# Priorities & Progress in Hydrogen Energy Research in the EU

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**European Commission**

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***Event: "Materials Innovations in an Emerging Hydrogen Economy" Conference***
***24-27 February 2008, Cocoa Beach, Florida, USA***

***sponsored by the American Ceramic Society & ASM International***

# Presentation Outline

- ***EU Energy Context: the challenges ahead***

- ***The EU RTD&D Framework Programme****: activities on hydrogen and fuel cell technologies*
  - ***EC co-funded & JRC-IE specific…some examples***

- ***A Strategy for Europe***

  ➔ ***European Hydrogen and Fuel Cells Technology Platform***

  *Implementation Plan and "Snapshot 2020"*

  ➔***The Fuel Cells and Hydrogen Joint Technology Initiative***

# EU ENERGY CONTEXT



## TODAY

- Rising prices for oil and gas
- The EU **imports 50%** of the total energy consumed
- Energy accounts for **80% of all GHG**

## BY 2030, and with current policies,

- **CO2 emissions** will increase by **5%** and GHG global emissions by 55%
- **Energy imports** will jump to **65%** of total consumption (gas: from 57% to 84%; oil from 82% to 93%)
- **Electricity demand** will raise **1.5 % per year**

| Challenges | Priorities | Need |
|---|---|---|
| SUSTAINABILITY | Combating Climate Change and Reducing environmental impact | ENERGY POLICY FOR EUROPE (EPE) |
| SECURITY OF SUPPLY | Limiting EU´s external vulnerability to imported hydrocarbons | |
| COMPETITIVENESS | Promoting growth and jobs; providing secure and affordable energy | |

## & Drivers for energy research

# EU ENERGY ACTION PLAN - 1

## European Council (8/9 March 2007)


European agreement on a NEW ENERGY POLICY


Energy is a vital part of our daily lives in Europe and we have come to rely on it. But the days of secure, cheap energy are over and we are already facing the consequences of climate change, increasing import dependence and higher energy prices. In order to ensure a sustainable, secure and competitive energy supply, a common European response is needed. A new European Energy Policy must be ambitious, effective and long-lasting – and involve everyone.

### Tackling climate change

Energy is the main factor in climate change, accounting for some 80% of EU's greenhouse gas emissions. It has been estimated that, without real efforts to reduce emissions, there is a real chance that global temperatures will rise by several degrees, dramatically altering the world's landscape and the way we live.

The EU is committed to reducing greenhouse gas emissions, but its present energy practice will result in increasing them by 5% by 2030. The EU's current energy and transport policies are not sustainable. Acting now to tackle climate change is essential.

### Ensuring security of supply

Rising, volatile prices, blackouts and difficulties in supply have all illustrated the risks of being overly dependent on oil and gas. With global need on the up, this pattern is set to continue. The International Energy Agency expects worldwide demand for oil alone to increase by well over a third by 2030 – so how will this be met?

If energy trends and policies remain as they are, the EU's reliance on imports will jump from half to almost two-thirds in 2030. 84% of gas would have to be imported, as would 93% of oil. But from where and how these supplies would come is unclear. Add to this the fact that several EU Member States are essentially dependent on one single gas supplier and factor in the lack of a crisis support structure between countries, the EU's growing vulnerability is evident.

There is also a need to increase capacity. Electricity demand continues to mount by around 1.5% each year, but existing infrastructure and electricity plants are reaching the end of their useful life.

Over the next 25 years, around €900 billion will be needed to invest in new coal- and gas-fired power plants, along with wind turbines. Even if we increase our energy efficiency to limit growth in demand, major investment in infrastructure is vital.

