Fuel cells and hydrogen

Joint undertaking

FCGEN project presentation

Programme Review Day 2012
Brussels, 28 & 29 November 2012

New Energy World JU
fuel cells & hydrogen for sustainability

http://www.fch-ju.eu/

Presentation Template

0. Project & Partnership description (1 slide)

Project name:

Fuel Cell Based On-board Power Generation

Project acronym: (FCGEN)

Programme: Seventh Framework programme of the European union

Project coodinator: Jazaer Dawody, Volvo Technology

Grant agreement no. : (277844)

Start date: 2011-11-01

End date: 2014-10-31

Project budget : 10 338 414 €

FCH JU contribution: 4 342 854 €

Partners

- Volvo Technology AB (Volvo), Sweden
- Powercell Sweden AB (Powercell), Sweden
- Forschungszentrum Juelich GMBH (Juelich), Germany
- Institut Jozef Stefan (JSI), Slovenia
- Centro Ricerche Fiat SCPA (CRF), Italy
- Institut fuer Mikrotechnik Mainz GMBH (IMM), Germany
- Johnson Matthey PLC. (JM), United Kingdom
- Modelon AB (Modelon), Sweden

1. Project achievements - project targets

To develop and demonstrate a proof-of-concept complete fuel cell based 3 kW$_{(net\ el.)}$ auxiliary power unit in a real application, on-board a truck.

- To further develop key components and subsystem technologies that have been advanced by the project partners in previous collaborations and move them closer towards commercially viable solutions.

1a: Vehicle Integration

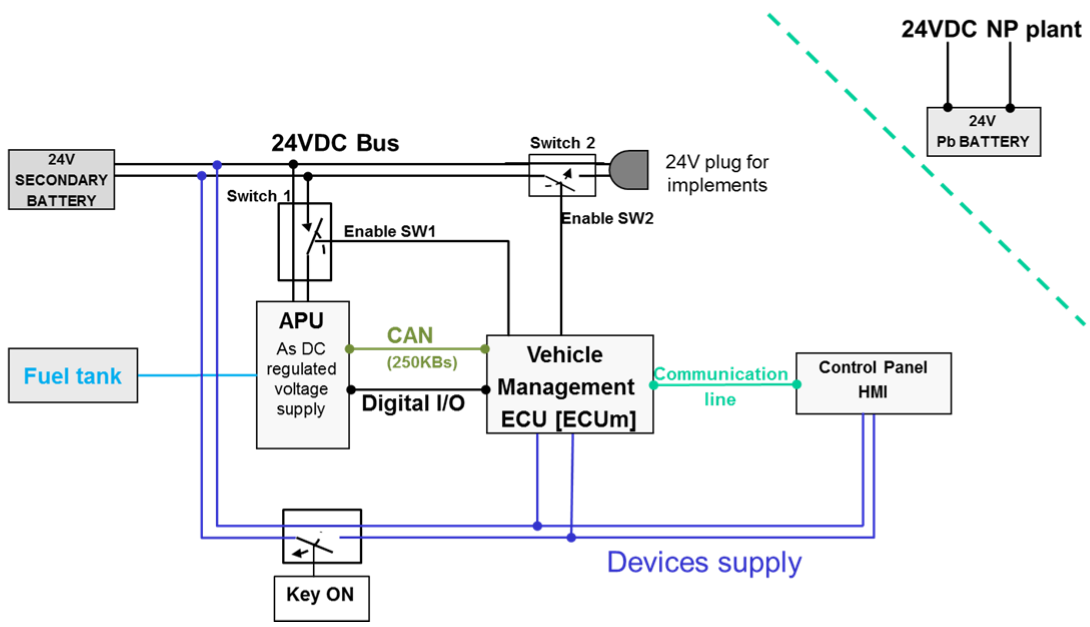
WP Leader: CRF

- Annual mission definition for truck covering traveling and stop phases. The mission definition covers traditional speed and engine load, but also vehicle auxiliaries usage and electric load.
- Business case evaluation for APU use in stationary use (profit). Also the business case in traveling phase was evaluated for complete analysis (loss).
- The engine auxiliaries were analyzed to be electrified to further exploit the APU performance during the vehicle stop phases.
- Definition of power requirement for the APU.
- Definition of the electrical layout and mechanical constraints for the APU integration on the vehicle.
- Definitions communication requirement for the APU.
- Definition of the HMI for the APU management on vehicle.

