

Fuel cells and hydrogen

Joint undertaking

Program Review Days 2013

Introduction to portfolio of System development, Components, Materials and Operation Diagnostics projects – Energy R&D



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

Nikolaos Lymperopoulos, Project Manager

Agenda Day 2

Morning

09:00 – 09:45

Introduction to portfolio of System development, Components, Materials and Operation Diagnostics projects

- **Energy:**
- **Transport:**

Nikolaos Lympieropoulos, FCH JU Project Manager
Carlos Navas, FCH JU Project Manager

Q&A session

09:45 – 10:15

Coffee break & networking

10:15 – 12:15

PARALLEL SESSIONS on Systems, Components and Materials Development projects for Energy and Transport applications

SESSION 1

Degradation Analysis and Materials Development for CHP

Moderators: Florence Lefebvre-Joud, Alan Atkinson

SESSION 2

Materials Development for Hydrogen Storage and Portable applications

Moderators: Andreas Dorda, Nikos Lymberopoulos

0:15-10:45

KEEPEMALIVE 'Knowledge to enhance the endurance of PEM fuel cells by accelerated lifetime verification experiments'
Steffen Moller-Holst, SINTEF

HYCOMP 'Enhanced design requirements and testing procedures for composite cylinders intended for the safe storage of hydrogen'
Clemence De Villers, Air Liquide

0:45-11:15

SOFC-LIFE 'Solid-Oxide Fuel Cells – Integrating degradation effects into lifetime prediction models'
L.G.J de Haart, Forschungszentrum Juelich

SSH2S 'Fuel Cell Coupled Solid State Hydrogen Storage Tank'
Marcello Barricco, University of Torino

1:15-11:45

MAESTRO 'Membranes for stationary application with robust mechanical properties'
Deborah Jones, Université de Montpellier II

HYPER 'Integrated hydrogen power packs for portable and other autonomous applications'
Juliet Kauffmann, Orion Innovations

1:45-12:15

METSAPP 'Metal supported SOFC technology for stationary and mobile applications'
Niels Christiansen, Topsoe Fuel Cell A/S

DURAMET 'Improved durability and cost-effective components for new generation solid polymer electrolyte direct methanol fuel cells'
Antonino Arico, CNR-ITAE

12:15 – 13:30

Lunch (Poster session)

Agenda Day 2

Afternoon

13:30 – 14:30

PARALLEL SESSIONS on Systems, Components and Materials
Development projects for Energy and Transport applications

SESSION 1

Sustainable Hydrogen Production

Moderators: Eden Mamut, Jean-Luc Delplancke

SESSION 2

Materials Development for Transport

Moderators: Daria Vladikova, Joerg Wind

13:30-14:00

COMETHY 'Compact multifuel-energy to hydrogen converter'
Alberto Giaconia, ENEA

PEMICAN 'PEM with innovative low cost core for automotive application'
Joel Pauchet, CEA

14:00-14:30

RESELYSER 'Hydrogen from RES: pressurised alkaline electrolyser with high efficiency and wide operating range'
Regine Reissner, DLR

STAMPEM 'Stable and low cost manufactured bipolar plates for PEM fuel cells'
Anders ØDEGARD, SINTEF

14:30 – 15:00

Coffee break & networking

15:00 – 15:30

Introduction to portfolio of Cross-Cutting projects

Cross-Cutting Issues: Guillaume Leduc, FCH JU Project Manager

15:30 – 17:00

SESSION on Cross-Cutting projects

Moderators: Guillaume Leduc, Carlos Navas

15:30-16:00

HYINDOOR 'Pre-normative research on safe indoor use of fuel cells and hydrogen systems'
Béatrice L'Hostis, Air Liquide

16:00-16:30

FC-EUROGRID 'Evaluating the Performance of Fuel Cells in European Energy Supply Grids'
Robert Steinberger-Wilckens, University of Birmingham

