



FUEVA

EUROPEAN FUEL CELL VEHICLES TECHNOLOGIES VALIDATION

Workshop: Regulations, Codes and Standards for H₂/FC Technologies

Brussels, 25th of February 2005

Martin Schüssler

e-mail: schuessler@ika.rwth-aachen.de

Overview

Project partners

ika INSTITUT FÜR
KRAFTFAHRWESEN
RWTH AACHEN

PSA PEUGEOT CITROËN

VOLVO

CENTRO
RICERCHE
FIAT



Research &
Advanced Engineering



Start: 01.01.2003
Duration: 42 month
Budget: 2 M€
EU contribution: 1,2 M€

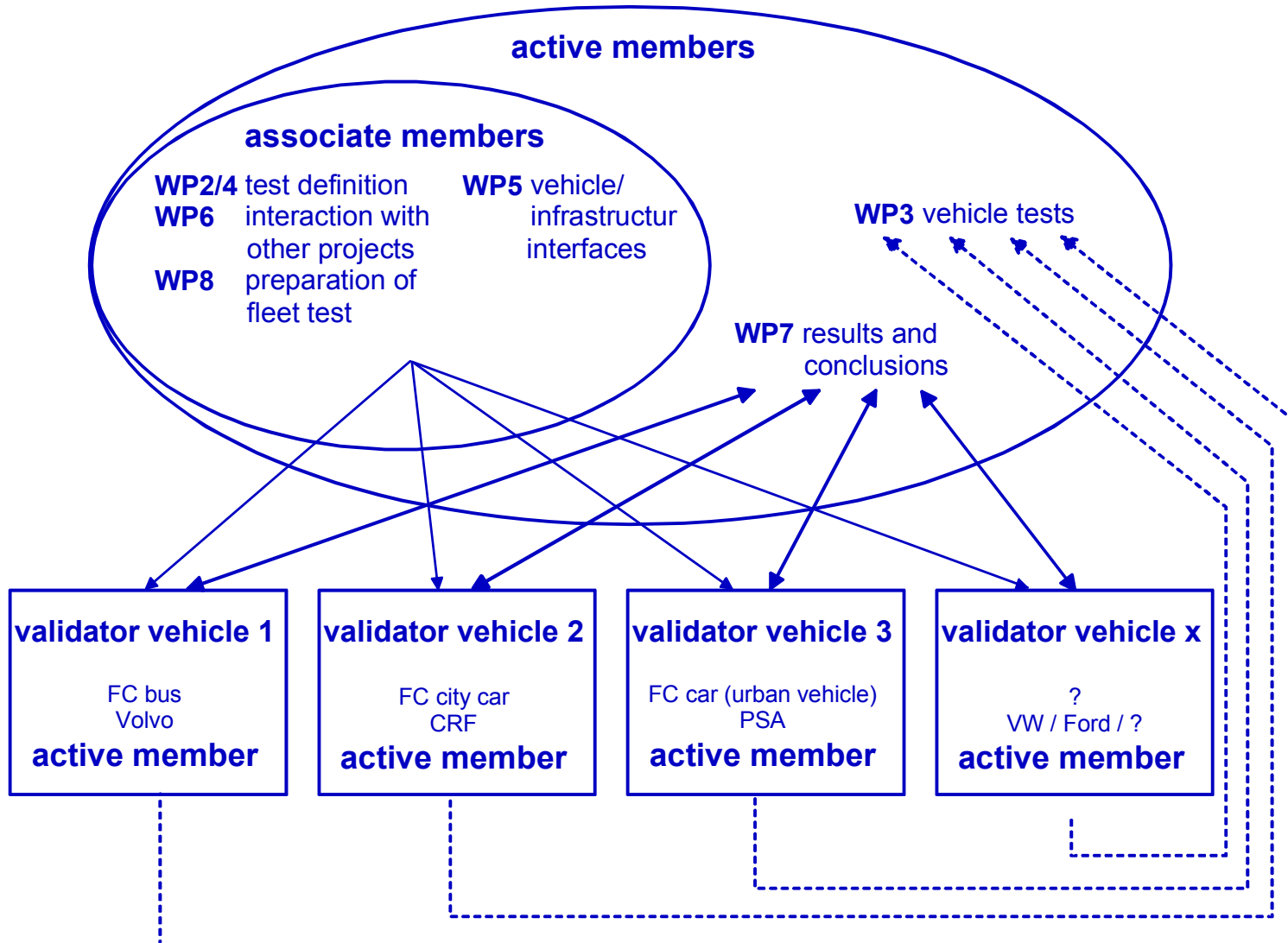
Overview

Work package description

2003				2004				2005				2006	
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
● WP1: Overall co-ordination lead by ika													
● WP2: Definition of test procedures for FCV regarding energy consumption and max. power lead by Renault													
● WP3: Test bench preparation & Execution of vehicle tests lead by ika													
● WP4: Definition and preparation of field tests for FCV regarding max. speed, noise, acceleration, etc. - lead by Renault													
● WP5: Hydrogen Infrastructure, refuelling (stations) and common interfaces lead by Volvo TEC													
● WP6: Interaction to other FC projects and standardisation/regulation organisations lead by C.R.F.													
● WP7: Results and conclusion in technological and operational point of view lead by PSA													
● WP8: Requirements and specifications for “Future European demonstration projects” lead by PSA													

Overview

Project structure



EU directives & ECE regulations

Bench test activities	European Regulation	ECE Directive	Priority
Fuel Consumption H ₂	R101	80-1268	XXXX
Fuel Consumption Liquid & CO ₂ emissions	R101	80-1268	XX
emissions	R83-05	70-220	XX
Start up time & energy	(R 101)	70-220	XX
Maximum Power & 30 min	R85-84	80-1269	XXXX
Maximum Electrical power (FC system + Battery)	--	new draft	XXXX
Range with fuel + Battery	(R 101)	--	XX