1a: Vehicle Integration

WP Leader: CRF

To facilitate the integration work, the electric architecture will be first based on a plug-in solution with a 24V independent battery supply for the APU. A Li-ion battery will be selected. After experimental testing the integration with the vehicle 24V powernet will be evaluated to have just one 24V battery.



1b: Fuel processor development

WP Leader: Juelich

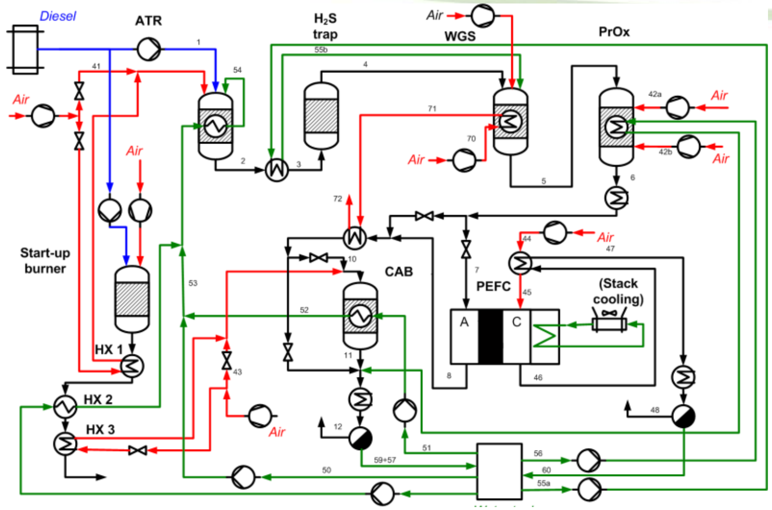
- ***System architecture***
  - WP3.1 Fuel processor design (M01-M06), Juelich
- ***Component development***
  - WP3.2 Reformer development (M01-M36), Juelich
  - WP3.3 Desulphurization (M01-M21), JM
  - WP3.4 Clean-up system (M01-M24), IMM
  - WP3.5 Catalytic burner (M01-M24), Juelich
  - WP3.6 Start-up system (M01-M21), Powercell
- ***Experimental evaluation***
  - WP3.7 Fuel processing demonstration (M19-M24), Volvo

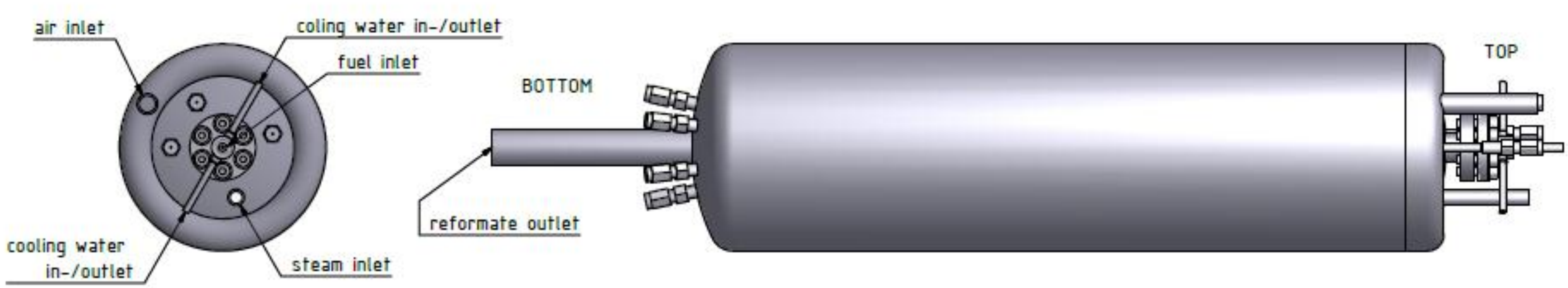
Milestones: Fuel processor system design *(M06)*