16:30-17:00

TEMONAS 'Technology monitoring and assessment'
Peter Claassen, CLIMT

17:00 – 17:30

Concluding remarks - Scientific Committee members

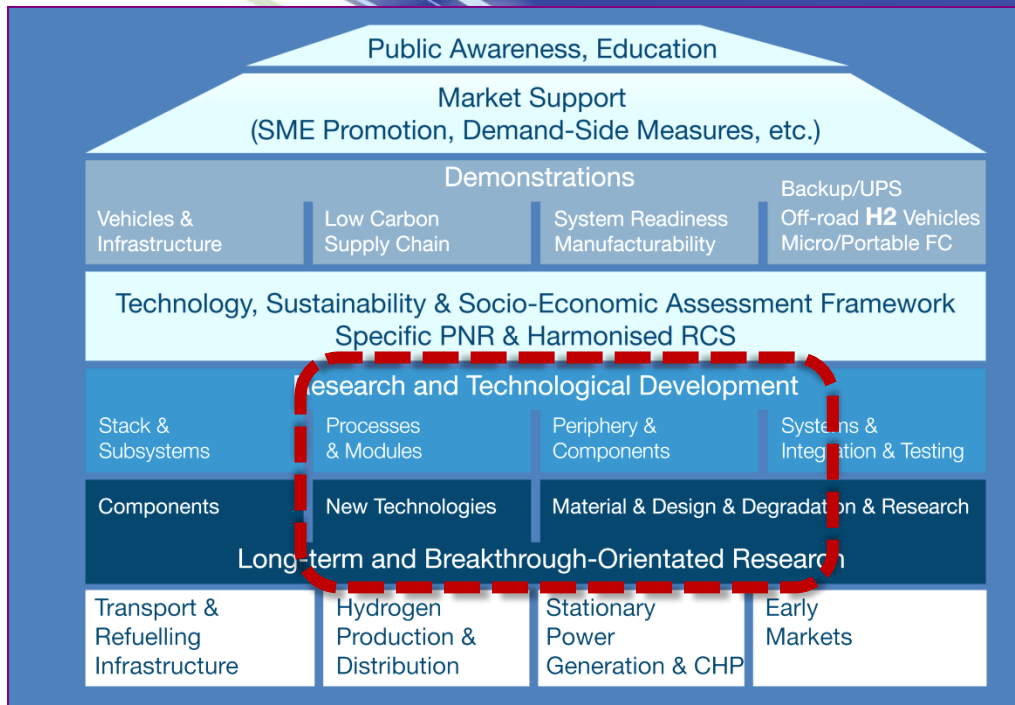
17:30 – 18:00

Closure speech
Bert de Colvenaer, FCH JU Executive Director

18:30 – 21:00

Cocktail dinner

FCH for ENERGY: 89 projects



RTD:
62 projects

DEMO:
27 projects

**Materials development
for cells, stacks and BoP**
21 projects

Portable
7 projects

**Fundamentals of
Degradation**
9 projects

**Operation *diagnostics*
and control**
5 projects

**Validation of integrated
systems readiness**
5 projects

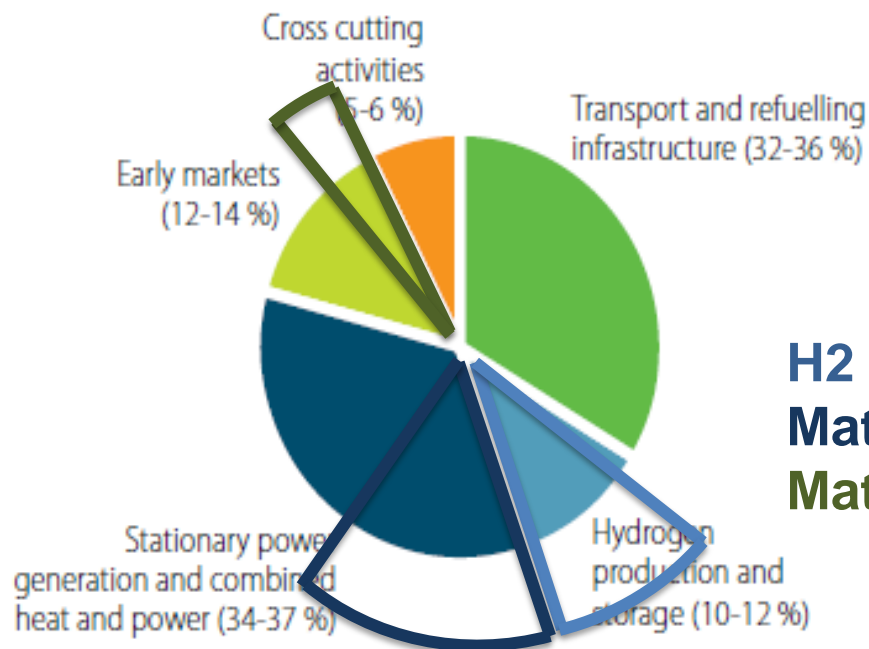
**Proof-of- concept
Systems**
4 projects