# EU ENERGY ACTION PLAN - 2

The first step of the European Energy Policy is the adoption of a comprehensive **Action Plan** comprising measures to address the following priorities:

- **Internal Market** for Gas and Electricity
- **Security of Energy Supply** (for the EU as a whole and for each MS)
- **International Energy Policy** ("*act with a common voice*")
- Energy **Efficiency** and **Renewable** Energies (set binding ambitious targets, e.g. the 20%´s by 2020)
- European Strategic Energy Technology Plan (**SET-Plan**)

# EU RTD Framework Programmes (FP)

**Main EU instrument** for funding RTD activities since 1984.

**Multi-annual** (4 years up to FP6); Partners from **outside the EU** welcome

**Competitive calls** for proposals

Evaluation by **independent experts** based on published selection criteria

**FP6 budget: 17 500 M€ with ~ 900 M€ for Energy**

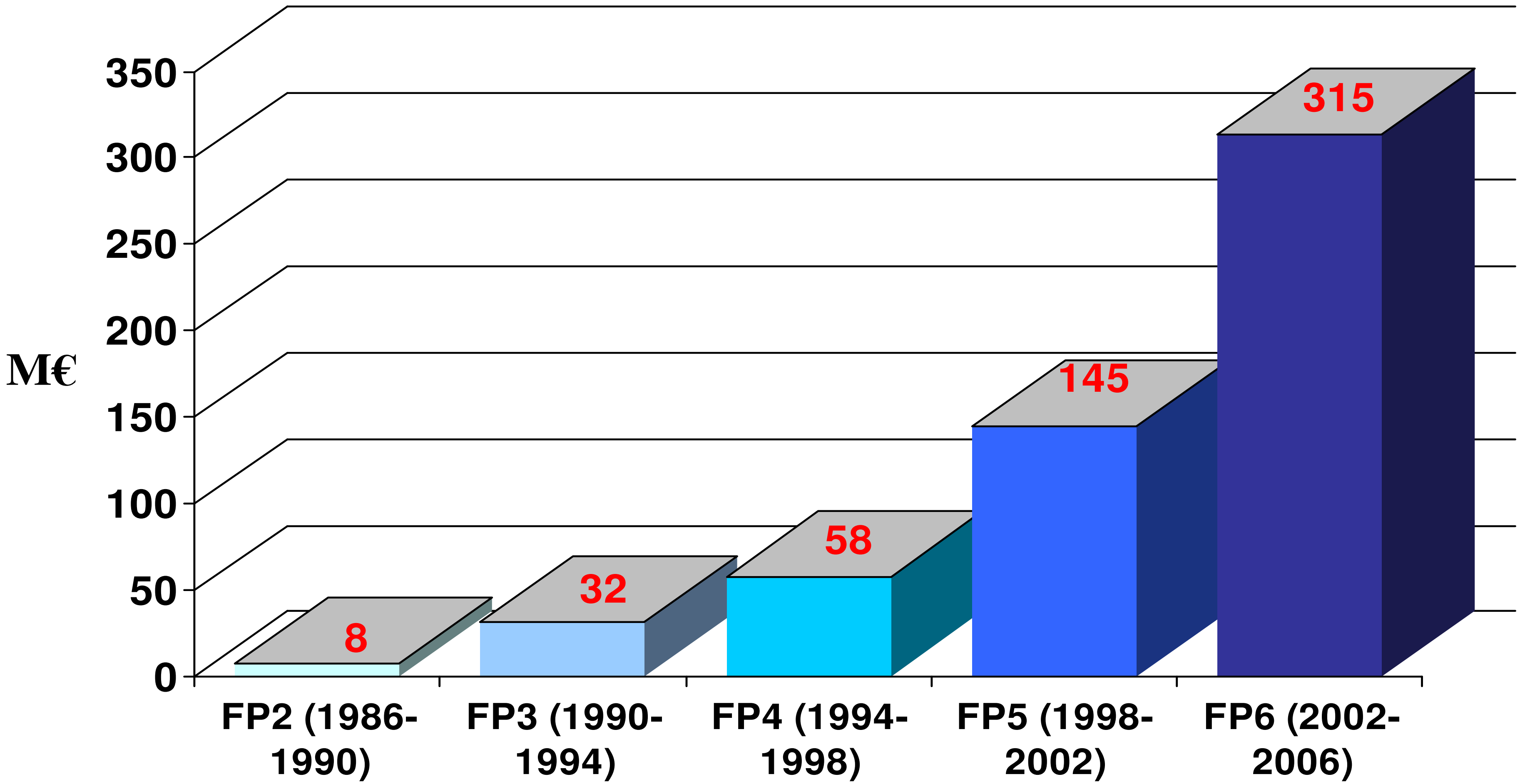
## Currently on the 7th FP (2007 – 2013)

