

## It's Alright Now – in fact it's a Gas!

### Beverley Nielsen

With more cities using gas-powered buses in the UK, ensuring that the supply infrastructure is fit-for-purpose remains a priority.

**Birmingham** and **Liverpool** are two cities in the vanguard in their use of hydrogen fuel cell electric buses.

Birmingham has had 20 fuel cell electric buses in service since 2021 operating on the 51 route from Birmingham to Walsall via Perry Barr. Having secured £30m grants from the Department for Transport in March 2022, a further 124 vehicles were ordered, making Birmingham's fleet of 144 hydrogen fuel cell buses the largest fleet in the western world. The original fleet of 20, purchased by Birmingham City Council, has been operated by National Express West Midlands as part of the JIVE project, co-funded by the Clean Hydrogen Partnership, a European public private partnership instigated by the European Commission and supporting hydrogen technologies across Europe.

Each bus, made by Wrightbus, Northern Ireland, includes six Kevlar-coated aluminium tanks which store the hydrogen. Refuelling takes under 10 minutes and the hydrogen is used when the buses fuel cell battery capacity falls to 80%.

Liverpool has also operating 20 hydrogen fuel cell buses owned by Merseytravel and leased to two key bus service operators in the Liverpool City Region, Arriva North-West Limited and Ribble Motor Services Limited (Stagecoach). These have been operating on the 10/10A route between St Helens and Liverpool city centre and had replaced existing diesel buses but were recently withdrawn by Arriva, who cited 'global hydrogen supply problems' as the cause. Their statements indicate they were previously relying on grey hydrogen, essentially a fossil fuel made from fossil fuel methane through a steam reformation process, however, they are currently seeking to secure a reliable green hydrogen supply.

Biomethane, another wholly renewable gas, is currently more widely used with 99 biomethane buses servicing Bristol including Cribbs Causeway. **Nottingham City Transport** operates the world's largest fleet of biogas double decker buses, comprised of 120 vehicles that have travelled over 15 million service miles since July 2017. These buses have prevented over 26,000 tonnes of CO<sub>2</sub> and 180,000 kilograms of NO<sub>x</sub> emissions from being emitted. A further 23 new Enviro400CBG City biogas buses were ordered in August 2022 from Scania and Alexander Dennis Limited.

There are 58 biomethane buses operating in **Reading**, **Sunderland** has had 17 double decker buses operating since 2017 – a British first when launched, **11 biomethane buses have been in operation in Darlington** for the past decade, with 12 Arriva buses in operation in Liverpool.

Natural Gas is noted online as powering as many as 28m vehicles worldwide. It's not only heavy goods vehicles, struggling with batteries to generate sufficient range whilst adding considerable weight loading, which are looking to gas powered solutions. Biomethane and BioLNG fuels many HGVs used by leading brands in the UK including John Lewis Partnership, Waitrose, Royal Mail, DHL, Hermes, Asda, Sainsbury, Ocado, B&Q, Tesco, amongst others, all saving thousands of tonnes of CO<sub>2</sub> emissions from the previously used diesel.

BMW is developing its own fuel cell electric vehicles (FCEV) claiming range capacity of over 500km aimed to be on the roads by 2030. These need 100kg less raw materials than a battery

electric vehicle (BEV) and 90% less 'critical raw materials'. BMW is clear that to achieve Net Zero targets we will need to use "the full spectrum of technologies to do the decarbonisation job." In addition, they note, existing petrol stations can be modified to include H2 pumps and don't require massive infrastructure upgrades like banks of new EV chargers.

So what are the refuelling stations currently available to operators considering use of gas-fuelled vehicles?

**Motive Fuels** currently operates out of Tyseley Energy Park refuelling the Birmingham Bus fleet and with ambitions for a national network. Their stations create green hydrogen on site by electrolysing water, collecting and storing the hydrogen made on site, ready to be dispensed when needed.

**Element 2** was engaged by UKRI and the DfT and formed the **Tees Valley Hydrogen Hub** to install a hydrogen refuelling infrastructure with fuel for seven hydrogen vehicles trials across Tees Valley. This made available three mobile refuelling stations across the Teesside region at bus depots, airports and MoD sites using clean, low carbon hydrogen, sourced through their distributed network. They also worked with **Highlands and Islands Transport Partnership (HITRANS)** – the transport partnership covering the Western Isles, Orkney, Highland, Moray and most of the Argyll and Bute area – and with Opportunity Cromarty Firth, for a hydrogen bus trial run from October and November 2021. They are now looking to establish a national hydrogen refuelling network.

