

Road to Net Zero:

How hydrogen has the potential to be a game changer for making bus travel cleaner and greener

Foreword from Jake Martin, EMEA Hydrogen Business Development Manager at Haskel

Haskel has produced this whitepaper to provide the bus and local transport sector with a useful guide to converting diesel-powered fleets to hydrogen in order to reduce carbon emissions and help local authorities meet ambitious net-zero targets.

Hydrogen offers a simple and effective way to make emissions-free travel a reality for buses, and it is encouraging to see governments, local authorities, manufacturers and infrastructure suppliers around the world backing hydrogen as a viable, sustainable fuel which can help to green the bus and local transport industry.

Given that the first fuel cell buses began running in China in 2006¹, hydrogen has been helping cities to decarbonise their transport fleets for the best part of two decades. The demand we are seeing for hydrogen refuelling stations globally shows that the appetite is there and growing, so it's now time for the bus and local transport sector to step up and rise to the challenge.



Hydrogen fuel cell buses

Not as new as you might think

The European Commission's 'Fit for 55'² plan aims to reduce greenhouse gas (GHG) emissions by 55 per cent by 2030, compared to 1990 levels.



One way for local authorities (LAs) to achieve this is by decarbonising their transport fleets, starting with their bus operations. Transport is responsible for 30 per cent of all GHG emissions in the EU³ and is therefore the largest emitting sector.

Local authorities across Europe have been using hydrogen-powered buses for many years now, so using hydrogen as an alternative fuel to diesel is not a particularly new development.

Transport for London began operating hydrogen fuel cell buses (FCBs) in 2004⁴, and LAs and cities in Europe have been running them for a decade. Aargau, in Switzerland, has been operating FCBs since 2011, while a number of European cities have recently invested in a hydrogen-powered fleet, including Barcelona and Lyon. In the UK, Dundee, Liverpool, Birmingham and Brighton have all made or are planning similar investments.

One of the most notable recent technological developments took place in Aberdeen, where 15 of the world's first model of hydrogen-powered double decker bus were introduced in 2021, following an £8.3 million grant from the EU and Scottish government.⁵

The buses, supplied by Wrightbus, have now travelled more than one million miles, preventing 1,700 tonnes of carbon dioxide emissions being released into the atmosphere. The same model of bus is also now running in London, Birmingham, Dublin and Belfast.

Many of the projects above have been funded by the Joint Initiative for hydrogen Vehicles across Europe (JIVE)⁶, which aims to deploy 139 FCBs and the associated refuelling infrastructure in the UK, France, Germany, Italy, the Netherlands and Spain. Haskel has contributed to JIVE via partnerships with existing members.

JIVE began in January 2017 and will run for six years. It is co-funded by a 32 million euro grant from the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) under the European Union Horizon 2020 framework programme for research and innovation. A second project, JIVE 2, started in January 2018. In total, the JIVE programmes will be responsible for the largest deployment of fuel cell buses in Europe to date: close to 300 fuel cell buses in 22 cities by the early 2020s.

UK public bodies interested in following the example of those above can now procure FCBs via a new procurement framework⁷ provided by The Procurement Partnership (TPPL), which gives local authorities access to 27 bus suppliers over the next four years.

1. First clean fuel buses running on Beijing roads (chinadaily.com.cn)

2. Fit for 55 - The EU's plan for a green transition - Consilium (europa.eu)

3. <https://www.statista.com/topics/7968/transportation-emissions-in-the-eu/>

4. Hydrogen buses on the RV1 [9 September 2004] (london-se1.co.uk)

5. Hydrogen bus launched in Aberdeen reaches million mile mark (pressandjournal.co.uk)

6. <https://www.fuelcellbuses.eu/projects/jive>

7. <https://www.smarttransport.org.uk/news/latest-news/new-procurement-framework-to-help-public-sector-access-hydrogen-buses>

The H2 advantage for bus fleets

More is more

FCBs provide a number of advantages to councils intending to decarbonise city bus fleets.



They can travel up to 300 miles on a full tank of hydrogen.



The refuelling process is similar to conventional refuelling and only takes 10-15 minutes, depending on the level of investment involved, all in accordance with international refuelling protocol SAE J2601.⁸



FCBs are also quiet in operation, helping to keep noise levels to a minimum, and the only thing emitted from their exhaust pipes is water



The refuelling infrastructure they require is modular, allowing councils to start with a relatively small unit and scale up from there as their fleets grow in size and different kinds of vehicle are added.

An additional benefit for local authorities of beginning their hydrogen-powered fleet conversion with buses is that they generally involve large volumes, meaning that projects can feasibly get off the ground with just a couple of buses to start with and then become more financially viable as fleet numbers begin to increase, which creates a more palatable cost per kilogram of hydrogen.

8. J2601_201003: Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles - SAE International

Nevertheless, refuelling stations can be configured to accommodate fleets of varying sizes and an overview of projects around Europe suggests 20-25 buses is an average figure in the first instance, as the economics are more favourable, and councils are able to reduce their emissions much more quickly. By installing a bigger station, they'll also find it easier to benefit wider applications and attract other users, such as trucks and cars.

Hydrogen buses also help councils achieve their net-zero targets in a highly visible and relatively quick manner, certainly when compared to smaller vehicle classes such as cars and vans.

