H2 Bus NRW – The Hybrid Electric Fuel-Cell Bus

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H_2 Bus NRW – The Hybrid Electric Fuel-Cell Bus

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1 Introduction

Clean and quiet, ample passenger capacity and low energy consumption, this sounds like a description of the bus of tomorrow. The “hydrogen bus” is an innovative approach to tomorrow’s local public transport. It’s special feature: fuel cells powered by hydrogen (H_2). Emitted from the exhaust pipe is simply steam and nothing more. The first prototype of the Phileas H_2 bus is on show up to May 20, 2010, at the World Hydrogen Energy Conference being staged in Essen. Developed under the overall control of Vossloh Kiepe and APTS, the bus is part of a series of test vehicles destined for local public transport services in Amsterdam and Cologne.

Figure 1: Phileas – 18-m vehicle.

2 City Bus with Hybrid Drive Including Fuel Cell

So that the vision may come true, a Dutch-German consortium led by Vossloh Kiepe is working on the development of this idea up to the stage of standard production: a city bus with series hybrid drive including fuel cell. The vision is a clean future for local public transport with no pollutant or noise emissions and this vision is becoming reality with the progressive implementation of the corresponding hybrid electric fuel-cell bus concept. Three companies are involved: Advanced Public Transport Systems, HOPPECKE Batterie Systeme, and Vossloh Kiepe. Other scientific project partners taking part in the design of the energy storage and energy management modules are: the Electrochemical Energy Conversion and Storage Systems Research Group, Institute for Power Electronics and Electrical Drives at RWTH Aachen University and the Institute for Automation Engineering at Cologne University of Applied Sciences.

Supporting the consortium are government departments in both Germany and the Netherlands. The Dutch government and the EU together with the European Regional Development Fund are sharing in the funding of the project as are the North Rhine-Westphalian Ministry of Economic Affairs and Energy plus the Ministry for Building and Transport. The state's Minister of Economic Affairs, Christa Thoben, presented the confirmation of financial aid in February 2009 to Vossloh Kiepe at its Düsseldorf headquarters, thus announcing the go-ahead for the research project.

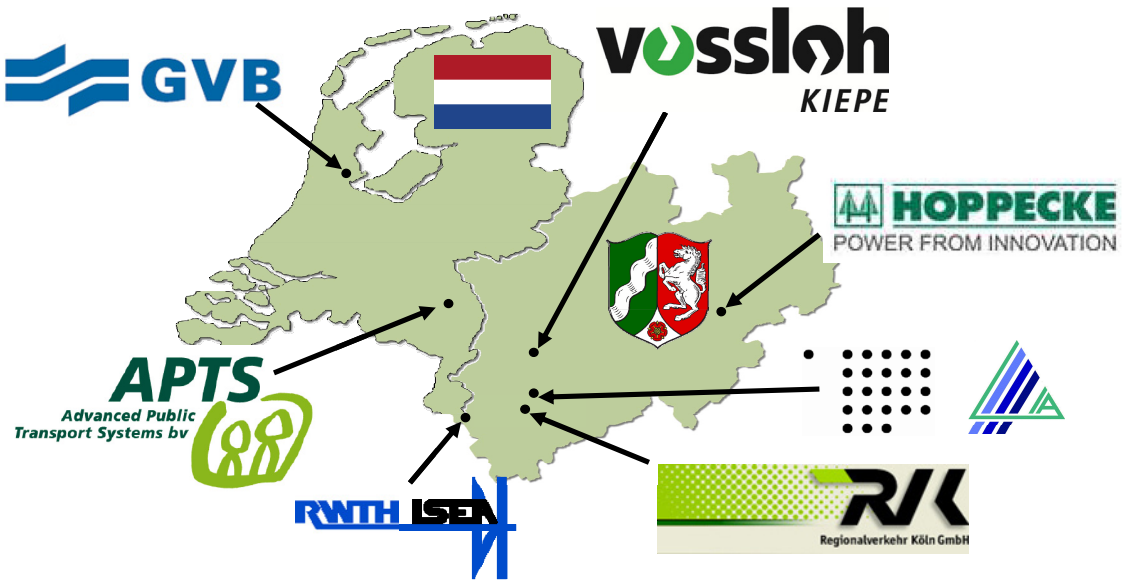

Figure 2: Project partners.

3 Innovative Lightweight Construction and State-of-the-art Drive Technology

The hybrid fuel-cell bus is based on the Phileas series (Figure 1: Phileas 18-m vehicle) built by Advanced Public Transport Systems BV (APTS). It was selected by the project partners for its lightweight modular design. In this way, innovative lightweight engineering is merged with advanced drive technology. Headquartered in Helmond, APTS is a member of the Dutch

VDL Group that builds annually some 2,000 buses. The company's ultramodern articulated buses have been in operation for some years now in the Netherlands, France, and Turkey. The Phileas bus is specifically engineered for comfortable passenger transport on very busy bus services. The triple-axle vehicles have a comparatively high capacity (35 seated and 140 standing passengers) and are nonetheless agile. Despite their length, the Phileas buses, just as standard 12-m buses, have a relatively tight turning circle made possible thanks to self-steer wheels mounted on all three axles.

