FCZ-H_2 Bus: The First Fuel Cells Hydrogen Bus in New EU Countries

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Abstract

The main objective of the project is to initiate activities connected with hydrogen utilisation in transport. Advanced technologies are utilised in order to optimise energy flows - the main energy source is electricity generated by fuel cells (50 kW). Other parts are accumulator and an ultracapacitor used for recuperation. About 20 kg of pressurized hydrogen (35 MPa) will be stored in pressure vessels, which will be mounted on the bus roof. The hydrogen bus as well as the first hydrogen filling station in central Europe is going to start in spring 2009.

Keywords

fuel cells, hydrogen, recuperation, hybrid

1. INTRODUCTION

At present, hydrogen as an energy source for the transport and power supply industry is one of the most intensively investigated topics. It is expected, world over, that there will be a gradual transition from the fossil-based economy (2000) to more ecological and source-independent hydrogen economy (2050). The related effort is performed on several levels - the topic is addressed at research institutes and industry. There is also a strong political support - the President of the USA declared the hydrogen economy support (stressing out the independence from oils supplies from politically instable regions), allocating 1.7 milliard dollars for the corresponding research and development for the next five years. The European Union has decided to become "a leading player" in a hydrogen and fuel cells field and consequently in 2008 founded Joint Technology Iniciative for Fuel Cells and Hydrogen (the NRI Rez plc - coordinator of the bus project under preparation takes part in this Platform) to support the necessary R&D.

Another reason, why energy use of the hydrogen is so much a centre of attention, is the environment protection. Hydrogen to electricity transformation in a fuel cell is accompanied with water as an only waste product, makes this energy generation method ecologically friendly. Hydrogen can be produced from a large number of raw materials (water, biomass, natural gas, etc.) using number of energy sources for the process, including renewable ones, obviously "home available", which minimises the country dependence on the strategic energy import. In near future, nuclear energy will be probably one of the most important sources for hydrogen production. Especially the IV generation of reactors is very suitable, providing high efficiency, due to high temperatures generated in its active zone. Scheme of VHTR, one of the IV generation reactors is shown on Figure 1. [Nuclear Energy Research Advisory Committee and the Generation IV International Forum, 2002]

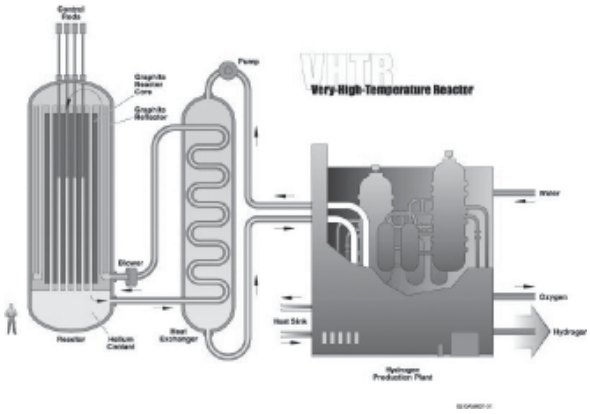

Fig. 1 Very-high temperature reactor (VHTR)

2. OBJECTIVES AND SCOPE OF FCZ H_2-BUS PROJECT

The main objective of the project "Hydrogen technologies for Fuel Cells, Transport and Energy Usage" is to initiate activities connected with hydrogen utilisation in transport and power supply, which should be a significant contribution to the Czech Republic sustainable development. One of the most important social areas connected with the energy utilisation is the transport area - the reason why it was selected for the pilot project, similarly as in many other countries.

The prerequisite of any technology successful development is its acceptance by the general public, so if the Czech concept of motor vehicles driven by hydrogen will fulfil this condition it would have great prospects for further development. Implementation of such a project (operation of motor vehicles driven by hydro-