Range with fuel	(R 101)	--	XX

EU directives & ECE regulations

Field test activities	European Regulation	ECE Directive	Priority
Noise level (NVH)	R51-02	70-157	XX
Electromagnetic compatibility	R10-02	80-1268	X
Maximum speed & 30 min	R68-01	--	XX
Acceleration 0 – 100 km/h			XX
Acceleration / Stop 0 – 1000 m			XX

EU directives & ECE regulations

Documents that have been modified up to date:

- ECE R101 (version to be validated by measurements)
- ECE R85 (version to be validated by measurements)
- ECE R68
- Customer Assessment Criteria
- Road operating characteristics
- Preliminary specification of interface for gaseous hydrogen refuelling

H2 measurement

H2 measurement methods

- **Electric current method:** the hydrogen consumption is calculated by measuring the output current of the fuel cell stack
- **Pressure temperature method:** the hydrogen consumption is calculated by measuring the pressure and the temperature of the gas in the high-pressure fuel tank before and after the test, calculating the change in the number of moles of gas in the storage by applying the measured values of p and T to the state equation
- **Weighing method:** the hydrogen consumption is calculated by measuring the weight of the high-pressure fuel tank before and after the test procedure
- **Flow volume method:** the amount of hydrogen supplied to and consumed by a fuel cell vehicle is measured by a flow meter, which will be installed in the H_2 feed pipe in between an external fuel supply source and the vehicle

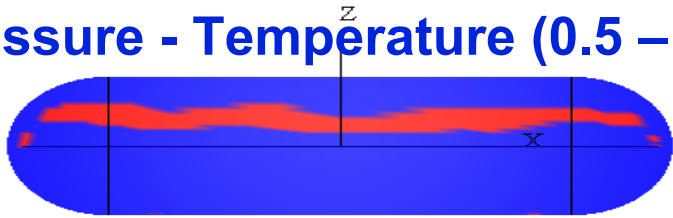
Main issues:

**Measurement range, accuracy and dynamics
(strongly depending on the method)**

H2 measurement

Benchmarking of H2 measurement methods suitable for H2 FCV

Pressure - Temperature (0.5 – 1%)



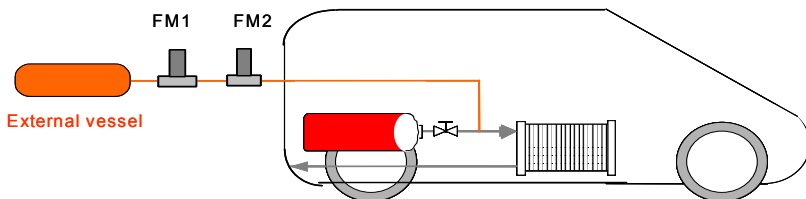
Redlich-Kwong Equation \leftrightarrow Van der Waals

Weight (0.2 – 0.5 %)

