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Project acronym: HyTRAN

Project title: Hydrogen and Fuel Cell Technologies for Road Transport

Instrument: Integrated Project

Thematic Priority: Sustainable Surface Transport

Publishable Executive Summary

Periodic activity report (48M)

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Start date of project: Jan 1st, 2004 Duration: 60 months

Project coordinator: Per Ekdunge, Volvo Technology
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1 Publishable executive summary

1.1 Introduction

The scope of the HyTRAN project is to advance the fuel cell technology towards solutions that are commercially viable. This is to be demonstrated in two fuel cell systems:

- **Technical Platform 1 (TP1):** Direct hydrogen 80 kW Proton Exchange Membrane (PEM) fuel cell for propulsion.
- **Technical Platform 2 (TP2):** A 5 kW PEM fuel cell system including a diesel based fuel processor for Auxiliary Power Unit (APU) applications.

Issues of oil dependency, greenhouse gas emissions and local air pollution are currently highly associated with the transport sector. Hydrogen and fuel cell technologies are widely seen as promising alternatives to internal combustion engines in road transport applications. In this respect, components and sub-systems are considered as major bottlenecks for fuel cell based vehicle systems. These project incentives are the background for HyTRAN being focused on the development of the necessary components and sub-systems. The specific aim is to make them meet the actual requirements derived from the two applications.

The expected outcome of the HyTRAN project is thus new components, sub-systems and systems. For the automotive manufacturers involved, another equally important outcome is the comprehensive knowledge and experience generated on these new and advanced fuel cell technology systems and an assessment of how they can best meet market requirements. For the suppliers' viewpoint, a further key outcome is the trade-off assessment of components on a system level and with end-user requirements.

The challenges for the technologies deal with factors such as cost, durability, weight, volume, efficiency that all need to be improved. A multitude of components are developed in HyTRAN such as:

- An 80 kW direct hydrogen stack with strong weight and volume reduction, increased efficiency, durability and start-up time, and with innovative MEAs.
- Balance-of-plant components customised for the application, for example air system and humidification devices.
- Micro-structured diesel steam reformer and gas purification units.

HyTRAN started in January 2004. The first three years have mainly been devoted to the development of innovative components to widen the technology. Considering the fourth year increased focus has been put on the integration of these components into subsystems, including tests and implementation into vehicles.

In total, 17 partners now participate in the project with their specific roles described in the following figure.

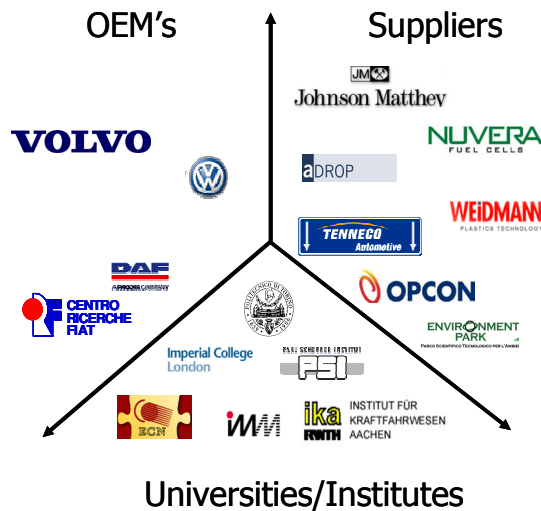


Figure 1. HyTRAN partners during 2007 and their role.

There are also transverse activities concerning dissemination and training, environmental, safety and marketing studies going on in two separate subprojects. Public seminars and technical courses are reported at project's website: www.hytran.org.

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1.2 Progress and main achievements

The main events for developing the **hydrogen fuel cell platform, TP1**, were during the first years stack design, characterising tests, air supply, water and thermal management studies. This work focused on the definition of the specification that could make the realization of a scalable FC system possible, considering the required characteristics of efficiency and compactness.

During the recent year of the project, activity focused mainly on development of subsystems and components. In some cases, subsystems were then ready to be sent to the testing phase. The work performed includes a design phase with vehicle layout, fuel cell system integration and control of an innovative powertrain.

The realisation of the fuel cell vehicle in HyTRAN is led by Centro Recherche Fiat. It incorporates a full power system, which is able to deliver all the power required by the

electric engine. This new generation fuel cell system offers high generating efficiencies and mainly consists of:

- Three fuel cells modules manufactured by Nuvera with innovative MEA developed by Johnson Matthey
- An innovative twin screw air compressor developed by Opcon to supply the cells with air directly humidified into the compressor itself
- A cooling system for correct management of reactant gases and a set of auxiliary components developed by CRF

Installation of a fuel cell powertrain on a vehicle introduces new features on vehicle design, with modifications involving all parts of the vehicle (body, floor, and chassis). The results from the integration and layout studies are shown in the figure below.

