Project

The transport and mobility sector is strongly responsible for the production of climate effecting gases. Due to mobility reasons most vehicles are powered by liquid, fossil fuels, which are well known to emit carbon-dioxide when burned in internal combustion engines. A “classic” hybrid drivetrain structure is capable of reducing the fuel consumption, but still requires fossil fuels. Within the Cologne region hydrogen qualifies as an adequate carbon-dioxide-free energy carrier, since it is a byproduct of the local chemical industry. To use this hydrogen environmentally reasonable for public transportation, the federal state of North Rhine-Westphalia (NRW) and the Netherlands support the development and evaluation of four hybrid electric fuel cell busses for public transportation.

Kindly promoted by:
EUROPÄISCHE UNION
Investition in unsere Zukunft
Europäischer Fonds
für regionale Entwicklung

The financial volume of the project is calculated to be around 4.7 million Euro for the partners from NRW, whereof the EU supports the project with ca. 2.1 million euro and the state of NRW provides ca. 360,000 Euro.

Project Partners

The project consortium consists of three industrial partners from NRW and the Netherlands, next to the academic partners and operating companies.
The project coordinator Vossloh Kiepe GmbH from Düsseldorf is in charge of the electrical system and drivetrain setup. Responsible for the development of the nickel-metal hydride battery is Hoppecke Batterien GmbH & Co. KG from Brilon. The body work of the bus is established by the Dutch partner APTS, based on one of their ‘Phileas’ models.

The academic partners RWTH Aachen and Cologne UAS establish the energy storage and energy management concept within the project. Furthermore their duty is the commissioning and system optimization based on modeling and simulating of the entire drive drain and on-duty measurements within the vehicles on line service.

Two of the four H_2-Bus prototypes are employed by the operating company RVK in the cologne region, while the other two are operated by the company GVB in the city of Amsterdam.

vossloh Electrical Systems
HOPPECKE POWER FROM INNOVATION
RWTH ISEK
APTS Advanced Public Transport Systems bv
Fachhochschule Köln
Cologne University of Applied Sciences
Institut für Automatisierungstechnik

Motivation

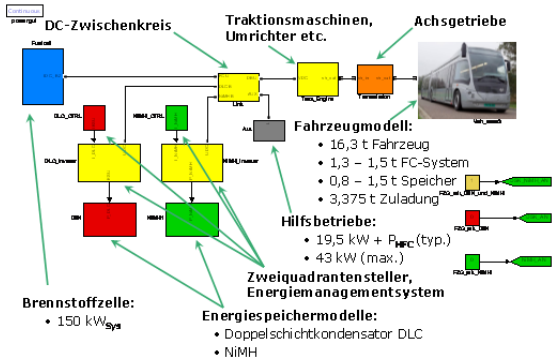
Central intention of this project is the development of an energy management system for a highly efficient drive train topology to use in public transportation vehicles. Additionally the lifetime of the essential components needs to be maximized to consequently minimize both, attendance and operating expenses.

The most expensive component is the fuel cell. At the same time this component is strongly affected by abrasion, due to the fact that the fuel cell´s lifetime decreases with increasing dynamics in the operating point.

Due to this fact the energy management system has to establish a stable power output of the fuel cell, although especially urban traffic is characterized by a strongly fluctuating power demand. Accordingly efficiency and lifetime of the fuel cell are maximized.

Modeling and Simulating

The decision, which energy storage topology is the most reasonable in terms of energy management (NiMH-, Li-Ion, Double-Layer-Capacitor topology or combinations of those), is based on Matlab/Simulink simulations.



Based on realistic public transportation driving cycles, the model helps to evaluate drive train components and their dimensions, like the battery´s capacity for example. During further progress of the project several energy management algorithms are developed, to minimize the use of primary energy per driven kilometer. Additionally fuel cell and energy storage units should be conservatively operated to assure a maximal lifetime for the components.

Fachhochschule Köln
Cologne University of Applied Sciences
Fakultät für Informations-, Medien- und Elektrotechnik

Institut für Automatisierungstechnik
Prof. Dr.-Ing. Andreas Lohner

Electric Motor Test Bench

Within the Cologne UAS facility an engine test bench was installed alongside the actual setup of the prototypes, in order to provide an adequate testing environment for energy management purposes. During the first EMS design and implementation phase, the test bench was used to ensure the proper functionality of the EMS. During the present evaluation and optimization phase, the test bench allows to test any kind of algorithm and software changes without interfering with the passenger operation.

Project History

Development time:	02/2009 – 04/2011
Delivery to operator:	05/2011
Line employment:	Since 09/2011

State of Project (Dez. 2012)

- Continuous bus line service in Hürth (RVK) and Amsterdam (GVB)
- Energy management system optimization
- Data recording and analysis alongside bus line service

Project Management

Prof. Dr.-Ing. Andreas Lohner
Dipl.-Ing. (FH) Tobias Balensiefen M.Sc.
Tel.: +49 (0) 221 8275 2257
E-Mail: tobias.balensiefen@googlemail.com

Laboratory Management

Prof. Dr.-Ing. Andreas Lohner
Dipl.-Ing (FH) Michael Nixdorf
Tel.: +49 (0) 221 8275 2261
E-Mail: andreas.lohner@fh-koeln.de
michael.nixdorf@fh-koeln.de

Faculty Office

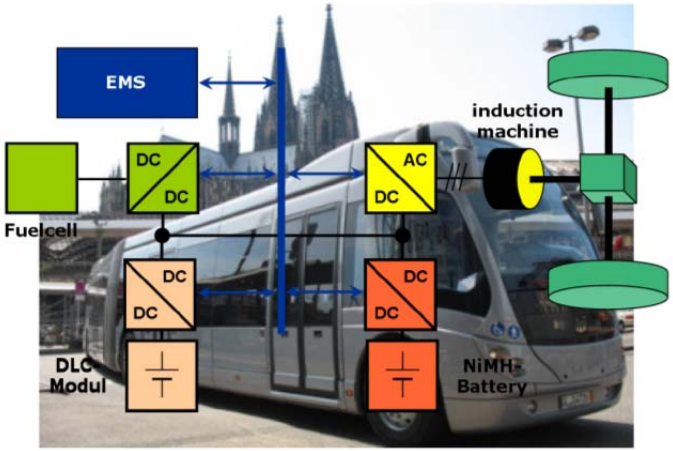
Frau Elke Jaax
Tel.: +49 (0) 221 8275 2252
Fax: +49 (0) 221 8275 2445
E-Mail: elke.jaax@fh-koeln.de

Adress Information

Fachhochschule Köln
Betzdorfer Str. 2
D-50679 Köln
www.fh-koeln.de
www.et.fh-koeln.de/ia/aa/index.html

Fachhochschule Köln
Cologne University of Applied Sciences

Fakultät für
Informations-, Medien- und Elektrotechnik



Development, Integration and Optimization of an Energy Management System for a Hybrid Electric Fuel Cell Bus with DLC Storage and NiMH Battery

Prof. Dr.-Ing. A. Lohner
Institut für Automatisierungstechnik