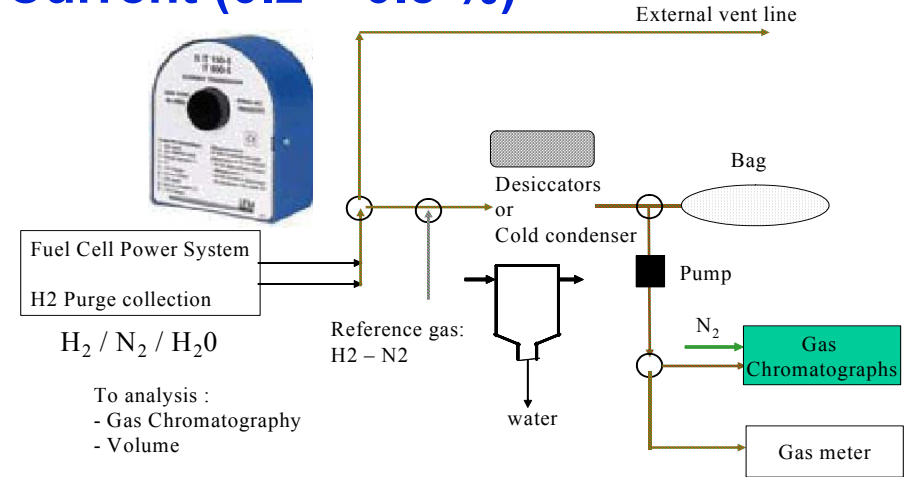


Accuracy Target: Error < 1 %

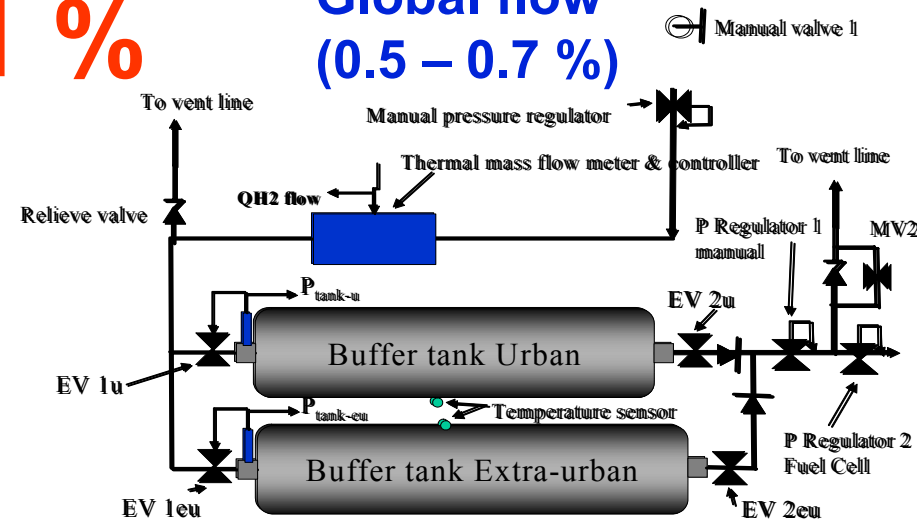
Instantaneous flow (0.9 – 1.3 %)



Current (0.2 – 0.5 %)

