Written evidence submitted by Ballard Power Systems Europe A/S (EVP0042)

1. About Ballard Power Systems Europe A/S

Ballard Power Systems Europe A/S is recognized as one of the leading players in the commercial application of fuel cell power solutions. Founded in January 2007, Ballard Power Systems Europe A/S is a wholly owned subsidiary of Ballard Power Inc. Headquartered in Hobro, Denmark, activities are focused on three key business areas:

- Heavy duty mobility (bus, truck, marine and rail)
- Critical Infrastructure (back-up power solution)
- European Service Centre

Ballard are the primary supplier of hydrogen fuel cell modules for current and previous fuel cell electric bus demonstrations in the UK.

2. Executive Summary

This submission concentrates on zero emission hydrogen fuel cell applications. The UK is already a leader in deploying hydrogen fuel cell electric buses and the hydrogen technology must be used for heavy duty goods vehicles, a sector where there is little penetration with zero emission.

Outlined in the submission are areas where the government could invest in hydrogen fuel cell buses that will stimulate further deployment in the heavy duty sector.

The UK has been instrumental in the demonstration of fuel cell buses, so the knowledge of how to operate heavy duty fuel cell vehicles already available. From hydrogen fuel cell buses progressing on to heavy duty goods vehicles, a path is made to using the fuel cell technology in other heavy duty applications such as marine and rail.

3. Introduction

The UK has had an interest in hydrogen for many years and is at the forefront of hydrogen fuel cell technology demonstrations. This is particularly true in bus projects where the first double deck hydrogen fuel cell electric buses have started to be deployed in Aberdeen.[1] Because of the many projects that have taken place and the continuing developments means that hydrogen fuel cell buses are now at the commercialisation phase.

Now there is an emphasis on climate change and air quality, this has cumulated in the release in November 2020 of the Government's Ten Point Plan for a Green Industrial Revolution. Transport is an obvious sector to be the first to transition to zero emission where hydrogen, especially in heavy duty vehicles, will be the primary choice for zero emission.

There have been a number of projects, including UK Hydrogen Mobility project, that have laid the foundation stone for a hydrogen transport system.[2] It is our opinion that the place to start in creating a hydrogen transport system is with heavy duty vehicles, first buses then leading on to trucks, particularly refuse collection vehicles (RCV) and other specialist trucks where the service is back to depot enables centralisation of fuelling infrastructure. Long haul

truck, trains and the marine environment also present excellent opportunities for creating a zero emission transport system where hydrogen fuel cell technology will perform the major role.

4. **Hydrogen Technology in Transport**

There are only two zero emission transport options available today, battery electric vehicles (BEV) and hydrogen fuel cell electric vehicles (FCEV). BEVs and FCEVs have fundamentally the same architecture, the only difference being that BEVs have their source electricity from the national grid, FCEVs generate their own electricity using hydrogen as the energy source. When spoken about, especially in the media, the term 'electric vehicle' generally refers to BEVs whereas both types of vehicles are electric. Policy and opportunities are often created around BEVs, for example, the electric bus town scheme all but excluded FCEVs.[3] At the Transport Committee on the 24th June 2020 the Secretary of State for Transport, Grant Shapps, stated there would be a hydrogen bus town but the detail has not yet been announced.

With the current technology there are severe restrictions on the range of BEVs. For most passenger car journeys this is not an issue as the majority of daily use is short allowing for overnight charging at home. However, for heavy duty applications range, charging or fuelling time are vital factors in continuing a service that matches diesel. Another major issue when running a fleet of heavy duty BEVs is the amount of power that is required for charging. For large fleets this can go beyond the grid capacity available nearby.

FCEVs do not suffer from the range anxiety of BEVs and once the infrastructure is in place, fuelling is undertaken in minutes at fuelling stations similar to current fossil fuel vehicles. Unfortunately, hydrogen fuelling infrastructure is currently not widespread. Government investment is required to kick start the hydrogen economy, first to get back-to-depot heavy duty operations, such as buses and RCVs, deployed. This will start the hydrogen fuelling infrastructure network and reduce costs so removing barriers to a net zero carbon UK. This would then stimulate further growth in the heavy duty goods vehicle deployment of zero emission fuel cell vehicles and would spread in to other transport sectors such as rail and marine.

5. **Green or Blue Hydrogen**

Any future use of hydrogen for transport must be either blue or green enabling a zero emission well to wheel operation.[4] Green hydrogen using electrolysis of renewable electricity is the long term desired source of hydrogen, but the majority of hydrogen today is produced for 'industrial' use utilising steam methane reforming (SMR) that does have a CO2 footprint. Carbon capture and storage (CCS) technology can be employed to create low carbon 'blue' hydrogen, therefore still being able to utilise the current hydrogen production set-up.

