Ballard Power Systems Europe A/S

Submission to Environmental Audit Committee

Technological Innovations and Climate Change: Hydrogen

Ballard Power Systems Europe A/S
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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 have been the primary supplier of hydrogen fuel cell modules for previous fuel cell electric bus demonstrations in the UK.

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3. Executive Summary

Post COVID-19 the UK must incentivise industry to create an environment for long term economic recovery while meeting net-zero targets. Hydrogen is required to meet those ambitious objectives and accelerate transition towards

zero emission mobility. We would recommend focusing on transport applications where hydrogen and fuel cell technologies deliver the most attractive value proposition, such as heavy duty vehicles particularly buses, but also are ready for deployment at scale. Hydrogen buses is one of those applications where:

- The UK already has extensive experience and is leading fuel cell bus deployments in Europe.
- Vehicles are ready and commercially available with a total cost of ownership competitive with other zero emission options.
- There is a mature local supply chain from vehicle manufacturing to hydrogen production and distribution.
- Hydrogen industry can kick start with £500million investment in fuel cell electric buses and infrastructure.

This document sets out how the UK government can be the catalyst to accelerate a potentially thriving business to assist the post COVID-19 economy, improving air quality and achieving the UKs greenhouse gas reductions.

4. Introduction

The UK has had an interest in hydrogen for many years, yet this has always been at the prototype or demonstration stage. However, this has resulted in many projects and developments that mean hydrogen vehicles are now at the commercialisation phase.

In recent years there has been an emphasis on climate change and air quality. Although different in aim, the solution to both is a net zero emission system. Transport is an obvious sector to be the first to transition to zero emission where hydrogen, especially in heavy duty vehicles, will be a choice for zero emission.

There have been a number of projects, including UK Hydrogen Mobility Programme, that have laid the foundation stone for a hydrogen transport system. 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, e.g. refuse trucks, where the service is back to depot to enable centralisation of fuelling infrastructure.

5. 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 by government and in the media the term ‘electric vehicle’ refers to BEVs where both types of vehicles are in fact electric. Policy is also created around BEVs, the recently announced electric bus town scheme all but excludes FCEVs.[i]

But, with current technology there are restrictions on the range of BEVs. For most car journeys this is not an issue as the majority of daily use is short allowing for overnight charging at home. However, this model assumes that there is the ability to charge at the home and in the UK, with the prevalence on on-street parking this is not always the case.

FCEVs do not suffer from the range anxiety of BEVs and once the infrastructure is in place fuel in minutes at fuelling stations similar to current fossil fuel vehicles. Unfortunately, fuelling infrastructure is currently not widespread. That is why investment in back-to-depot heavy duty operations, such as buses and refuse trucks , is an ideal place to invest and kick start the hydrogen economy that would spread into other sectors, reducing cost and bringing down barriers to a net zero carbon UK.

6. 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. [ii] 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.

7. Back to Depot Heavy Duty Operations

Back-to-depot operations solve the requirement to have a network of hydrogen fuelling infrastructure. For an operation such as buses and municipal truck fleets only a depot infrastructure is required which is simple to manage. There is no need for a regional or national hydrogen refuelling network to be in place for a viable operation.

8. UK Hydrogen Fuel Cell Buses

8.1 UK Hydrogen Fuel Cell Bus Experience

The UK has a track record on the operation of hydrogen fuel cell buses going back to early 2002 with the HyFleet:CUTE project in London.[iii] 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.[iv] 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.[v] These buses were split between two operators, First and Stagecoach with the project co-ordinated by Aberdeen City Council.

In late 2020 and 2021 there are plans for 72 buses as part of the JIVE and JIVE2 projects in London, Aberdeen, Birmingham, Dundee and Brighton and Hove.[vi] Also there are 25 fuel cell buses planned in Liverpool plus three in Belfast.[vii]

When these buses enter service, the UK will be the leading operator 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.[viii]

8.2 UK as a World Leader

With previous and current projects, it shows that the UK is already among one of the leaders in hydrogen mobility technology. There are UK companies that provide a complete eco-system for the adoption of hydrogen fuel cell buses. Three UK bus manufacturers have shown a commitment to fuel cell buses, Wrightbus, Optare and ADL. There are UK integrators with companies such as Arcola Energy and green hydrogen suppliers with Ryse, ITM Power and BOC/Linde.

8.3 So What is the Bottleneck?

8.3.1 What comes first?

Hydrogen is poised to make a large contribution to the future reduction of greenhouse gas emissions and improvements in air quality and is needed to achieve decarbonisation of transportation especially for difficult to abate applications like heavy duty vehicles. The battery electric is the most publicised and currently promoted method of decarbonisation. This is not feasible in many industries and this is true for a large sector of transport, namely heavy duty due to:

- Restricted range.
- Long charging times (impact vehicle utilization).
- Payload reduction due to the batteries weight.
- Drainage on power and energy storage due to heating or air conditioning requirements.