H2 storage
3 projects
Sustainable H2 production
22 projects

**Components
Improvement**
6 projects

Technology Readiness Level, TRL

470 M€ FCH JU Budget distribution



FCH JU Support

H2 Production & Storage 10.4% (50.9M€)

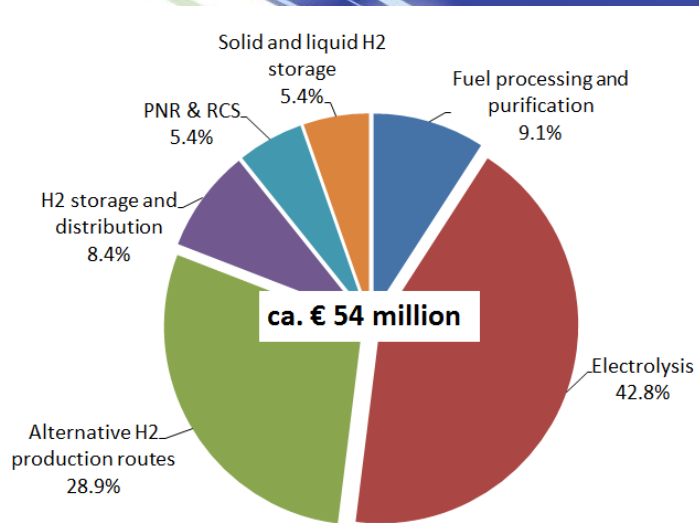
Materials for CHP 15% (70.6M€)

Materials for portable 3% (13.6M€)

AA2 Sustainable H2 Production MAIP objectives

- Develop cost-competitive, energy efficient, sustainable H2 production processes**
- Various feedstocks**
- Centralised (large scale) or distributed (small scale)**
- Short-term: meet demand with mature technologies**
- Longer-term: variety of technologies exploiting mainly renewable energy sources**
- Hydrogen storage in gaseous, liquid and solid form**

AA2 Sustainable H2 Production MAIP Coverage



Total R&D: 28 projects, 50.9M€

Low Cost, low Temp electrolysis: 4 projects, 6 M€

High temp electrolyzers: 4 projects, 10.1 M€

Materials for PEM electrolyzers: 2 projects, 4 M€

Biomass to H2: 1 project 2.2 M€

**High Temp thermochemical water decomposition:
3 projects, 5.3 M€**

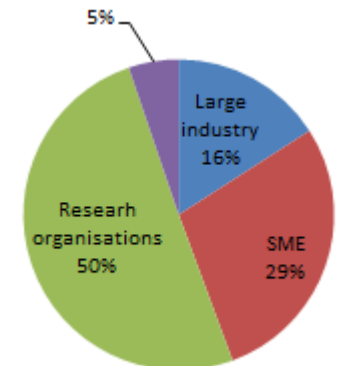
Low temp H2 prod. processes: 4 projects, 8.1 M€