SEVENTH FRAMEWORK PROGRAMME

- **Duration** & Annual **budget** increased (e.g. for ***Energy:*** ~M€ 225 ⇒ ~M€ **335**)
- ***European Research Council*** (~ €1 billion per year) → ***Frontier Research***
- ***Technology Platforms*** to define R&D priorities
- ***Joint Technology Initiatives (JTI):*** Public-Private Partnerships at European level – implementation led by industry Only a few areas…

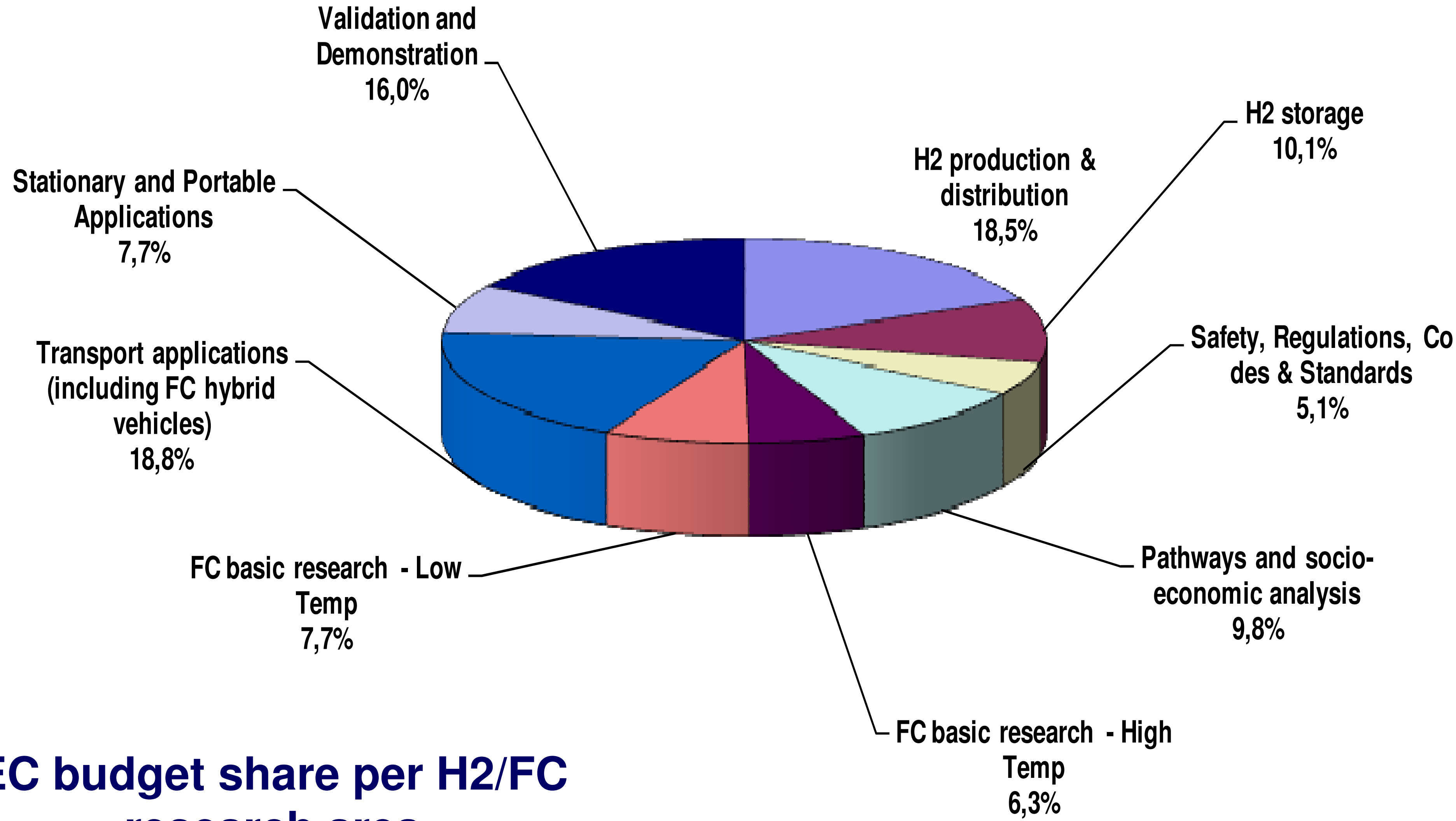
***more later…***

# EC Support to Fuel Cell and Hydrogen RTD in Framework Programmes



# FP6 Budget Breakdown for $H_2$/FCs
## *Total EC Contribution ~315M€*






**EC budget share per H2/FC research area**

JRC EUROPEAN COMMISSION

# Important FP6 R&D H2/FC Projects

Institute for Energy



CHRISGAS fuels from biomass

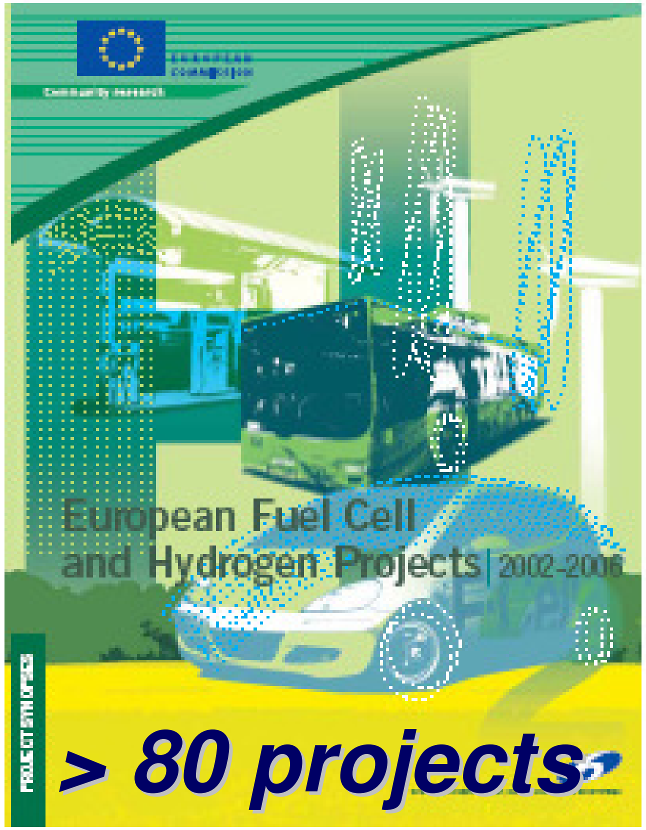
HySafe

STORHY

NATURALHY

FURIM

HyTRAN




HyWays A European Roadmap

ftp://ftp.cordis.europa.eu/pub/fp7/energy/docs/hydrogen_synopses_en.pdf

automotive membrane

FELICITAS

NESSHY Novel Efficient Solid Storage for H2

Zero Regio

REAL SOFC

## Hydrogen – strategic topics pursued & materials issues

- **Clean production:** development & techno-socio-economic assessment of cost-effective pathways for $H_2$ production from existing & novel processes
- **Storage:** exploration of innovative methods, incl. hybrids, which could lead to breakthrough solutions, ….
  - gaseous storage ➔ **fibre/reinforced composites for tanks, cost /time effective laminating processes, recyclable materials**, safety
  - liquid storage ➔ liquefaction; boil-off; **novel insulating material** for lightweight/low volume tanks …
- **Basic materials: functional materials for electrolysers and fuel processors, novel materials for hydrogen storage and hydrogen separation and purification**
- **Safety:** pre-normative RT required for preparation of regulations & safety standards at EU & global level
- **Preparing the transition to a hydrogen energy economy:** support the consolidation of current EU efforts on $H_2$ pathway analysis and road mapping