6. Decarbonising Buses with Hydrogen Fuel Cell

6.1 UK Hydrogen Fuel Cell Bus Experience

The UK has a proven track record on the operation of hydrogen fuel cell buses dating back to early 2002 with the HyFleet:CUTE project in London.[5] Since then London has been involved in running 10 hydrogen fuel cell buses in full daily service since 2011 as part of the CHiC and 3Emotion projects.[6] In these projects, co-ordinated by Transport for London (TfL), the buses ran in normal revenue service. The operator, Tower Transit, undertook all the maintenance by upskilling diesel technicians to full hydrogen fuel cell bus technicians. All fuelling infrastructure was on site at the Lea Interchange depot making the process of operating a bus the same as that of a diesel, therefore a drop-in replacement.

Other projects in Aberdeen, HyTransit and High V.LoCity, have also been operating 10 hydrogen fuel cell buses since 2015, again in normal revenue service.[7] These buses were split between two operators, First and Stagecoach with the project co-ordinated by Aberdeen City Council.

Just being delivered and starting operation are the next group of hydrogen fuel cell buses. There are plans for 72 buses as part of the JIVE and JIVE2 projects in London, Aberdeen, Birmingham, Dundee and Brighton and Hove.[8] Also there are 25 fuel cell buses planned in Liverpool plus three in Belfast.[9]

When all these buses enter service, the UK will be one of the leading operators of hydrogen fuel cell buses in Europe.

Finally, the H2Bus Europe consortium aims at deploying 200 buses in UK out of a total of 600 buses to be deployed in elsewhere Europe.[10]

6.2 Challenges to Decarbonising Buses

Decarbonisation of buses is one of the most successful of transport decarbonisation projects. In the UK there are a number of routes that have taken up the option of battery electric buses (BEBs) and there are a number of cities introducing hydrogen fuel cell electric buses (FCEBs). However, the adoption is ad hoc. There are a number of bus operating companies that have committed to decarbonising their fleet in a relatively short time frame and a number of cities are introducing clean air zones (CAZ) but there are few companies or cities that have a definite plan to achieve zero emission.

6.3 Rapidity of Change

Buses in the UK typically have a life of 15 years. So, of the 30,000 buses in operation in the UK, there are many buses in service that are not scheduled to be replaced until the 2030's. Many of these buses would already have the cleanest Euro6 diesel technology. To remove these buses from service before the end of their life require subsidies. It must also be noted that many buses that are taken off the road before their end of life are put in to the second hand market so could continue to run for a number of years. Care must be taken not to pass the carbon problem on.

6.4 Cost

Made worse following the COVID crisis, bus operating companies are extremely conscious of the cost of converting to zero emission vehicles. This includes the fuelling infrastructure that is required to be installed. Bus operators are looking for any subsidies and grants that are available to assist them to transform to zero emission.

Schemes like H2Bus Europe available in the UK can bring the price of a fuel cell bus to commercial rates.

Both capital cost and operational cost are falling and will continue to fall dramatically with the mass uptake of fuel cell buses. In a Deloitte/Ballard report it concludes following a comprehensive total cost of ownership (TCO) analysis that it will become cheaper to run a FCEV than a BEV of an internal combustion engine vehicle for commercial vehicle applications.[11]

6.5 Technology Choice

Currently, there are two choices for a zero emission bus, either BEB or FCEB. Both drivelines are hybrid electric so have an electric driveline, but BEB carry the stored energy and is recharged at a charging terminal and a FCEB uses hydrogen in a fuel cell to generate the electricity on board. But there are major differences between the two technologies especially with the range and the time required to refuel. Making the wrong decision on the technology for the zero emission bus for the require route or service could have serious implications that will have a long lasting implication. Especially given the 15 year life of the bus.

The technology choice must be made with further zero emission deployments in mind. There may be factors, such as an unwillingness to mix technologies at the same depot, that may need to be taken into account.

Many bus operators are concerned that if they are a first mover that they could potentially make the wrong decision when choosing a zero emission technology. So many operators are looking to see results of trials before taking the decision on a zero emission vehicle type. However, as there are numerous deployments of both BEBs and FCEBs across the UK and Europe this should no longer be a consideration. Zero emission buses are available and practical now.

6.6 What Should Government do to Boost the FCEB take up?

To boost FCEB deployment, the government or local authorities should not be deciding on a technology when offering future grant schemes. This should be left to the industry and engineers to make the decision on what technology, FCEB or BEB, is best to create a zero emission fleet.

Subsidies and grants are required to that any new purchases of buses are zero emission closing the gap between the cost of a diesel bus and that of a zero emission bus. Fuelling

infrastructure also cannot be ignored. The amount of subsides required for zero emission buses will reduce substantially as the numbers rise.