While the hydrogen fuel cell is already proven to be an alternative zero emission option, it is not being taken up on a wide scale. Hydrogen and fuel cell vehicles go hand in hand, the one needs the other to scale, become successful and competitive. In the UK we have both parts of the industry well represented and a golden opportunity to create a strong local zero-emission value chain and enabling export opportunities.

8.3.2 Bus Operator Investment

Even before the COVID-19 epidemic, the privatised bus industry has difficulty in justifying the extra investment for zero emission buses. Currently, most low emission schemes have support through Office for Low Emission Vehicles (OLEV) or backed by a public transport authority. The result has been a preference for battery electric buses (BEB) rather than hydrogen fuel cell electric buses (FCEB) due to the initial lower capital cost of BEB and the seemingly easier transition to electric infrastructure. True on a small scale, but not on a large scale when the overnight demand exceeds the depot capacity and space availability, so expensive improvements to a depot supply is required or the power supply may simply not be available. There is another issue with BEB as the main adoption of zero emission buses, there is a reliance on China that has over 70% of lithium cell manufacturing capacity.[ix] Most battery electric buses originate from China. By the UK buying in this technology there is a flow of money out of the UK. Fuel cell systems are currently produced in Europe and large scale deployment of FCEB will incentivize companies like Ballard to invest in the production of fuel cell systems for buses and trucks in the UK.

8.4 Solution

If there was a subsidy to the bus operators to replace their diesel fleet with FCEB, UK original equipment manufacturers (OEMs) will be able to produce FCEB in large numbers, bringing the price down and preparing them for a competitive product on the world market.[x] Also, UK suppliers of green hydrogen would have demand to further reduce the price to diesel parity or below. The demand of hydrogen would be enough that it would be an incentive for industry to invest in carbon capture and storage (CCS) technology to produce 'blue' hydrogen from UK natural gas resources.

8.5 Cost

An investment of £500 million, specifically for FCEBs, could be the catalyst to kick start the process of converting the 33,900 buses in the UK to zero emission.[xi] This could either:

- Directly fund the first 1,250 FCEBs at £400,000 per bus[xii]
    - The total cost of the bus would be covered, leaving the fuelling infrastructure to be paid for. In many hydrogen fuelling models, the cost of the infrastructure can be covered in the hydrogen cost. This relies on conversion of a large number of buses to hydrogen fuel cell or a complete depot conversion.
    - The model does not work with a small fleet of buses being converted to hydrogen fuel cell.
- Fund the difference between FCEB cost and diesel bus cost, approximately 5,000 FCEBs with a £100,000 subsidy per bus.
    - Again, this model would only work if a large number of buses are converted at one site as the hydrogen fuelling infrastructure would have to be installed.
    - This model produces the most buses that could be running zero emission, so best for air quality.
- Fund projects with some FCEB subsidy and some fuelling infrastructure subsidy could create about 50 bus depots with fuel cell fleets of 70 buses and fuelling infrastructure. With a £100,000 subsidy per bus plus a £3 million subsidy for the fuelling infrastructure.
    - As there is a subsidy for the fuelling infrastructure the model could also work with a smaller fleet size. Less buses would be running as zero emission, but the model is potentially easier to justify.

Following this subsidy, economies of scale brings the total cost of ownership (TCO) at parity or lower than diesel.

8.6 Benefits

The stimulus that this would create would 'kick start' a whole hydrogen economy in the UK that would directly transfer to other modes of heavy-duty transport, HGV, LGV, rail and marine and accelerate potential hydrogen supply for other industry areas, heating, heavy industry etc.

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, including trucks, will be created.
- 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

As the low hanging fruits, the deployment at scale of fuel cell electric buses 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.

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.

The 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.

10. Notes and References

[i] https://www.gov.uk/government/publications/apply-for-the-all-electric-bus-town-scheme
[ii] Well to wheel is from the source of the fuel to the exhaust pipe.
[iii] https://www.fuelcellbuses.eu/wiki/history-fuel-cell-electric-buses/hyfleet-cute-2006-2009
[iv] https://www.fuelcellbuses.eu/projects/chic
https://www.fuelcellbuses.eu/projects/3-emotion
[v] https://www.fuelcellbuses.eu/projects/hytransit https://www.fuelcellbuses.eu/projects/high-vlo-city
[vi] https://www.fuelcellbuses.eu/projects/jive
https://www.fuelcellbuses.eu/projects/jive-2
[vii] 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
[viii] https://www.h2bus.eu/
[ix] https://www.forbes.com/sites/rrapier/2019/08/04/why-china-is-dominating-lithium-ion-battery-production/#12cfef483786
[x] Only UK Bus OEMs currently produce double deck FCEBs so it most likely they would be the chosen supplier.
[xi] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/852652/annual-bus-statistics-2019.pdf
[xii] Price estimates taken from https://www.h2bus.eu/

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