H2 Storage & Distribution: 3 projects, 4.5 M €

PNR & RCS: 2 projects, 2.9M €

Solid and Liquid Storage: 2 projects, 2.9 M €

Fuel processing, and gas purification: 3 projects, 4.9 M€



AA2 Sustainable H2 Production

Main Technical Achievements

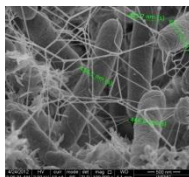
- Alkaline electrolyzers with advanced membranes, $\eta > 80\%$, 1000 on/off cycles, 3,000€/Nm³/hr
- Development of large scale PEM electrolyzers aiming for MW scale commercial units
- SOE electrodes operating at 700°C, 15% increased performance @ 0.9A/cm²
- Advanced catalysts for steam reforming at 400-550°C
- Thermochemical water splitting using solar energy: simulations - pilot-scale demonstration
- 1-10kg/day H₂ production from thermophilic fermentation of 2nd gen biomass
- 50% reduction of energy consumption for the liquefaction of hydrogen through up-scaling and optimisation.
- Improved designs and testing procedures for pressurised hydrogen tanks
- Hydrogen delivery with 400bar composite tanks
- 5 wt% H₂ in MH tanks capable of 20NI/min for 2h, integrated with FC



RESelyser



SSH2S



HYTIME



PRIMOLYSER



DELIVERHY



SOL2H2



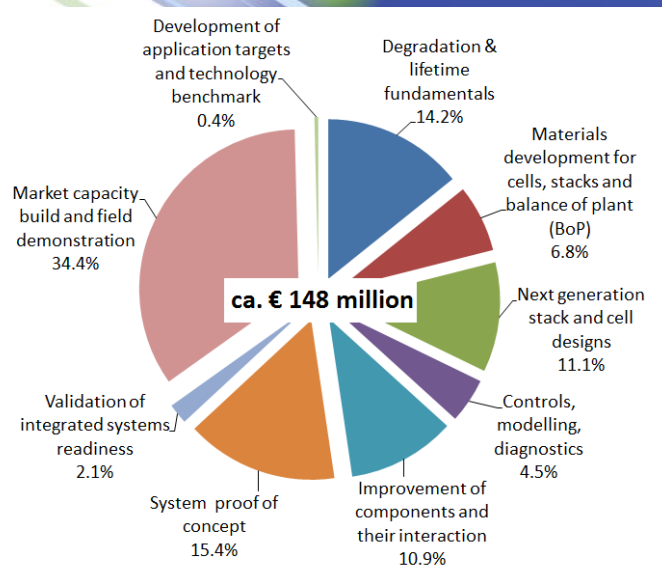
UNIfHY

AA3 Stationary CHP Degradation & Materials MAIP objectives

- **Improve FC stack and BoP components**
- **R&D on:**
 - Degradation and lifetime fundamentals
 - New and improved materials
 - Control and diagnostic tools
 - Components and sub-systems
 - Novel cell & stack architectures

Step change in endurance, robustness, durability, cost

AA3 Stationary CHP Degradation & Materials MAIP Coverage



Degradation: 11 projects, 21.1 M€

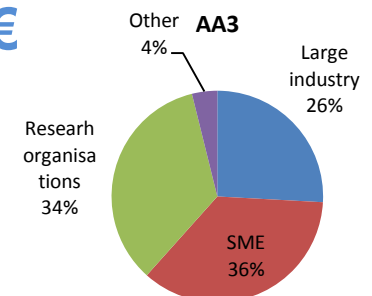
**Materials development for cells, stacks and BoP:
5 projects, 10.1 M€**

Next generation stack and cell design: 7 projects, 16.5 M€

Control and diagnostics: 4 projects, 6.7 M€

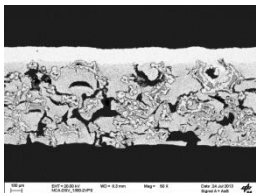
Improvement of components, 7 projects, 16.2 M€

Total for R&D: 34 projects, 70.6 M€

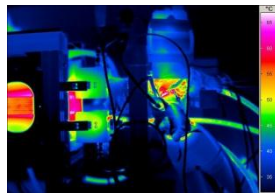


AA3 Stationary CHP Degradation & Materials Achievements

- 160-200°C PEM stacks with >20,000 h lifetime and $\eta > 45\%$
- Metal supported tubular SOFC with >40,000 h lifetime
- Triode architecture of SOFCs for x10 power factor and $\eta > 55\%$
- AFCs with advanced stack design → estimated 100MW @ 1,500-2,000 €/kW
- Ammonia fuelled 5kW AFCs for remote power
- Membranes and MEAs with improved mechanical properties
- Improving durability through accelerated testing procedures