Reformer ready (M24)

Autothermal reformer design ready

Fuel processor system design ready

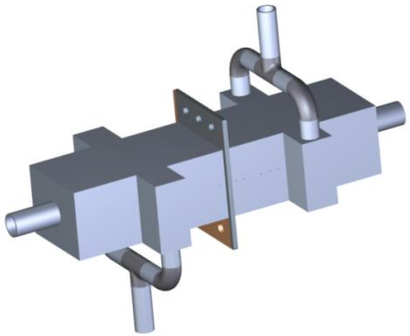




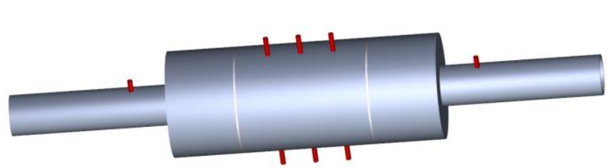
1b: Fuel Processor development

WP Leader: Juelich

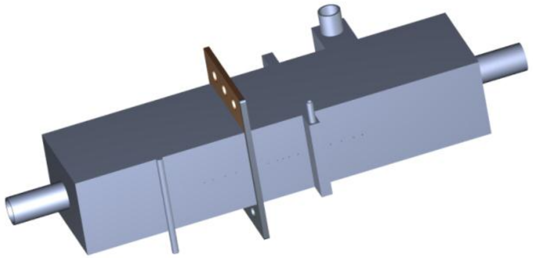
Design water-gas-shift reactor



Design desulphurisation trap



Design Prox reactor



Design catalytic burner

Development of catalysts with focus on PGM thrifting and and robust materials for desulphurisation

Coated substrates

Microchannel plates

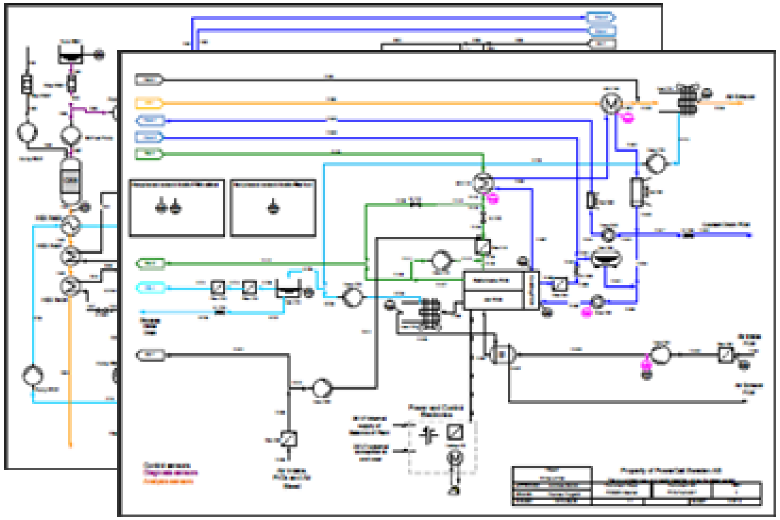
Structured sulphur sorbent

1c: Complete APU system

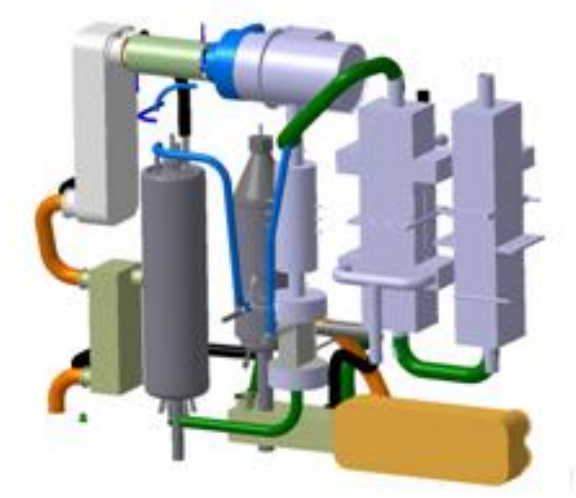
WP Leader: PowerCell

- **Simulation and optimization support for APU design**
  - WT2.1 Full system modelling, design and verification (M01-M24), Modelon
- **BOP (Balance of plant) design, implementation and test**
  - WT2.2 BoP optimization (M01-M15), Powercell
  - WT2.3 Components and subsystem testing (M07-M21), Powercell
- **Integration/packing of APU components/subsystems for vehicle environment**
  - WT2.4 System integration and packaging (M06-M27), Powercell
- **Commissioning of full APU prior to installation in vehicle**
  - WT2.5 Complete system testing and demonstration in lab (M20-M30), Powercell