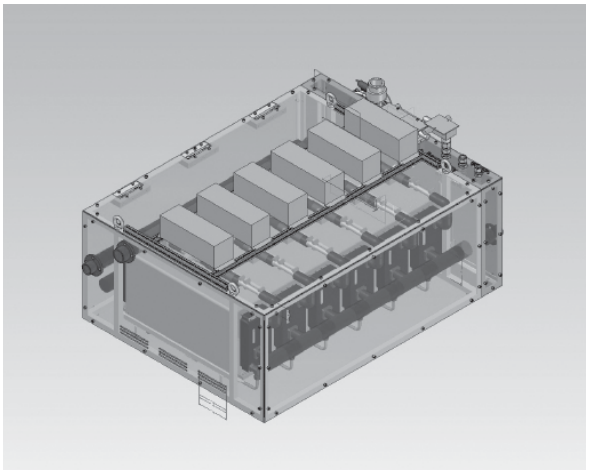

Fig. 2 Fuel cell module

gen) requires solution of a number of partial issues: hydrogen production, purification, storage, transportation to the end-users and vehicle actual operation. Research and development of the corresponding technologies and their implementation in practice is the backbone of this project, which will be the first of its kind in the new EU countries.

2.1 Hydrogen supply

The project objective is the development, implementation and operation of hydrogen driven bus. Hydrogen would have been obtained from Spolana Neratovice, where it is generated as a by-product of several technologies (esp. chlorine production by amalgam electrolysis) in the amount of approximately several tonnes per day. For technological reasons such hydrogen should be purified and dried, which is a joint task for ICT Prague and Spolana Neratovice. Because the cost of the required drying technology is quite high (taking into account the amount of H_2 produced and on the other hand required by the H_2 bus), it was finally decided to use commercially available hydrogen.

Purified hydrogen will be available for the bus at filling station in Klicany (near Prague), which will be developed and constructed by Linde Gas within the existing operational filling station site. In the future the same facility may be used also for some other hydrogen-driven vehicles.

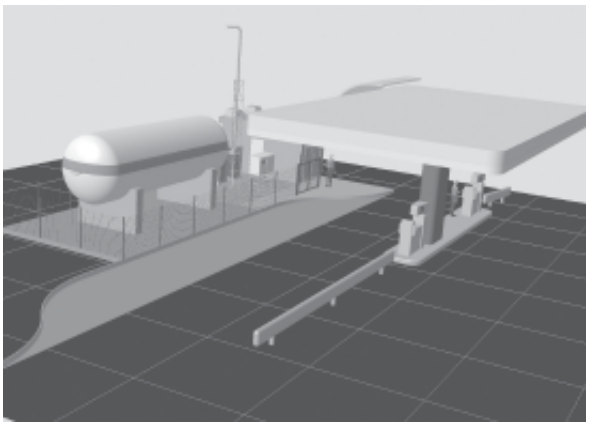

Fig. 3 Visualization of hydrogen filling station

2.2 Technical arrangement

Advanced technologies utilised in the bus will allow optimising energy flows (fuel savings - longer range). The main energy source will be electricity generated by fuel cells (manufacturer Proton Motor (Germany), output approximately 50 kW - Figure 2.), other key parts are: Li-ion accumulator 68Ah for energy recuperation while braking, and a bank of ultracapacitors to carry over the current peaks during starting up to speed. Hydrogen will be stored as a gas under pressure of 35 MPa in pressure vessels (~20 kg of H_2), which will be mounted on the bus roof (Figure 4). This will result in driving range of about 300km, the H_2 consumption 7-8kg of H_2/100km. Electric drive (Figure 5) will be developed by Skoda Electric that has many-years experience with trolleybuses, including engine control system. The company will be also responsible for final completion of all parts and finally - the bus commissioning.