The Secretary of State for Transport announcement that there would be a hydrogen bus town must be acted upon. This innovation would not only give the FCEB industry a boost in the UK, but the benefits would stretch in to other transport sectors, such as heavy duty goods vehicles.

7. **Phase Out of the Sale of Diesel Heavy Duty Vehicles**

Trucks and haulage is an area that has currently had little penetration in decarbonising in the UK, but where hydrogen fuel cell will play a major part. With the same issues as buses, range, time to refuel as well as payload are all areas that will be compromised if a battery version is used. Long haul trucking will require a fuelling infrastructure, particularly along major corridors. However, back to base operation can easily be converted to a zero emission operation using hydrogen using the lessons learnt from the FCEB experience. Particular areas of interest would be vehicles such as refuse collection vehicles (RCV) as they require an all-day service, then have to travel to a disposal site that can be some distance away with a heavy payload, then return to base where they can be fuelled, cleaned ready for the next days' operation.

For a zero emission heavy duty operation that is not back to base a network of fuelling infrastructure is required. If hydrogen fuel cell is adopted, this would be a series of fuelling stations potentially along the main corridors such as motorways and trunk roads.

7.2 Specialist Vehicles

Where hydrogen fuel cell can make a quick and immediate impact is in the adoption of specialist vehicles such as emergency services or refuse collection vehicles(RCVs). Battery electric versions would struggle to deliver the high power service requirements of these vehicles. In the case of the emergency service vehicles such as the fire appliances and ambulances, recharging of a BEV would not allow the quick turnaround required. Being back to base operations, the fuelling infrastructure would be centralised and could even be shared with other operations such as bus.

Governments and local authorities have more direct influence on the vehicles chosen for public service tenders so it is simple to specify that a hydrogen fuel cell vehicle must be used.

8. **Benefits**

With previous hydrogen fuel cell vehicle projects, particularly buses, the UK is one of the world leaders in hydrogen transport technology, deployment and operation.

Already outlined in the Ten Point Plan for a Green Industrial Revolution, the production of both green and blue hydrogen will be stepped up. This stimulus that this would create will 'kick start' a whole hydrogen economy where an immediate beneficiary should be heavy duty transport. It will be quick to move projects from concept to reality, going from buses to HGVs then rail and marine.

Alongside making UK companies world leaders in hydrogen technology there are potentially huge societal benefits:

- A zero emission well to wheel bus operation reducing greenhouse gases and improving air quality.
- Attract investment into the hydrogen and fuel cell industry.
- A larger workforce will be required so there will be job creation.
- An upskilling of workforce will be required including for manufacturing, service and maintenance jobs.
- An easy transition to other forms of heavy transportation, marine and rail.
- The UK hydrogen and fuel cell eco-system will become more competitive leading to export opportunities.
- UK leadership for climate action and the use of hydrogen in the decarbonisation of our economy.

9. **Conclusion**

The deployment at scale of FCEBs is the opportunity to create jobs and value in the UK with zero emission vehicles which are a direct replacement of diesel buses with no compromise on operational service.

From the leading knowledge already gained in the deployment of FCEB the technology can easily be migrated in to the heavy duty goods vehicle market, a market that is not yet well developed with zero emission vehicles.

The UK is in an ideal position to use the hydrogen industry as a catalyst to achieve the greenhouse gas emission targets, improving air quality and boosting the economy post COVID-19.

Further deployment of fuel cell electric buses will strengthen the UK hydrogen eco-systems, generate export opportunities and drive down cost for hydrogen fuel paving the way for the deployment of fuel cell trucks, marine vessels and trains which have a larger impact on the UK transport sector emissions.

February 2021

10. **Notes and References**

[1] https://news.aberdeencity.gov.uk/worlds-first-hydrogen-double-deckers-to-start-their-routes-tomorrow-in-aberdeen/
[2] http://www.ukh2mobility.co.uk/about/
[3] https://www.gov.uk/government/publications/apply-for-the-all-electric-bus-town-scheme
[4] Well to wheel is from the source of the fuel to the exhaust pipe.
[5] https://www.fuelcellbuses.eu/wiki/history-fuel-cell-electric-buses/hyfleet-cute-2006-2009
[6] https://www.fuelcellbuses.eu/projects/chic
https://www.fuelcellbuses.eu/projects/3-emotion
[7] https://www.fuelcellbuses.eu/projects/hytransit https://www.fuelcellbuses.eu/projects/high-vlo-city
[8] https://www.fuelcellbuses.eu/projects/jive

https://www.fuelcellbuses.eu/projects/jive-2

[9] https://www.alexander-dennis.com/media/news/2019/march/liverpool-city-region-launches-64m-hydrogen-bus-project/

https://www.translink.co.uk/corporate/media/pressnews/hydrogenbuscontract

[10] https://www.h2bus.eu/

[11] https://info.ballard.com/deloitte-vol-1-fueling-the-future-of-mobility