Milestones: APU system design concept (M12), BoP components (M15), APU integrated on truck (M30)



System design



Initial packing of FuelProcessor

1c: Complete APU system

WP Leader: PowerCell

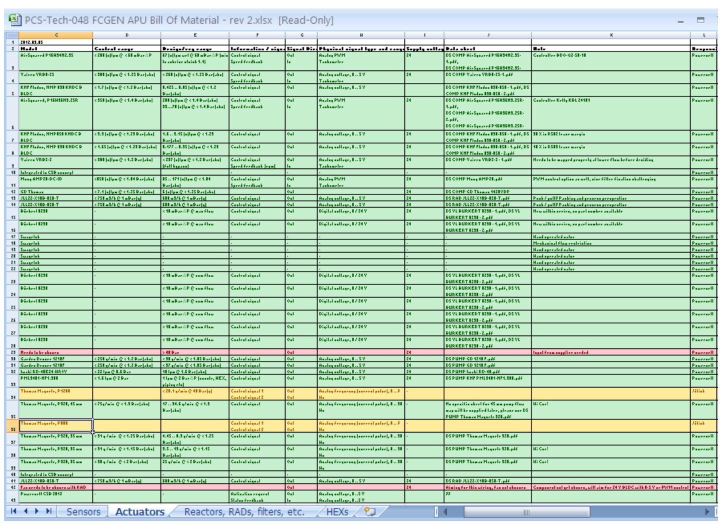
BOP (Balance of plant) design, implementation and test

Deliverables:

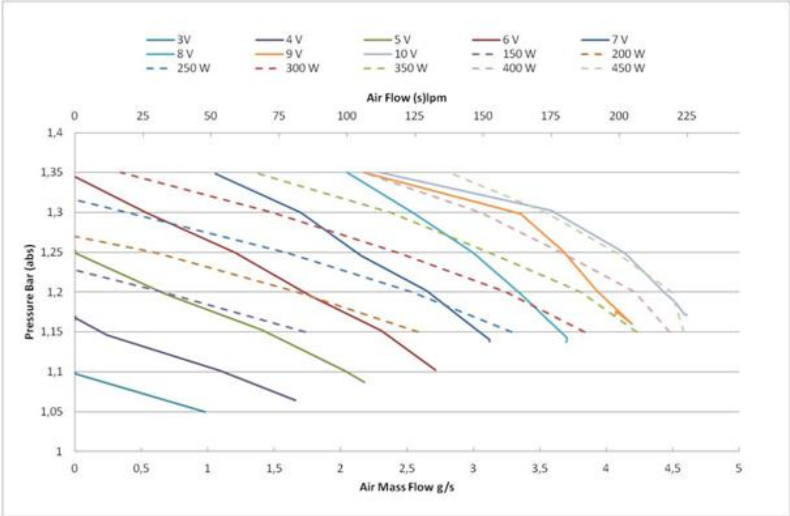
- D2.3 BoP air, coolant and process water subsystems **initial** design **(M10)** , PowerCell
- D2.3 BoP air, coolant and process water subsystems **final** design **(M15)**, PowerCell

Status ”initial” M10:

- System design is still subject to modification, e.g. fuel suppy, cooling for powerEl, MFM for control.
- ”Good” candidates for 37 of 41 actuators, 53 of 54 sensors, 5 of 7 HEXs, most passive components.
- ~ 25 % of main candidates for actuators verified in component and sub-system level tests. HEX testing and design is ongoing.