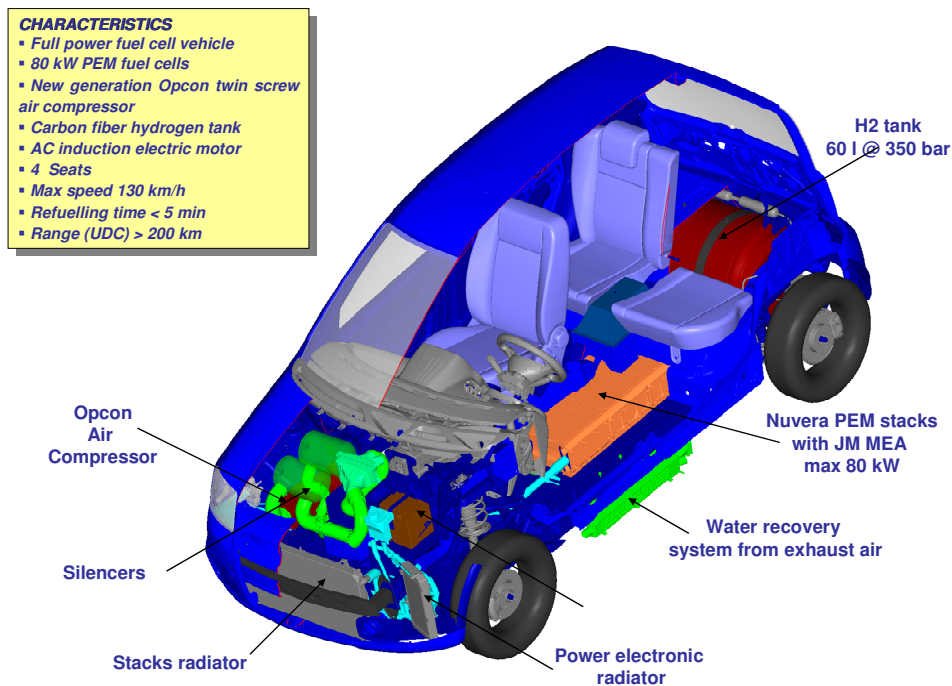


Figure 2. TP1 fuel cell vehicle, Panda HyTRAN, with main components and characteristics.

The progress from activities in HyTRAN for TP1 during 2007 is mainly according to plan, with foreseen delays not affecting reaching main targets. Among the technical achievement are:

- Manufacturing and delivery of hydrogen stack
- Development and manufacturing of twin screw compressor with water injection and silencers
- Design and components for hydrogen feeding line
- Virtual installation of FC powertrain completed

- Control strategies developed and HAZOP performed
- Global model in Matlab/Simulink available
- Mechanical/electrical modifications to existing vehicle in progress
- FTA analysis completed

Also for the **diesel fuelled FC APU system, TP2**, continued activities during the first years were devoted to develop the key components and provide a viable system design for the 5 kW system. This can be broken down to the main subsystems:

- Fuel processor with integrated components, all reactors based on micro-channel heat exchangers
- Fuel cell, stack design & membrane electrode assembly (MEA) development
- Air supply system

The fuel processing system has the aim to produce a hydrogen-rich gas by reforming diesel fuel. This will then be used in the PEM fuel cell and together act as a part of an APU application for vehicles. For example, truck drivers use electrical on-board equipment during resting, (radio, phone, television, computer, freezer, microwave, air conditioning, cab ventilation). When idling, diesel engines run at one of its most inefficient working points. Both emissions and fuel consumption from idling can be reduced with a diesel fuelled FC APU system.

In HyTRAN, the technology will be demonstrated in a laboratory system, which can be regarded as a compromise between a compact system that could be mounted on a truck and a system that is comfortable for testing in the laboratory. This system has a modular build up, with a hot area mainly consisting of the fuel processing parts.

The overall progress from the year on the platform level is best demonstrated by the state of the integration of the APU components in end of 2007 as shown in Figure 3 and Figure 4.

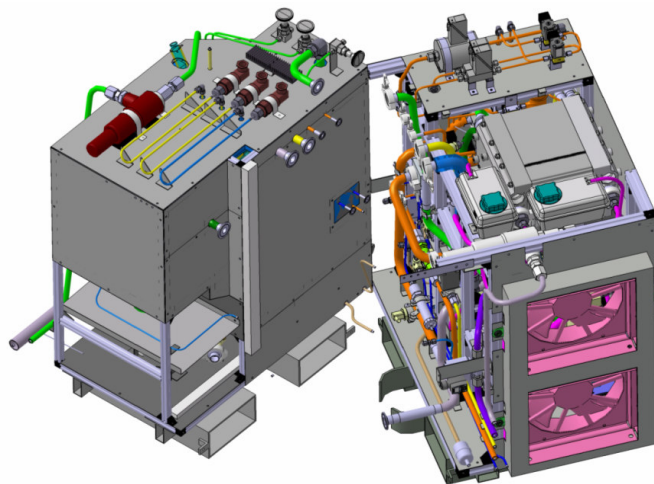


Figure 3. TP2 laboratory system, the modular build up and interfaces between hot and cold area.



Figure 4. Fuel Cell APU prototype during assembly.

In more detail, the highlights from this year's activities can be listed as:

- Laboratory system scheme final design freeze and updated CAD model
- Manufacturing and construction of fuel cell APU prototype
- Safety study conducted and the results implemented in the system layout
- Stack tested and waiting for integration
- Compressor system developed, tested and delivered
- Most of the sub-system tests finished
- A virtual system study to point out way forward for a future product has been performed, including a first draft of CAD model