# Materials Research & Hydrogen storage – FP6 Energy Programme



| Project Acronym | Co-ordinator | Duration (months) | Topic | EU indicative funding (M€) |
|---|---|---|---|---|
| ***STORHY*** | Magna Steyr, Austria | 54<br>***since 01/03/04*** | Next generation storage technologies for vehicle on-board applications | **10.7** |
| ***NESSHY (+ HYSIC)*** | NCSR Demokritos, Greece | 60<br>***since 01/01/06*** | Novel efficient solid storage for hydrogen | **7.5 (+ 0.3)** |

***See presentation 26 Feb 09:40 am***

# STORHY = "Hydrogen Storage for Automotive Application"

**Aim**: develop robust, safe & efficient on-board vehicle H2 storage systems, suitable for use in H fuelled FC or ICE vehicles. High pressure compressed gas, cryogenic liquid, solid: advanced alanates

Co-ordinator:Magna Steyr-Austria

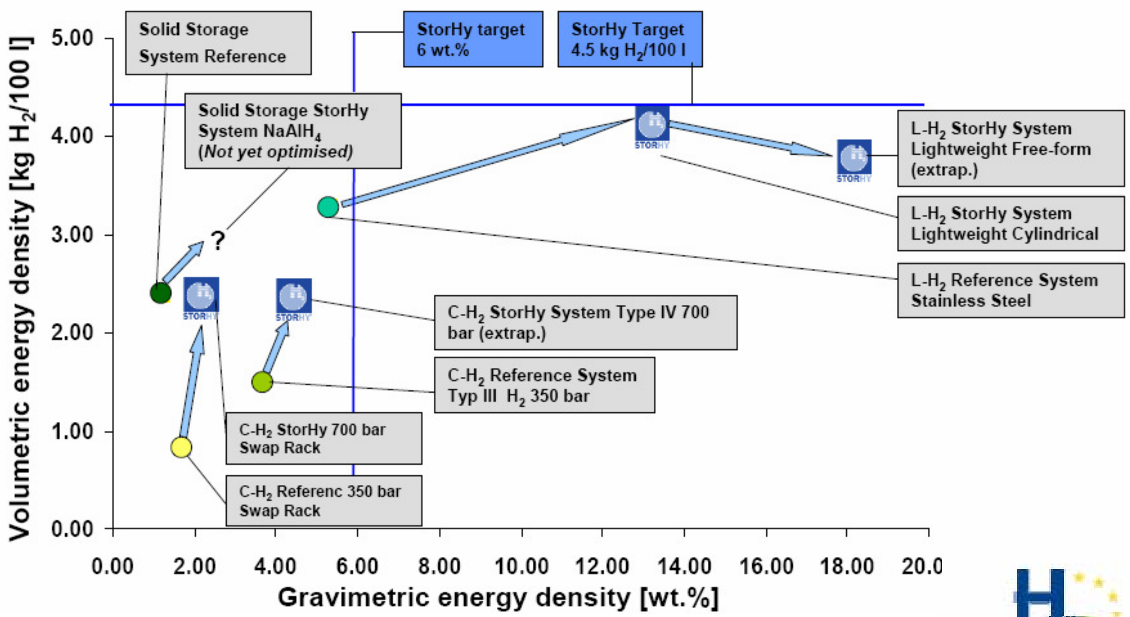
34 partners - 13 European countries

Duration: 01/03/04 → 31/08/2008

Budget: 18.7 M€
EC contribution: 10.7 M€

www.storhy.net

## Comparison of system storage densities




Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007 10-11 October 2007, Brussels, Belgium