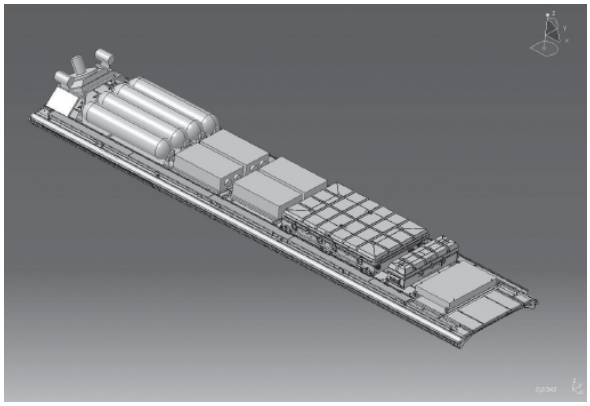

Fig. 4 Hydrogen storage

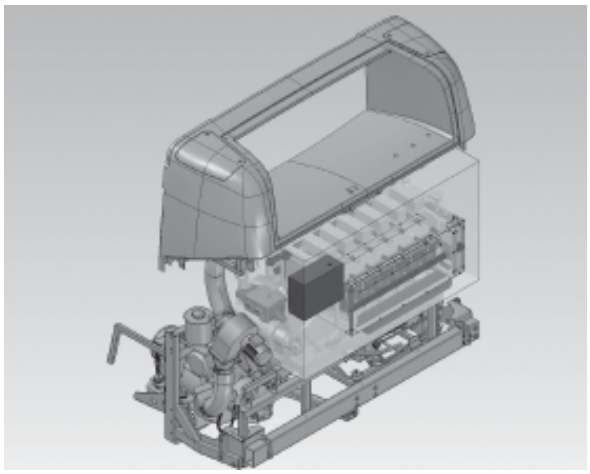

Fig. 5 Rear compartment of the bus

Table 1 Project partners

NRI Rez	CZ	Project coordinator, owner of the bus and filling station, safety and legislation issues
Skoda Electric	CZ	Electric drive, control system, bus finalisation (assembling)
Proton Motor GmbH	Germany	Fuel cell development and fabrication, fuel tanks, hydrogen infrastructure within the vehicle
Linde Gas	CZ	Hydrogen filling station, hydrogen supply
ICT Prague	CZ	Proposal of the hydrogen purification technology
IFE Halden	Norway	Monitoring, information and control technologies, MMI (Man Machine Interface)
Veolia Transport	CZ	Bus operation in Neratovice town

MMI System (LCD panel), which will be developed, will demonstrate interesting parameters of the new bus (energy flows, amount of CO_2 and other harmful substances "saved" during run) to its passengers.

3. PROJECT CHARACTERISTIC

3.1 Project partners

Main partners of the project are listed in Table 1. Important project partners are also Central Bohemia region - transport section, town Neratovice and TUV SUD Prague that provide licensing of the bus operation on highways.

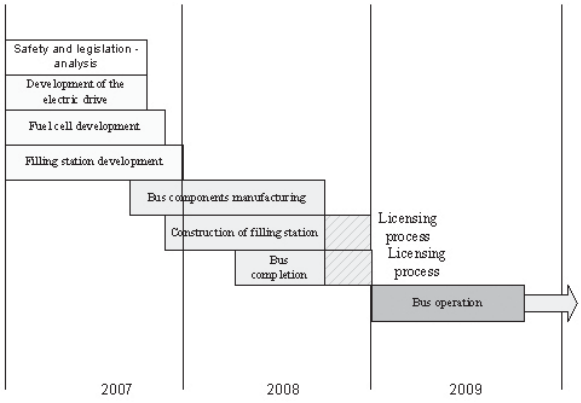

Fig. 6 Project time schedule

3.2 Time schedule

Time schedule of the project is given on Figure 6.

3.3 Financing

The hydrogen purification issue is at present addressed within the framework of the ongoing project of the Ministry of Industry and Trade of the Czech Republic, in which, besides the main contractor - Nuclear Research Institute Rez plc, participate Spolana and ICT Prague. The project objective is hydrogen in a quality suitable for fuel cells.

Development and manufacturing of the bus and filling station is co-financed from the EU Structural funds, total sum of 3,4 mil •, subsidy 75% (Operational Program Infrastructure programme, action 2.3 - support of the alternative fuels implementation). For technical reasons the project was divided into two parts: development and realisation.

4. CONCLUSION

The Czech Republic step-by-step joins in the international effort of starting-up the hydrogen economy seen as a way to achieve the sustainable growth and significant improvement of the environment. At the past, in our country this effort is very sporadic and divided, therefore the presented project will be a clear momentum, which would in this area set the Czech Republic forward - into the family of the most developed countries. This has already moved to the initialization of the Czech Hydrogen Technology platform (www.hytep.cz). Thus, the project realisation will put the base for the Czech ecological transport. As a result, the harmful emissions and noise pollution of the environment will be significantly reduced and last but not least - reduced will be also dependence on the oil import.

Reference

Nuclear Energy Research Advisory Committee and the Generation IV International Forum, *A Technology Roadmap for Generation IV Nuclear Energy Systems*, U. S. DOE, 2002.

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