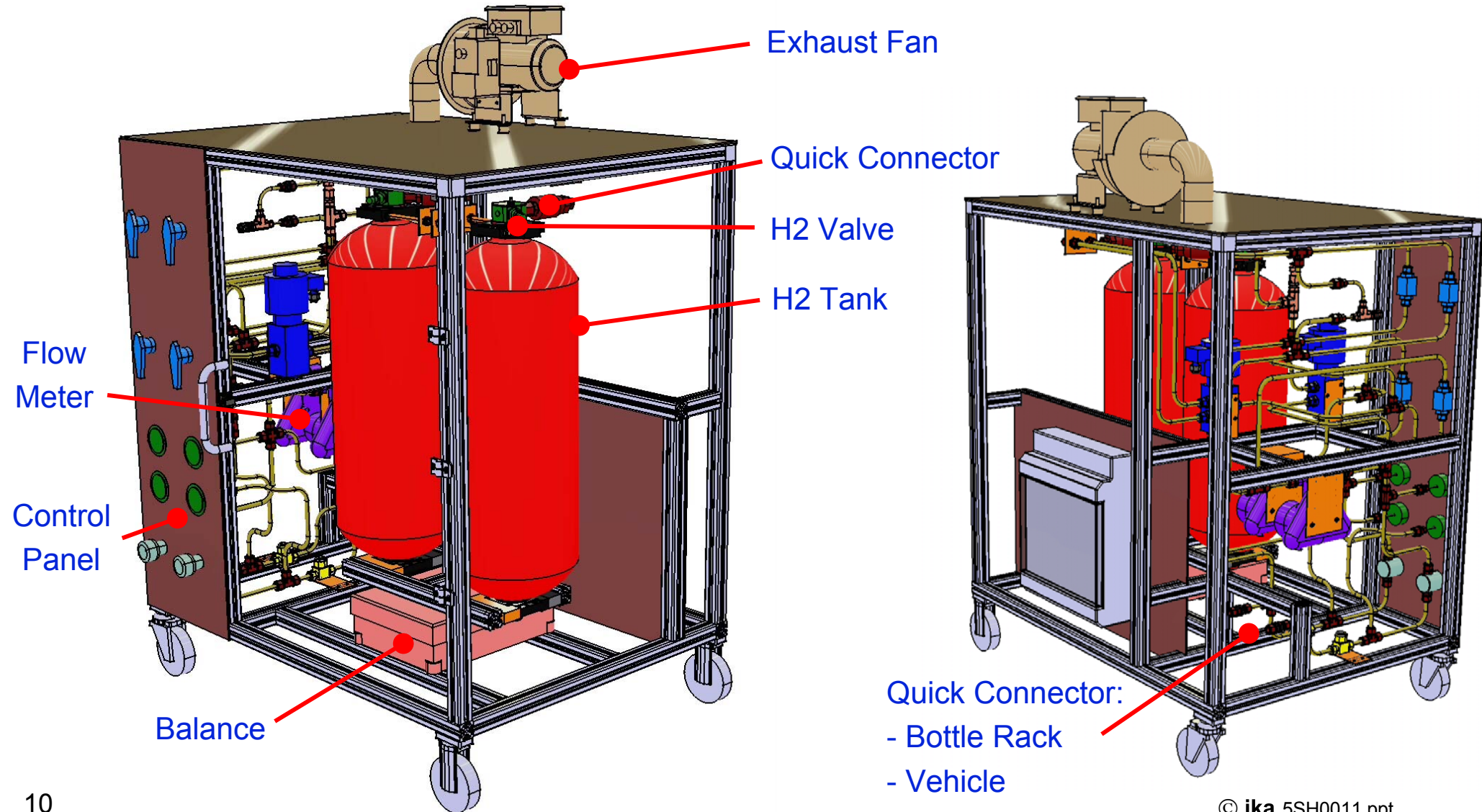


Global flow (0.5 – 0.7 %)