# StorHy some results & Materials Research -1



## 700 bar C-$H_2$ Storage


Source: Dynetek

- Achieved 4.5 wt.%, 2.4 kg H2 / 100l (system level)
- Further optimisation requires:

fundamental understanding of ageing & failure behaviour of composite & liner materials

- Further Cost reduction, requires:

new industrialisation concepts for mass production & new CF

- Also changes in RCS as well as new vehicle platforms

STORHY

## L-$H_2$ Storage


Source: Magna Steyr

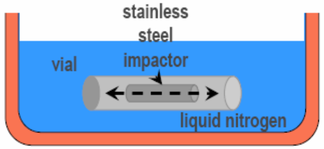
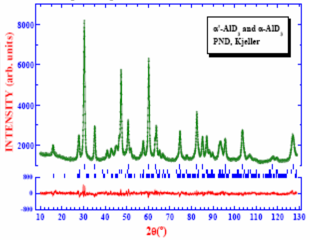
- 14 wt.%, 4 kg H2 / 100l - on system level for metal design, even up to 18 wt.% with advanced composite materials)
- free form tank design with improved conformability demonstrated
- Further Cost reduction indispensable!
- Specific L-H2 issues such as boil-off & permeation still challenging

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007
10-11 October 2007, Brussels, Belgium

# StorHy some results & Materials Research -2



## StorHy & Solid-State storage

| Storage Material | Automotive Challenges |
|---|---|
| Screening experiments for synthesis and characterization for new mixed alanates:<br>• Mg-Al-Li-H, Mg-Al-Ca-H, Ca-Al-Li-H, Ca-Al-Na-H<br>• Mg-Al-Li-H, Mg-Al-Ca-H, Mg-Al-Na-H, Mg-Al-K-H<br>• Mg-Al-Li-H, Mg-Al-Ca-H, Ca-Al-K-H | No new reversible hydrogen storage compound found<br>No break-through up to now |
| Synthesis and stabilisation of aluminium hydride $AlH_3$ (Alane) – basic research purpose<br><br>Spex 6750 freezer mill for cryomilling<br>Source: IFE, FZK, GKSS | High material storage density 10.1%, but not reversible!<br>Simplified method to synthesize $AlH_3$ by milling at liquid nitrogen temperature, compared to wet chemistry<br>Work in progress to change the stability of $AlH_3$ |



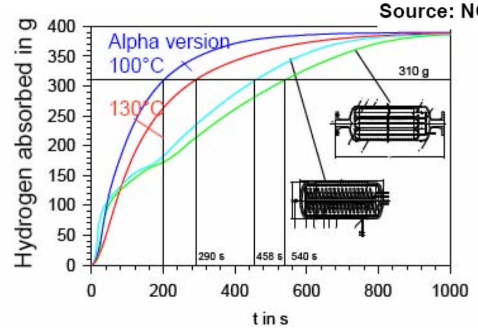


Hydrogen and Fuel Cell Review Days 2007, Brussels 10th-11th October

STORHY

- **2.0 wt.%** (on system level) with complex hydrides on alanate basis
- **solid filling** - demonstrated feasibility for fast heat removal in a tank using lightweight complex hydrides;

Source: NCSRD/GKSS/TUHH




- **safety studies** – minimised explosion in case of hydrogen release
- **Potential for mass production** of complex lightweight hydrides at low costs
- **Prototype tank** built

**STILL REQUIRED: breakthrough materials & fundamental research novel materials with improved storage densities, kinetics & thermodynamic behaviour & advanced system components e.g. heat exchangers**

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007 10-11 October 2007, Brussels, Belgium

| Project Acronym | Co-ordinator | Duration (months) | Topic | EU indicative funding (M€) |
|---|---|---|---|---|
| ***HYCONES*** *[FP6-Materials Programme]* | **NCSR Demokritos**, Greece | 36 ***since 01/11/06*** | Hydrogen storage in Carbon cones | **1.55** |
| ***COSY*** ***[FP6-MC RTN]*** | **GKSS,** Germany | **48** ***since 01/11/06*** | Understanding of sorption kinetics in reactive hydride composites | 2.5 |

