture. As part of the approach to building a demonstrator vehicle, the fuel cell, battery, hydrogen storage tanks and other related equipment are housed in the motor vehicle

4.5 The creation of a 'lab in a train' fulfilled two functions. From a production perspective it enabled the team to refine their traction system controllers in a suitable environment, and accelerate the engineering required to develop the traction system for full mainline application. It also allowed industry stakeholders and media attending Rail Live in 2019 to enter the 'Hydro-chamber' and view this alternative power source whilst gaining confidence that any risks could be safely mitigated and effectively managed

5 Realisation of HydroFLEX

5.1 Hydrogen is zero carbon at the point of use, the only emissions being water vapour. Currently, hydrogen used by HydroFLEX is created as a by-product of chemical processes, but hydrogen can be generated from water utilising off peak renewable energy, making it carbon free. It also offers similar refuelling times to diesel

5.2 Hydrogen is very lightweight but also requires a larger volume to have a similar range to diesel. This low energy density doesn't make hydrogen suitable for long-distance high-speed intercity trains, or heavy freight trains. For these types of journey clean diesel hybrid trains or electrification are the best option

5.3 HydroFLEX is fitted with a 100kW fuel cell with a 100kWh battery bank with which the train is self-propelled and can operate away from the overhead wires. The train is a working prototype, allowing both organisations to learn about the hydrogen powertrain and develop improvements. The train has been testing at Quinton Rail Technology Centre at Long Marston.

5.4 The fuel cell converts hydrogen stored in tanks on the train and oxygen from the atmosphere into electricity and water. The electricity can be used to charge the battery, or to power the train. The power from the battery is used to satisfy the peak power demand of the train, with the fuel cell filling in and recharging the battery. The water produced is a by-product and is exhausted from the vehicle either as water vapour or in a condensate drain to track

5.5 This solution enabled vehicles, emission-free at the point of use, to run on the non-electrified network. Importantly, moving to a fuel cell system with a more direct conversion from chemical to electrical energy immediately enables higher efficiencies compared to combustion, and solves the problem of producing by-products of combustion such as greenhouse gases and NOx

6 Next Steps

6.1 Looking beyond the prototype HydroFLEX, Porterbrook has also commissioned a feasibility study from the University of Birmingham into the potential configuration and recommended design of a production unit of the train

6.2 A further collaborative research project with Porterbrook is focusing on feasibility testing, and concept design for the world's first bi-mode electric/hydrogen train and other projects, including new train production and design specifications

6.3 We are looking at further innovations such as using hydrogen electrolysers, to deliver a new hydrogen refuelling plant at Long Marston. We are also looking at further potential uses for HydroFLEX's fuel-cell and batteries

6.4 With funding from Innovate UK, Porterbrook and the University of Birmingham HydroFLEX began testing onto the mainline network in September 2020 which made it the first hydrogen powered train to travel on Network Rail's network. The train achieved a speed of 50mph

6.5 Going forward, a feasibility study has been commissioned with the University of Birmingham to examine the potential configuration and recommended design of a production unit of the train. A further collaborative research project is exploring concept design for the world's first bi-mode electric/hydrogen train and other projects, including new train production and design specifications

6.6 To date, Porterbrook has invested around £1 million in the development of HydroFLEX. Our ambition is to invest more should the right commercial opportunity be brought forward underpinned by a clear regulatory framework

7 HydroFLEX video

7.1 A HydroFLEX video can be found here

8 Conclusion

8.1 We are grateful for the opportunity to contribute to this inquiry and hope our comments give the committee a sense of the potential role hydrogen-powered trains can play in decarbonising the rail network by 2040 and the longer terms objective of reaching net zero by 2050. We look forward to further direction from government on precisely where it sees a role for hydrogen-fuelled trains on the UK rail network

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