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B. Jermer, C. Bußjaeger

This document appeared in

Detlef Stolten, Thomas Grube (Eds.):
18th World Hydrogen Energy Conference 2010 - WHEC 2010
Parallel Sessions Book 6: Stationary Applications / Transportation Applications
Proceedings of the WHEC, May 16.-21. 2010, Essen
Schriften des Forschungszentrums Jülich / Energy & Environment, Vol. 78-6
Institute of Energy Research - Fuel Cells (IEF-3)
Forschungszentrum Jülich GmbH, Zentralbibliothek, Verlag, 2010
ISBN: 978-3-89336-656-9

PHILEAS – The Operation of a 18m Hybrid Fuel Cell Bus in the Cologne Area

Boris Jermer, HyCologne – Hydrogen Region Rhineland, Germany
Carsten Bußjaeger, RVK – Regional Transport Agency Cologne, Germany

1 Introduction

Hydrogen buses can become a dominant technology for future sustainable public transport systems. However, this will only occur if hydrogen buses and associated refuelling can meet key commercial requirements for cost reduction and well to wheel sustainability. Therefore the Hydrogen Bus Alliance (HBA) has initiated an industry dialogue in 2008 which served as a basis for the strategy paper published in 20091 (www.hydrogenbusalliance.org). In this strategy document the target prices for hydrogen busses can reach a commercial level (diesel-hybrid-bus equivalent) by 2015.

Moving closer to the aim of zero emission public transport in European cities, four new hybrid fuel cell busses are being built with Dutch and German partners during late 2009 and 2010. The first bus is presented during WHEC 2010 and put into demonstration in August 2010 in the greater Cologne area in Germany and – after a test-period - operated in daily public transport service both in inner city transport and interurban traffic. Today, the cost of the hydrogen fuel cell transit bus is significantly higher than the cost of a conventional diesel bus. However, the consortium around the Dutch manufacturer APTS established a comprehensive technical plan to reduce costs significantly. Specifically, the consortium expects to reduce capital costs to the general range of a diesel hybrid bus. By anticipating operating cost savings due to fuel efficiency and low maintenance needs, this concept should make the fuel cell system cost-competitive with conventional diesel-systems while using a zero-emission technology. The consortium aims to offer commercial fuel cell busses by 2015 depending on a procurement volume greater than a few hundred units per year.

The bus has a total length of 18 metres and is currently the only articulated hybrid fuel cell bus in the world. The lightweight chassis and the bus-system is manufactured by the Dutch Company APTS and the PEM fuel cells are supplied by Ballard Power. The electrical integration has been organized by the Düsseldorf-based Company Vossloh Kiepe while the Batteries are supplied by Hoppecke.2 The bus will be operated by the regional public transport service in Cologne and Hürth (RVK) and is connecting cities in the south of Cologne (Hürth and Brühl) with Cologne central station. The hydrogen necessary for the operation of the bus (approx. 15KG / day and bus) originates from waste hydrogen streams from chemical industry which has a total capacity to power more than 1000 busses in the area of Cologne. The quality of the hydrogen meets the commercial grade defined in SAE J2719.

2 Technical Concept

The 18 meter fuel cell bus is 100% low floor and offers all wheel steering and fully independent suspension. The top speed is at 80 Km/h and the acceleration 0 to 60 Km/h is

measured with 20 seconds. German climate conditions are met (-15°C to + 45°C) and the busses are designed for most German cities. The bus can handle grades until 10% with completed seated load and brings a significant noise reduction of <75 dB external and internal. The range is about 300 kilometers which is equivalent of today's standard diesel bus technology. The bus will be in operation for 16 hours per day and will travel approximately 55.000 KM per year in urban transit and inner city drive cycles. The Hydrogen Fuel Package supplied by Dynetek can store 35 kg of gaseous hydrogen at 5000psi (350bar) and includes carbon wrapped tanks, regulators, valves, piping and custom mounting points. The systems and components are certified and compliant with Germany industry standards.

The Vossloh Drive System is designed as a serial hybrid system and includes the motor, the energy storage system (Batteries supplied by Hoppecke) and a propulsion control system. Vossloh Kiepe is the world's leading producer of efficient, low-emission hybrid electric propulsion systems for heavy-duty vehicles. Vossloh has equipped more than 1200 trolleybuses with AC-technology. Those busses are in service world wide and have travelled more than 400.000.000 kilometres.

The supplier of the Fuel Cell module Ballard Power has equiped over 50 busses (CUTE, Vancouver, London).3 Based on the state of the art automotive fuel cell stack, Ballard's FCvelocity-HD6 fuel cell module offers 150kW of electrical power at 550-800V. The dimensions are 1270 x 870 x 505mm and the operation temperature level is at 63 degree C. Experience from previous versions of this concept allows the FCvelocity-HD6 advantages in cost, through design for volume manufacturing, and compatibility with APTS system requirements. The heavy duty power module features a control unit that can interface with a CANBus system controller, making integration easier for the Phileas hybrid fuel cell bus platform. Besides the technology Ballard warranties a reliable operation for 12.000 hours or five years. This has been a necessary requirement to convince to allow the operator RVK to demonstrate this technology.

For service and maintenance support APTS will set up a support center in the Cologne area. Vossloh located 25km away from Cologne can provide service from the existing service infrastructure and Ballard will set up service and spare parts centre in NRW region to support the fuel cell buses. In addition Ballard will provide training to transit operators to carry out preventive maintenance work on the fuel cell modules.

In the Rhine-Area around Cologne and other parts of NRW, big resources of hydrogen as a by-product from the chemical industry are available.4 HyCologne focuses on using these resources and is building up a local network of innovation for hydrogen related technologies. Currently there are twenty members organised in a cluster. Starting early 2010 HyCologne establishes a hydrogen bus fleet and aims to replace a significant part of the existing diesel-fleet until 2020. Therefore a project has been set up to use the availably by-product hydrogen. The project called "Chemergy" will demonstrate clean energy solutions that make use of an existing but currently untapped source of hydrogen fuel – hydrogen emitted as the by-product of a sodium chlorate manufacturing plants. The purified hydrogen could be used to continually fuel a fleet of up to 500,000 hydrogen-powered passenger cars or 1000 busses (fuel cell hybrid) in the Greater Cologne area, significantly reducing greenhouse gas emissions, local air pollutants, and the use of fossil fuels. By making use of an existing by-

product stream, the plant significantly reduces the financial cost and energy required to provide 99.99% pure hydrogen.

„Chemergy“ is a milestone for electric traffic & transport concepts which are both economically viable and environmentally friendly, and it offers competitive fuel costs and profits made possible by the favourable local situation. The development of the infrastructure is clearly beneficial for the location’s and the region’s competitiveness. In parallel to the local activities the project partners examine how the findings of the Chemergy project can be transferred to other regions and how the potential resources of the industrial by-product hydrogen can be put to use in the area, in Northern-Rhine-Westphalia (NRW)5 and in Germany as a whole to ensure optimal results in efficiency.

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