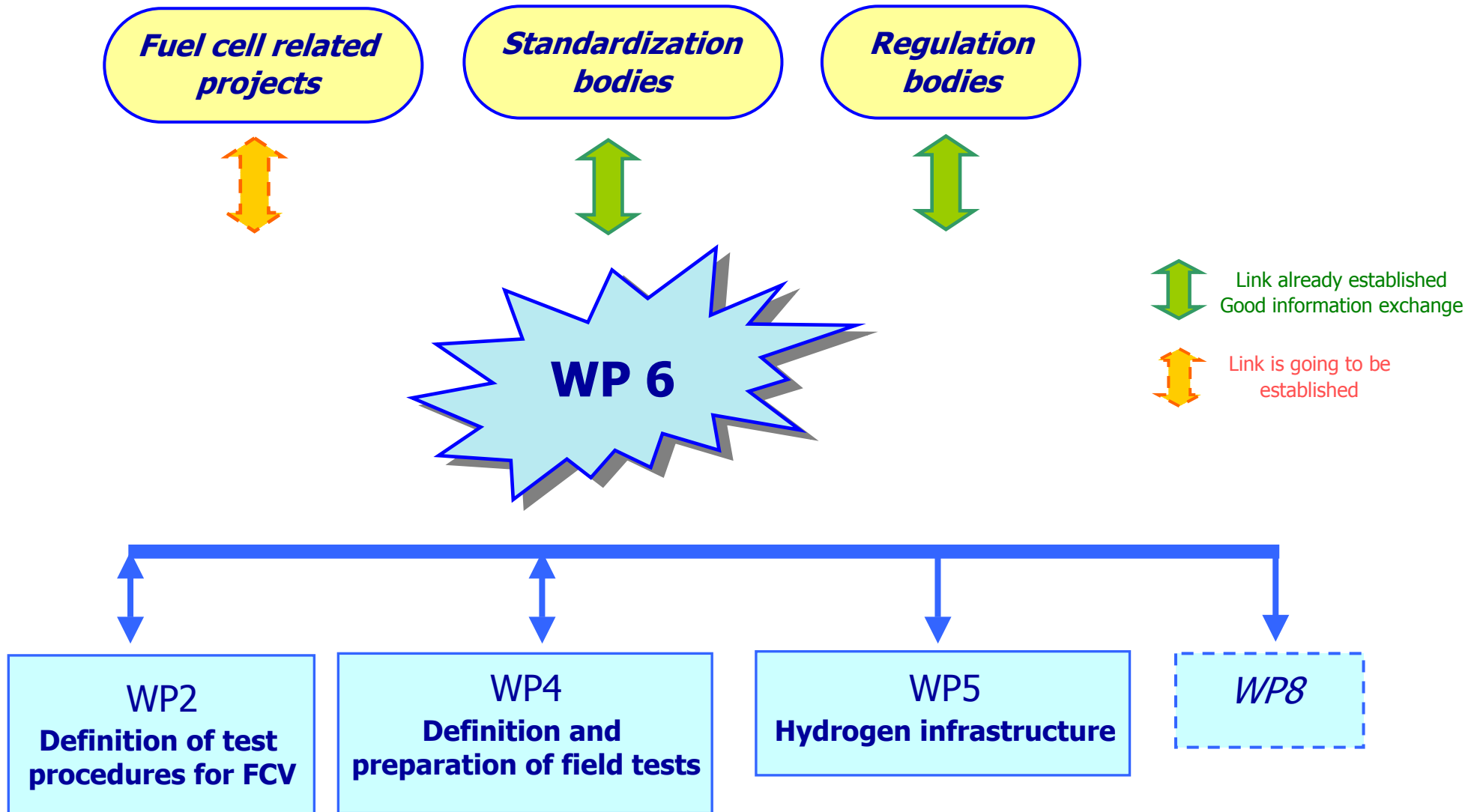
H2 measurement

HYMEM "Hydrogen Measurement Equipment (mobile)"

