

## Case Study – Fuel Cell Zero-Emission Buses for Aberdeen, Scotland

### SITUATION

The City of Aberdeen, Scotland has a world-wide reputation in the energy industry. With the discovery of significant oil deposits in the North Sea, Aberdeen became the centre of Europe's petroleum industry. However, downturns in the oil and gas sector have impacted the economy and city leaders are repositioning the city as the "Energy Capital of Europe," with a focus on the development of new energy sources. The launch of the Strategy Framework "A Hydrogen Economy for Aberdeen City Region" in 2013 reflects Aberdeen's ambitions to become a leading European region in the early deployment of hydrogen technologies.

### SOLUTION

City Council implemented the Aberdeen Hydrogen Bus Project to deploy Europe's largest fleet of hydrogen fuel cell buses, replacing ten polluting diesel buses on the city's streets with zero-emission buses.

The Aberdeen Hydrogen Bus Project is designed to test the economic and environmental benefits of hydrogen fuel cell transit technologies and aims to drive the development of hydrogen technologies. It is part of the larger H2 Aberdeen initiative, which provides the opportunity to create a new industry and greater choice in energy production and usage.

Implementation of the fleet of hydrogen fuel cell buses in Aberdeen was co-financed through two projects funded by the European Fuel Cells and Hydrogen Joint Undertaking (FCH JU): High V.LO-City and HyTransit. Other Scottish, UK and European partners came together to co-fund the balance of the project, including the UK's innovation agency, Innovate UK; the Scottish Government; Scottish Enterprise; Aberdeen City Council; transit operators First and Stagecoach; Scottish Hydro Electric Power Distribution; and Scotland Gas Network. BOC, a member of Linde Group, has invested in the hydrogen production and refueling station.

### FUELING

The hydrogen bus refueling station, based at Aberdeen City Council's Kittybrewster depot, is the first fully integrated



hydrogen production and bus refueling station in Scotland. The commercial-scale hydrogen station is owned and operated by BOC, a member of the Linde Group. The facility has three electrolyzers to produce the hydrogen on site from water, with extremely low emissions. The hydrogen is then compressed to 500bar and stored ready for dispensing at 350bar when required. A purpose-built hydrogen fuel cell bus maintenance facility is co-located at the depot.

### SUMMARY

**Sites:** Aberdeen, Scotland

**Application:** Ten zero-emission hydrogen fuel cell buses, Europe's largest fleet

**System:** 150kW FC<sup>®</sup>veloCity<sup>®</sup>-HD power modules integrated onto Van Hool chassis

**Fuel:** Hydrogen provided by BOC, a member of the Linde Group

**Objective:** To support Aberdeen's goal to remain a world-class energy hub, leading a low carbon economy.



## RESULT

Ten Van Hool hydrogen fuel cell buses, powered by Ballard fuel cells, have now been deployed. Six buses are operated by Stagecoach on the X17 Aberdeen city centre to Westhill route, while First operates four buses on the X40 Kingswells to Bridge of Don park-and-ride route. The buses emit only water vapour, reducing carbon emissions and air pollution, as well as being quieter and smoother to run than diesel vehicles.

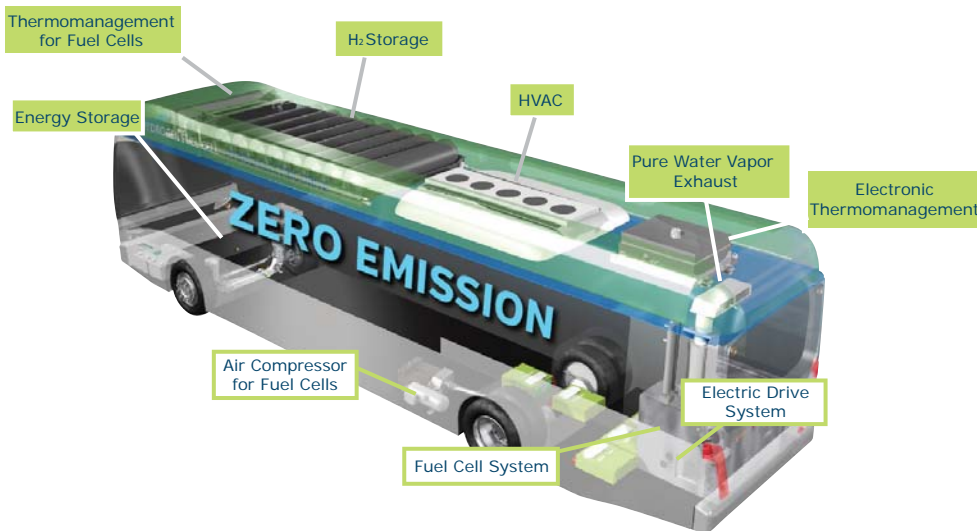
The buses had travelled more than 730,000 kilometers and carried an average of 36,700 passengers per month, operating six days a week at 90 percent availability. More than 1,600 refueling events had taken place at the hydrogen station, each taking just five to seven minutes per refueling. With more than 35,000 kilograms of hydrogen dispensed in the first year, the hydrogen refueling station has been extremely reliable, demonstrating 99.99% availability.

Aberdeen City Council has received accolades commending the success of the project, including the 2016 Low Carbon Championship award for the transport initiative of the year. Recently The Aberdeen Hydrogen Bus Project has been so successful, city planners are now considering expansion of the fleet through participation in the European-wide Fuel Cell Bus Commercialisation Project.



## FUEL CELL BUS TECHNOLOGY

A fuel cell bus is an electric vehicle that uses compressed hydrogen as the fuel, rather than storing energy in large batteries. Fuel cell power modules onboard the bus generate electricity through an electro-chemical process, producing only water and heat as by-products. The electricity generated by the fuel cells powers the hybrid electric motors and charges the energy storage system. Regenerative braking on the buses increases the fuel economy. High pressure tanks located on the roof of the bus store hydrogen fuel, providing sufficient range for a full day of operation, over 16 to 18 hours. This compares well with the previous generation of fuel cell buses, whose range was less than 200 km, where buses were forced to operate in half day shifts before fuelling.



## PERFORMANCE STATISTICS

### Distance Travelled:

>730,000 kilometers in the first year

### Refueling Events: >1,600 in the

first year

### Refueling Time: 5 to 7 minutes

### Availability: 90%

## ABOUT BALLARD



Ballard designs and manufactures high performance and easy to integrate FC<sup>®</sup>veloCity<sup>®</sup> fuel cell modules for use in hybrid electric buses. Ballard's leading-edge fuel cell technology combined with our customer's advanced hybrid system designs deliver zero emissions at the tailpipe with no compromise in vehicle performance compared to other zero emission technologies.

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