In the UK firms involved in delivering biomethane refuelling station solutions include **CNG Fuels**, which opened Europe's largest bioCNG filling station in Warrington whilst also opening large refuelling stations in Northampton and Birmingham Erdington, capable of serving over 1,000 HGVs a day, more than doubling their 600-a-day capacity of their existing stations at Leyland, Lancashire and Crewe, Cheshire.

**Gasrec** design build and operate BioCNG and LNG filling stations across the UK delivering CNG via gas grid connection of tanker and LNG using gas-fuelled tankers.

These are the road-based refuelling station options and where they are not connected to the grid the fuels will arrive via heavy good vehicles usually 44 tonne vehicles. But rail operators have also been experimenting with gas fuel solutions and are they to rely on the same types of solutions?

Hydrogen trains include **the Mireo Plus Hydrogen train** in development by Siemens Mobility and Deutsche Bahn, **The HydroFLEX hydrogen Class 319 train** developed by Porterbrook, **the Breeze / Cordia iLint hydrogen train** produced by Alstom and Eversholt, the **CRRC Changchun and Chengdu Railway Group's hydrogen-powered EMU, the FCH2Rail demonstrator train**, developed by a consortium including CAF, DLR, Toyota, Renfe, Adif, CNH2, IP and Stemmann-Technik, **the ScotRail, hydrogen-powered Class 314 train** being developed by a wide partnership between the University of St Andrews, Transport Scotland, Scottish Enterprise, Ballard Motive Solutions, Abbott Risk Consulting, ARUP, Aegis and Angel Trains, **The Škoda 15T hydrogen fuel cell trams and the Tig-M street tram**.

**Biomethane trains include the ATER X 73500 biomethane model being pioneered in Nouvelle-Aquitaine** as a first train demonstrator running on biomethane. **Amanda the biomethane-powered train** was launched in 2005 when Sweden became the first country in the world to introduce this passenger train, powered solely by biomethane. Developed by Svensk Biogas at a cost of ten million kronor (1.08 million euro), the train, still in operation since the launch almost ten years ago, carries up to 54 passengers along Sweden's east coast, between Linköping and Västervik.

**Ultra Light Rail Partners (ULRP) Ltd's Car10** was developed from the original flywheel driven 'Bristol tram' then powered from 'green' mains electricity and operated along Bristol's dockside between

1998-2000. Following a First-of-a-Kind Innovate UK grant for £400k in 2019 this four-wheel railcar was fitted with a biomethane fuelled engine driving a flywheel and hydraulic pump to power individual hydraulic wheel motors. The result is an efficient long range rail vehicle which uses no fossil fuel, has no Li-ion batteries, causes no climate change and requires no external electricity. It was successfully trialled at Long Marston in 2020 and has been based at BCIMO in Dudley since May 2023.

Following this trial, ULRP successfully won a further Innovate UK grant designing the hybrid gas and battery, or gas and flywheel powered 'BioUltra Zero Climate Change Lightweight Train or Tram' (BØLT), enabling far greater range of up to 1,000km and completed in 2021. This would weigh under

20 Tonnes or 5 tonne for each axle and carry 120 people as a train and 210 people as a tram.

Given the growing demand for gas power amongst railcar operators and especially in light of range challenges associated with battery electric trains, ULRP has developed the designs for a gas refuelling station which is refuelled by light vans of 7.5 tonnes and less, rather than heavy 44 tonne vehicles. The designs were funded by Innovate UK and Global Centre for Rail Excellence near Port Talbot in Wales following receipt of a successful grant and bid completion.

This design is unique in providing options for hydrogen or biomethane and ensuring there is no need for a large gas store on site or any transfer of gas between tanks.

It consists of three stillages which contain lightweight composite tanks holding over 50% more biomethane (CH<sub>4</sub>) or green hydrogen (H<sub>2</sub>) than conventional steel containers. Each tank has an atmospheric buffer to lock them into position and are designed to have a 30 year life span.

The focus on lightweighting means there is no requirement for cranes or forklift lifting equipment. Restocking this refuelling station is a manual operation involving the sliding of the wheeled tank cage from the small van delivery vehicle thereby offering a solution for rural communities or inner-city locations unable to host larger 44 tonne lorries for refuelling.

The aerogel insulated composite tank-based system increases the safe storage time of either biomethane or green hydrogen, enabling even more space efficiency, longer storage time and significant cost benefits. Given the use of smaller vans for refuelling, there is no requirement for the gas tank delivery drivers to have HGV licences and no requirement for an inspection every 20 days to which normal fuel tankers are subjected.

ULRP are now working on their second stage grant application for the GreenGas Refuelling station which, if successful, would see the installation of this innovative facility at GCRE in Wales.