HySYS: Fuel Cell Hybrid Vehicle System Component Development

Project Overview

Final Event
22.09.2010 Stuttgart, Germany
Jörg Wind
Daimler AG
FACTS

Coordinator: Daimler AG

Total budget: 22.7 M€

EC-Funding: 11.2 M€

Partners: 28 (17 Industry, 2 SMEs, 4 Institutes, 5 Universities)

Countries: 8 EC Member States and Switzerland

Duration: 01.12.2005 – 30.11.2010
HySYS - Fuel Cell Hybrid Vehicle System Component Development

IP-Partners

6 OEM’s

DAIMLER  CENTRO RICERCE FIAT  VOLVO
PSA PEUGEOT CITROËN  RENAULT

14 Suppliers

AVL  SAFT  BOSCH  fumatech  NuCellSys  Continental
Eldor Corporation  Rivoira  Selin  ATB  Fischer  Precise
Magna Steyr  e2V

3 Institutes

ENEA  CNM  TNO

5 Universities

Hochschule Esslingen
University of Applied Sciences
Motivation

- Improvement of system components for FC-hybrid vehicles is necessary to meet all necessary requirements for mass production
- Involve supplier industry more deeply in FC- and ICE Hybrid component development by cooperation in a European project
- Close cooperation of car industry with suppliers is needed for a successful market introduction of FC-vehicles

Objective

- Improved low cost FC-system components (air supply, hydrogen supply, humidifier, H$_2$-sensors) suitable for mass production
- Improved low cost E-drive components (E-motor, power electronics, battery) suitable for mass production
- Optimised system architecture for low energy consumption and high performance
- All achievements will be validated in vehicles (2 validators)
Project Goals

- Improvement of **fuel cell** system components for **market readiness**
- Improvement of **electric drive train** components (Synergies FC and ICE-hybrids) for market readiness
- Optimisation of **system architecture** for low energy consumption, high performance, high durability and reliability
- Optimisation of energy management, enhanced FC-drive train efficiency
- Development of low cost components for **mass production**
- **Validation** of component and system performance on **FC Vehicles**
Regarded Components

- Low cost automotive **electrical turbochargers** for air supply with high efficiency and high dynamics
- Low cost **humidifiers** with high packaging density
- Low cost **hydrogen sensors** for automotive use
- Effective low cost **hydrogen supply** line
- High efficient, high power density **electric drive train**
- Low cost high power **Li-ion batteries**
## Definition of Vehicle Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DAIMLER Validator (MB-Sprinter)</th>
<th>CRF Validator (FIAT Panda)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Power (cont/Peak)</td>
<td>70 / 100 kW</td>
<td>40 / 75 kW</td>
</tr>
<tr>
<td>Fuel Cell Power</td>
<td>80 kW</td>
<td>60 kW (nominal)–75 kW (peak)</td>
</tr>
<tr>
<td>Gearbox</td>
<td>One gear ratio</td>
<td>One gear ratio</td>
</tr>
<tr>
<td>Batterie LiIon</td>
<td>30 – 50 kW, 2 kWh</td>
<td>Not foreseen</td>
</tr>
<tr>
<td>Weight empty/fully loaded</td>
<td>&lt;= 2.7 t / 3.5 t</td>
<td>1.4 t / 1.7 t</td>
</tr>
<tr>
<td>Range at ½ load</td>
<td>&gt; 300 km</td>
<td>250 km</td>
</tr>
<tr>
<td>Vmax</td>
<td>130 km/h @ grade 0%</td>
<td>140 km/h @ grade 0%</td>
</tr>
<tr>
<td>Vmax continuous</td>
<td>0-80km/h &lt; 21 s</td>
<td>0-50km/h &lt; 7 s</td>
</tr>
<tr>
<td>Acceleration</td>
<td>0-100 km/h &lt; 37 s</td>
<td>0-100 km/h &lt; 15 s</td>
</tr>
<tr>
<td>Climbing ability fully loaded</td>
<td>35%</td>
<td>23 %</td>
</tr>
<tr>
<td>Vmax at ½ load on 4% slope</td>
<td>N/A</td>
<td>&gt; 80 km/h</td>
</tr>
</tbody>
</table>
HySYS component integration

- The HySYS validators use different base fuel cell systems and e-drive train components
- Some major components are replaced by those which are developed in HySYS

HySYS components which are integrated in the validators:

- Air supply: electric turbo charger and integrated air sensor
- Hydrogen Metering Device
- Hydrogen humidification system
- Electric Motor
- Inverter
- DC/DC converter
- Li-Ion battery system
Vehicle Integration – DAIMLER Validator: Packaging Concept

HV Battery

Converters

Drive Train

H2 Storage

FC Stack

Air supply

HV Battery
VEHICLE INTEGRATION – CRF VALIDATOR:
Packaging Concept
Fuel Cell System Components, #1

Air supply

Current Technology:
Screw-Compressor

Innovative Technology:
Electrical Turbocharger

- High Efficiency
- Low Cost, volume & weight
- High Dynamic response
- Noise reduction

Humidifier

Current Technology:
Contact humidifier

Innovative Technology:
Gas-to-gas humidifier

- high packaging density
- high humidification efficiency
- low degradation tendency
- low cost materials
- easy production technology

Involved partner: Fischer, Daimler, Bosch
Wind, Daimler

Involved partner: Fumatech, Daimler, CRB, Rivoira

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### Hydrogen Sensors

**Current Technology:**
- electrochemical sensors
- semiconductor sensors
- catalytic bed sensor

**Innovative Technology:**
- Palladium Nanostructure

- Low cost, weight & volume
- Fast response
- No calibration needed
- High gas selectivity
- Integrated design

### Hydrogen supply line

**Current Technology:**
- standard H2 line with pressure regulator valves

**Innovative Technology:**
- Fully automated H2 line with Hydrogen Metering Device

- dual stage pressure reduction
- fully automatic operation
- flexible regulating FC stack pressure
- fail safe with failure recovery
- improved lifetime of FC system

Involved partner: EPFL, MiCS, PSA, LIRIM, Montpellier

Involved partner: Bosch, CRF
E-Drive System

Current Technology:
AC induction and PM brushless with low liquid cooling temperature (55-60 °C) power electronics

Innovative Technology:
Buried PM synchronous and mixed motors
• e-motor: higher specific torque-power and efficiency
• power electronics: higher integration and cooling temperature (up to 90 °C)
• HV-HV DC/DC converter: modular solution with high power density

Battery System

Current Technology: Ni-MeH

Innovative Technology: Li-ion
• higher specific power: from 1.35 to 2 kW/kg
• higher specific energy: from 46 to 63 Wh/kg
• higher efficiency: from 85 to 95%
• improved lifetime: from 8 to 15 years

Involved partners: CRF, Eldor, Daimler, PSA, ContiTemic, ATB, Univ. Maribor, wind, Daimler

Involved partners: Saft, Daimler, PSA, ContiTemic, Magna, ENEA
Parameter characteristics of fuel cell system during NEDC driving cycle

- Requested Current
- Electrical Load
- Stack Voltage
- Air mass flow
- Stack Current

Graphs showing data trends over time.

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Fuel Cell System Efficiency Comparison

Fuel Cell system efficiency comparison

EUCAR TTW (V2c 07)

HySYS efficiency (Faraday)

Fuel Cell System Comparison:
HySYS fuel cell system efficiency compared with fuel cell system efficiency curve from EUCAR WTW Study
Thank you very much for your attention

More information on:
http://www.hysys.eu