According to England's national bus strategy⁹, each zero-emission bus reduces carbon emissions by about 70% (46 tonnes) annually compared to a diesel bus and also avoids the 23kg of nitrogen oxides (NOx) emitted by a diesel bus each year. Zero-emission buses also produce cleaner air and improve air quality.



9. <https://www.gov.uk/government/publications/bus-back-better>

The range of hydrogen refuelling experiences

There is a range of refuelling infrastructure options available to local authorities wishing to install their first hydrogen station.

Authorities could start with a cost-effective, small-scale portable refuelling station. These types of small units are ideal for demonstration purposes and could be moved from depot to depot to allow a range of users the chance to trial and evaluate hydrogen vehicles and the refuelling experience.

This kind of station has several advantages, including a small footprint, simple plug-and-play installation, and integration, as well as its portability. They would usually come in either a 350bar or 700bar solution, although dual pressure solutions may also be available in the market.

Another alternative would be to fill 700bar vehicles to 350bar, which typically achieves around a 60% fill, often enough to allow for a reasonable demonstration of the fleet in normal operation.



Smaller refuelling units will typically fill up to 100kg per day, allowing them to be used as a permanent solution for small fleets of light vehicles, as well as for demonstration and evaluation of vehicles and refuelling systems. For trials of a small number of larger vehicles where fast filling is required, external ground storage could be installed alongside the refuelling unit to give it the ability to fast fill buses, waste trucks or HGVs and to achieve back-to-back fills.

Once you have made the decision to transition your fleet to hydrogen at scale, then a larger refuelling system will be required. Systems can be configured to meet the required operational and refuelling profile and typically range from 100kg/day to over 1,000kg/day.

This kind of station can refuel a mixed portfolio of vehicles such as buses, waste collection trucks, vans, cars and other light, medium and heavy duty vehicles. They can dispense at both 350bar for larger vehicles and 700bar for smaller ones through multiple dispenser points and fuel a fleet of vehicles within a given timeframe or throughout the day.

Features such as fuel management systems and pay-at-pump systems can be added to enhance fuel usage monitoring and invoicing of fuel, enabling the systems to be deployed in either a private depot-based scenario or a public location.

In short, a hydrogen refuelling experience shouldn't be any different from a conventional refuelling experience. Users will find refuelling with hydrogen is straightforward, fast and easy to use.

Location, location, location

Where should councils place their refuelling stations?

Hydrogen refuelling stations can be deployed within either a depot-based environment or on land dedicated for a refuelling hub, and it is likely that in a city-wide refuelling network both scenarios will be required.

Stations can be designed to meet the specific needs of a fleet and so the footprint of a station can be tailored to fit into existing depot facilities. Of course, with limited space this can be challenging at times and so a dedicated piece of land for a refuelling hub could make things easier, especially with future growth in mind, and taking into account local permitting, ATEX zone criterias and COMAH considerations, plus installation and commissioning.

A typical set of considerations for site selection would include the following::



Available land for siting hydrogen infrastructure and mobile delivery assets, such as interchangeable multiple element gas containers and Pressure Equipment Directive-approved skids and storage



Locations available allowing existing traffic routes to pass the proposed station location



The ability to create safety distances between the hydrogen station and other areas of the site



The availability of utilities and possibilities to upgrade power provision (especially if onsite hydrogen production is being considered)



Site access and egress for hydrogen delivery vehicles, such as tube trailers



Third-party access potential, if within project scope



The option of adding solar panels and wind turbines to produce green hydrogen via electrolysis and other generation processes

If the council is planning on developing new depots in the future, as early as possible in the design phase it should consider how a refuelling solution could be integrated.

This land could be designed from the start to accommodate everything that's needed and to allow for future scalability of the infrastructure as usage grows.

The other option is to acquire through purchase or lease third-party land which could be dedicated for the production and refuelling of hydrogen. The land selected could be in an area within reach of the council fleet, but also other private fleet operators, and developed to be a public or semi-public refuelling hub, which could feature both hydrogen and electric charging.



Conclusion

Bus manufacturers, public transport operators, local authorities, refuelling infrastructure developers and other stakeholders should bear the following points in mind when considering hydrogen as an emission-free alternative to diesel:

- Hydrogen fuel cell technology is not new – it is proven and reliable.
- The hydrogen refuelling experience is quick, simple and virtually identical to the current experience.
- The main difference between refuelling cars and vans with hydrogen and doing the same with buses is the increased volume of fuel required for the latter.
- Current refuelling stations take up a similar footprint to conventional diesel stations and so can be located on existing traffic routes or within depots.



Haskel is here to help and advise you on hydrogen refuelling solutions and how these can be integrated into your project. If you would like more information on refuelling options for your fleet of hydrogen buses, please contact us at:

<https://www.haskel.com/en-gb/modals/contact>

Haskel offers a range of hydrogen refuelling solutions, including complete hydrogen fuel stations, hydrogen compressors and transfer equipment and a range of hydrogen rated valves and fittings to support a growing global refuelling infrastructure for hydrogen mobility. Working to develop and support hydrogen infrastructure for mobility globally, we provide design, build and maintenance support across the life of the station. Haskel components have been used in over 200 hydrogen refuelling projects around the world, fuelling a range of hydrogen fuel cell electric vehicles (FCEVs), including cars, trucks, buses and trains globally.