Bill of Material



Plot from Blower test

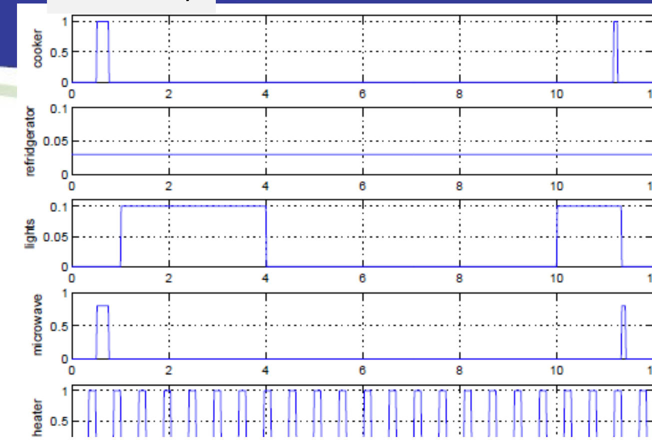
1d: Control system, electrical interface and power conditioning

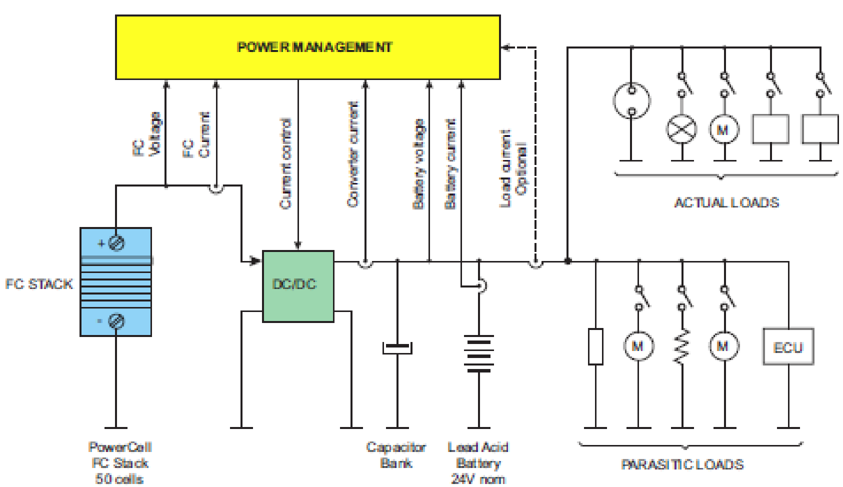
WP Leader: JSI

- ***development of the Control System (CS)***
  - WT4.1 CS architecture and functionalities (M01-M12), JSI
  - WT4.2 CS development and testing (M08-M28), JSI
- ***development of a vehicle interface***
  - WT4.3 Vehicle interface (M07-M18), CRF
- ***power conditioning of the APU electrical energy***
  - WT4.4 Power conditioning (M19-M24), JSI
- ***functional testing of control system***
  - WT4.5 Hardware in the loop testing (M10-M26), Powercell

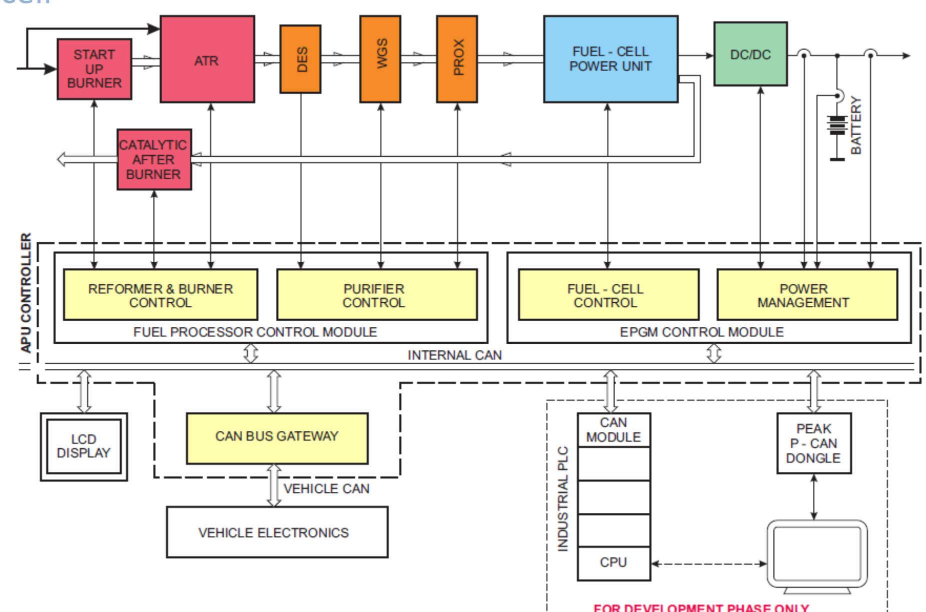
Milestones: *CS prototype (M18), CS ready (M24)*