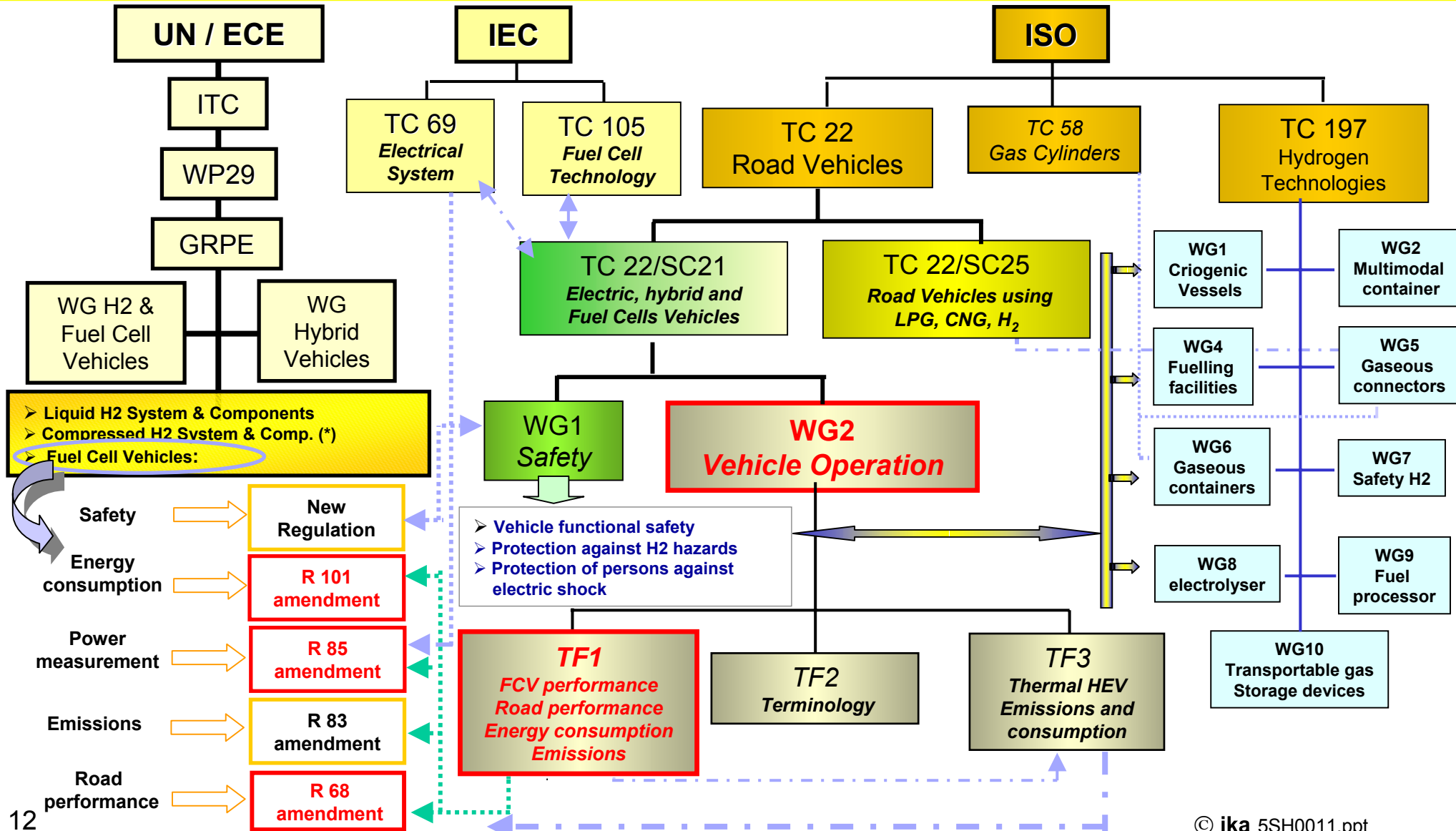


FUEVA cooperation

Internal and external links



FUEVA and S&R Bodies (1)



FUEVA and S&R Bodies (2)

	Standard by ISO TC22/SC21	Standard by ISO TC197	UN ECE Regulations	SAE Standards
<p>Other aspects including energy and environmental considerations</p> <ul style="list-style-type: none"> - Fuel consumption * - Fuel quality • - Fuel Cell System Power measurement - Road performance (proposal) ■ 	<p>Involved: WG 2/TF1 F.C. Electric Hybrid Road Vehicles Energy consumption measurement *</p> <p>Part 1: Fuelled with compressed Hydrogen (ISO/TC22/SC21/WG2/TF1 N°47) Pure F.C. Road Vehicles</p> <p>Energy consumption measurement *</p> <p>Part 1: Fuelled with compressed Hydrogen (ISO/TC22 /SC21/WG2/TF 1 N°38-2)</p> <p>Electric Hybrid Road Vehicles Road operating ability measurement (ISO/ TC22/SC21/WG2/TF1 N°46) ■</p> <p>Pure F.C. Road Vehicles Road operating ability measurement (ISO/TC22/SC21/WG2/TF1 N°41) ■</p>	<p>ISO 14687 Hydrogen fuel – Product specification</p>	<p>R 101 Amendment proposal concerning energy consumption measurement for Pure F.C. and Hybrid F.C. vehicles fuelled with gaseous H2 (<u>Proposal by FUEVA project consortium</u>)</p> <p>R 85 Amendment proposal concerning approval of internal combustion engines or electric drive trains, ... with regard to the measurement of Net Power and 30 min Power.</p>	<p>J 2572 Recommended practice for measuring the exhaust emissions, energy consumption and Range of fuel cell powered electric vehicles using compressed gaseous hydrogen</p> <p>J 2601 Compressed hydrogen vehicles fuelling communication devices</p> <p>J 2615 References test procedures of fuel cell systems for Automotive application</p> <p>J 2616 Performance test procedures for the fuel processor sub-system for automotive application</p> <p>J 2617 Performance test procedures of PEM fuel cell stack subsystem for automotive application</p>

- Modification of regulations, codes and standards for usage with FCV with focus on fuel consumption measurement
- Preparation of test equipment
for performing the various measurement methods at different locations
- Start of vehicle measurements in mid of 2005
- Refinement of the proposed documents
- Verification of measurement methods,
also possible in cooperation with other European projects

Thank you for your attention.

Contact: Martin Schüssler
e-mail: schuessler@ika.rwth-aachen.de
phone: +49 241 8025625