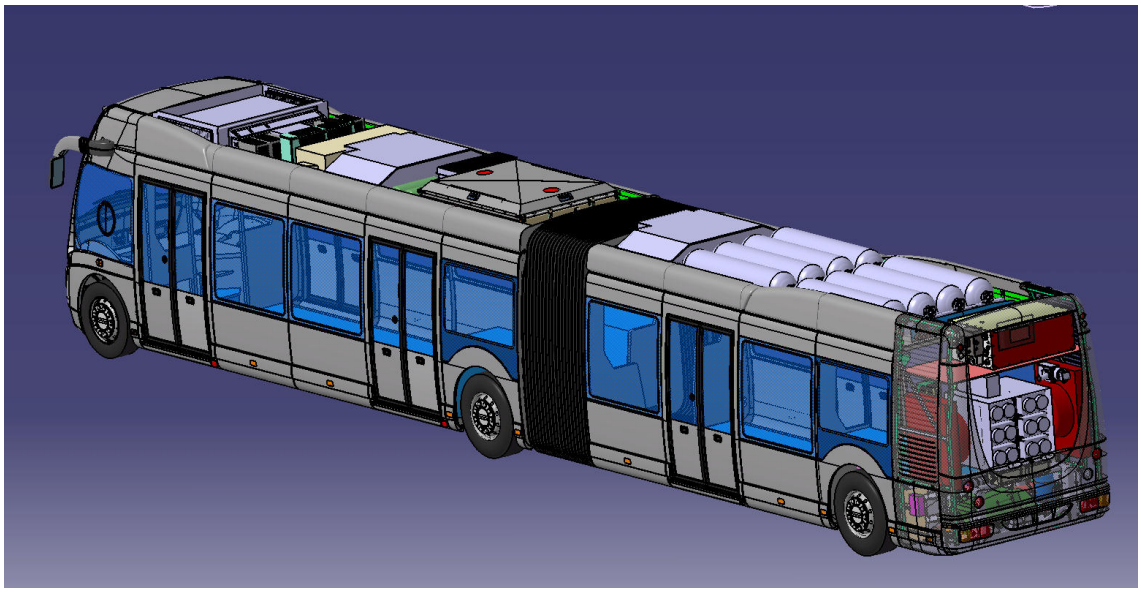

Figure 3: Phileas – H_2 bus system.

4 Drive System

The new version of the Phileas bus (Figure 3: Phileas – H_2 bus system) has a fuel-cell system located in the rear of the vehicle. Energy is also supplied by batteries and supercapacitors. A brake-energy recuperation device allows these energy storage modules to be recharged by converting kinetic energy into electrical when the brakes are applied. The electricity thus generated can then be used for the next start-up phase. The supercaps are chiefly used for covering peak load demands (starting-up/accelerating) while the batteries handle normal/cruising load requirements. The fuel cell works much like a base-load power plant and continuously feeds electrical energy into the onboard energy storage module.

The complex series hybrid system (Figure 4: System overview) is provided by Vossloh Kiepe GmbH. Hence, this Düsseldorf-based enterprise is responsible for the entire energy management system and supplies both batteries and supercaps. The nickel-metal hydride battery and the battery management system have been engineered in cooperation with Brilon-based Hoppecke Batterien GmbH & Co. KG. The traction unit is an asynchronous motor rated at 240 kW.

The first generation of this series hybrid drive systems has already been used on the 24-m double-articulated hybrid bus known as the LighTram. In the shape of this second-generation vehicle, Vossloh Kiepe is now extending its capabilities and the output range of the series

hybrid bus. On the basis of the series hybrid drive platform, it is now possible to build, alongside diesel-electric, also all-electric vehicles. The fuel cell is sourced by APTS from the Canadian manufacturer Ballard Power Systems. For base-load requirements this has an output of up to 150 kW.