EVOLVE



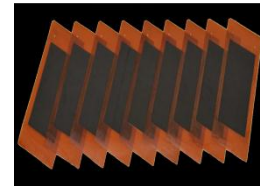
EUREKA



DeMStack



MAESTRO



CISTEM

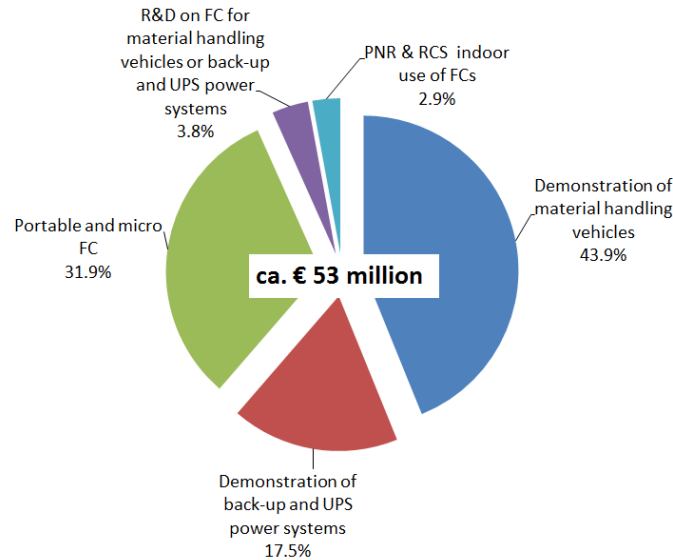


ALKAMONIA

AA4 Early Markets Portable Apps MAIP objectives

- **Show the technology readiness of portable and micro FCs**
- **R&D on:**
 - **Reduced cost of FC**
 - **Improved efficiency & lifetime**
 - **Enhanced fuel supply, reduced H2 delivery costs (supply concepts, on-board reforming)**

AA4 Early Markets Portable Apps MAIP Coverage



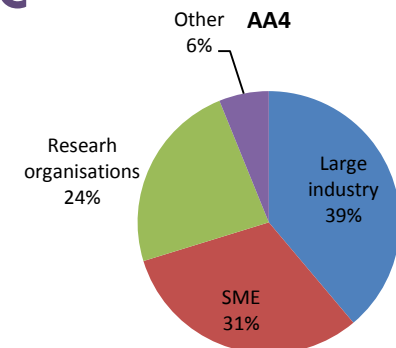
Fuel supply concepts for portables: 2 projects, 2.4 M€

Durability of micro FCs: 1 project, 1.5 M€

R&D of new portable FC systems: 4 projects, 7.7 M€

R&D of 1-10kW FC systems: 1 project, 2 M€

Total for R&D: 8 projects, 13.6 M€



- Optimised DMFC components with reduced cross-over and 2x<degradation, PGM <0.5 mg cm²
- Miniaturised SOFCs & BoP for UAVs, resulting to doubling of flight times
- H₂ based power packs (20kg/kW, 20l/kW))for portable apps
- Portable internal reforming methanol high temperature PEM



Conclusions: R&D in Energy

Comprehensive level of MAIP coverage

- **Conventional and innovative H₂ production concepts supported**
- **All FC technologies covered in CHP applications**
- **PEM, DMFC, SOFC in portables**

- FCs for power production: η increase, cost reduction to levels competitive with conventional technologies
- H2 production: η increase, reduce capital cost
- Demonstrate the feasibility of using H2 to support the integration of RES into the energy systems



Thank you for your attention!

Further info:

- FCH JU: <http://fch-ju.eu>
- NEW-IG: <http://www.new-ig.eu>
- N.ERGHY: <http://www.nerghy.eu>