Load study





Power conditioning



APU control system

2. Alignment to MAIP/AIP

MAIP targets Topic: 3.4.1 2008 - 2013	Project approach to reach the MAIP target	Status at30% of the project
Demonstrations of increased efficiency of on-board power generation and reduce CO2 emissions and local pollutions	*-system design optimization for most proper utilization of heat generated in the system for streams heating where needed.* - *Select optimized BOP components to reduce parasitic losses in the system* *- substitute homogeneous start-up burner used for system heating at start-up with catalytic burner to reduce the amount of emitted pollutants such as CO, NOx and unburned HC at start-up* .	- initial simulations show that a system efficiency of 30% at steady state condition with the current system design is achievable. - Some of the selected and tested BOP components have demonstrated low parasitic losses. - A Catalytic start-up burner is acquired. Tests are on-going to find the most optimal operating conditions for the unit to ensure ultra low pollutant emission levels.

2. Alignment to MAIP/AIP

AIP targets Topic: 2.1 Call: 2010	Project approach to reach the AIP target	Status at30% of the project
Research, development and proof-of-concept demonstration of APU systems for on-board power generation	- *development of functional and mature components and sub-systems that can withstand the on-board conditions.*	- fuel processor units are designed based on the defined requirements and are currently under construction. - several BOP components are acquired and tested - system design optimization to reduce the number of components and ensure proper performance. - control system architecture and functionalities defined and conceptual design is ready.
Demonstrated feasibility of using logistic fuels	*Run the system on low sulfur diesel (EN590)*	The fuel type is selected. On-going work to prepare the demonstration vehicle for the integration of an additional tank for the selected fuel
Demonstrated fuel processing technology for logistic fuels	*Test the reformer catalysts during the development face with the selected fuel*	reformer catalyst development is on-going using the selected fuel
Defined requirements for fully integrated systems in the specific application.	- *ensure system compactness to fit on the specified place on the truck.* - *ensure secure system design to avoid hazards upon system operation.* - *prepare the vehicle for on-board integration of APU and communications between the vehicle and the APU system*	- Initial Fuel processor packaging model ready - study on Vehicle interface and specification ready. - on-going work on risk analysis

3. Cross-cutting issues

- Contributions to Training and Education :
  - academic partners may use the non-confidential knowledge gained in the project in training and academic courses if suitable.
- Safety, Regulations, Codes and Standards:
  - *Safety issues will be covered and reported in the project in form of reports and FMEA work.*
- Dissemination & public awareness:
  - non-confidential project findings will be presented in conferences, workshops, etc.
- Information on publications:

  expected number of peer-reviewed papers during the project time: 8

  expected number of conferences and workshops per year: 4

  expected generated patents during the entire project time: 2

4. Enhancing cooperation and future perspectives

- Technology Transfer / Collaborations
  - The FCGEN project is using *important knowledge and findings from previous EU projects such as HyTran, some of which are highlighted below*
    - *System compactness via employment of multi functional components such as catalyst-coated micro channel heat exchangers.*
    - *Lessons learned from system design strategies giving optimal basis for system architecture, integration and coupling/decoupling issues.*
  - Proposed future research approach and relevance
    - *the project findings will be used for future development work where the APU system can be upgraded to function as electric power provider under driving conditions for example for replacing some of the current auxiliaries in the truck*