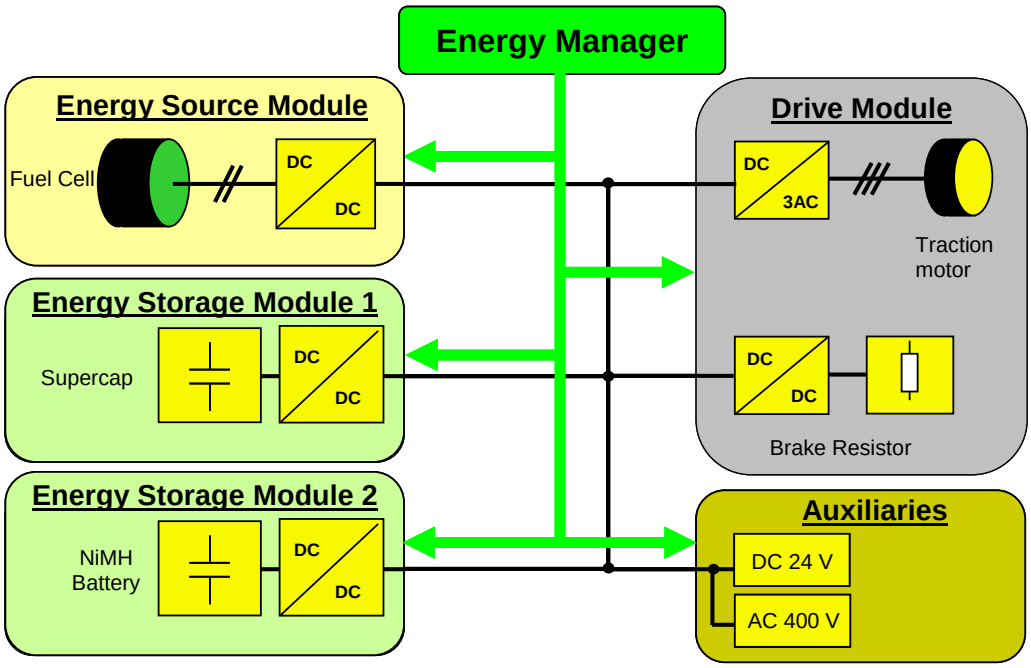

Figure 4: System overview.

5 Toward the "Hydrogen HyWay"

The hydrogen required for the fuel-cell system is stored in gaseous form in pressure tanks which can be filled up to 350 bar and are seated on the vehicle's roof. With 40 kg of hydrogen, the bus can operate up to 300 km. Dependable and even cost-efficient supplies of this fuel will be available in North Rhine-Westphalia through sufficient quantities of hydrogen sourced as a byproduct from the chemical industry located in the region around Cologne (such as from Bayer and InfraServ). For some years now, HyCologne, the regional innovation network for hydrogen and fuel cells, has been advocating the sensible use of these valuable resources. Meanwhile, altogether 16 organizations are represented in this interest pool and all of them are pushing ahead with the market rollout of fuel-cell systems.

6 All the Advantages at a Glance

The thinking behind all these efforts is that hydrogen-driven buses have numerous advantages over diesel vehicles. Fuel-cell buses have zero emissions since the exhaust pipe emits nothing but steam. The exhaust gas can simply be termed "waste air." Normal diesel engines, in contrast, operate at low efficiency especially when starting up and, in addition, emit pollutants (such as soot) plus noise. Fuel cells, in contrast, are very quiet. So such state-of-the-art energy converters may be seen as a major step toward "green" local public

transport since both noise and pollutant emissions have been significantly reduced and, in the case of the latter, completely eliminated.

Irrespective of such considerations, energy consumption by these innovative vehicles is well below that of their diesel cousins since the entire system works extremely efficiently together with the fuel cells. Simply through the use of the series hybrid drive system combined with Vossloh Kiepe's newly developed energy management system, the vehicle's specific consumption can be lowered by up to 25 percent and the life-time of the fuel cell significantly prolonged. Thanks to the lightweight design, the dead weight is much the same as that of conventional city buses. The zero-emission hybrid will therefore have virtually the same passenger capacity as a conventional city bus. So it embodies the combined goals of creating a zero-emission local public transport vehicle and ensuring this innovative bus's operability on regular services. The top speed will be over 80 km/h.

7 Political Framework

In procuring these innovative zero-emission vehicles, the Cologne and Amsterdam public transport services (RVK and GVB) are giving their support to this technological development. In the actual acquisition of the buses, they are being assisted by the NRW Ministry of Economic Affairs, the NRW Transport Ministry, and the Dutch Transport Ministry. Politically, the project is also designed to help the regions merge closer together and act as a step toward the goal of a joint hydrogen pipeline extending up to Amsterdam.

8 Project Phases

The entire project for developing a hybrid fuel-cell bus ready for series production and platformed on the Phileas has three phases:

The first: development of a drive system culminating in a recommendation for the energy storage module and the design details of the fuel-cell system.

The second: four vehicles to be assembled, two to go to Cologne (Regionalverkehr Köln GmbH, RVK) and another two to Amsterdam (GVB), both in 2010.

The third: the buses will be tested on regular services for a period of several years.

The first official presentation of the concept took place during #rail2009 in Dortmund. The first prototype is presently being shown at the 18th World Hydrogen Energy Conference in Essen. More details are available at the Vossloh Kiepe booth 830 in hall 3.

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