# HYCONES: "Hydrogen Storage in Carbon Cones"

**Aim: explore the potential of Carbon Cones as hydrogen storage media for on-board transport applications**

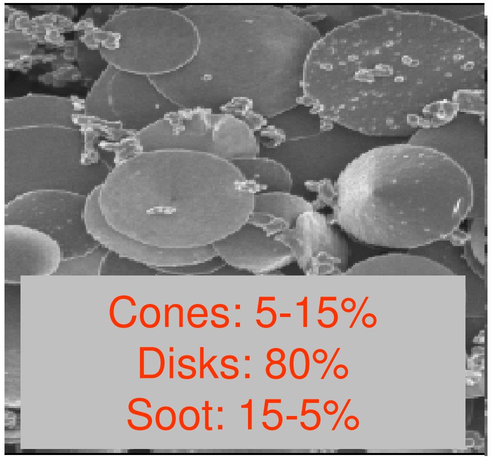
**Co-ordinator: NCSR-Demokritos, GR**

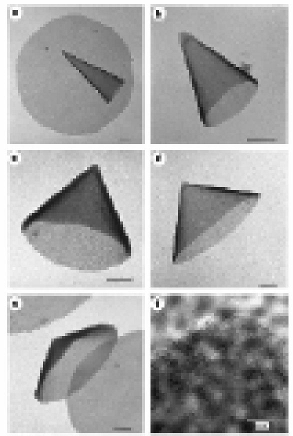
**5 partners - 4 European countries**
**External Research Collaborators Group**

**Duration: 01/11/06 ➔31/10/2009**

**Budget: 2.56 M€**
**EC contribution: 1.55 M€**

**www.hycones.eu**



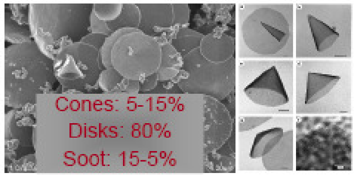
**Carbon Cones (CCs) = carbon micro-structures flat discs & cones**

**= curved graphite sheets; 5 different cone angles - incurrence of one to five pentagons at the cone tips.**

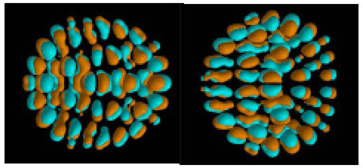
- **are economically produced ➔in industrial quantities during the so-called Kværner Carbon Black H2 Process**

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007
10-11 October 2007, Brussels, Belgium

## HYCONES: "Hydrogen Storage in Carbon Cones"

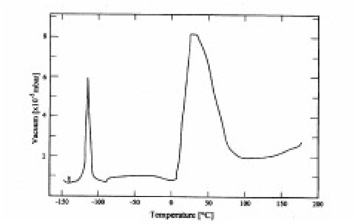




✓ Possibility of producing carbon cones cheaply in industrial quantities by Carbon Cones A. S.

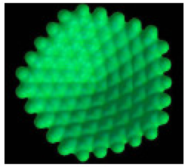


*Degenerate E1 HOMO orbitals of the conic anion*

✓ Unique electronic properties due to topology distinctively different from any other carbon (Bucky-balls, Single- and Multi-Wall Nanotubes)



✓ Preliminary experiments reveal unprecedented uptake-release of $H_2$ **unlike** those for any other carbon material (patent)



*Coulomb potential of the anion*

✓ Computer calculations indicate a new form of H-C binding mechanism distinctly different from physi-or chemi-sorption

Cell Review Days 2007, Brussels 10th-11th October

## Aim: explore their potential as H storage medium ← understand H-C interactions:

✓ Optimize usage by purification & separation of the different CC types

✓ Systematic investigation of the pertinent H2 uptake/release mechanisms (combination of advanced experimental and computational tools)

**> 6% wt. storage capacity ( 90% recoverable) based on material weight**

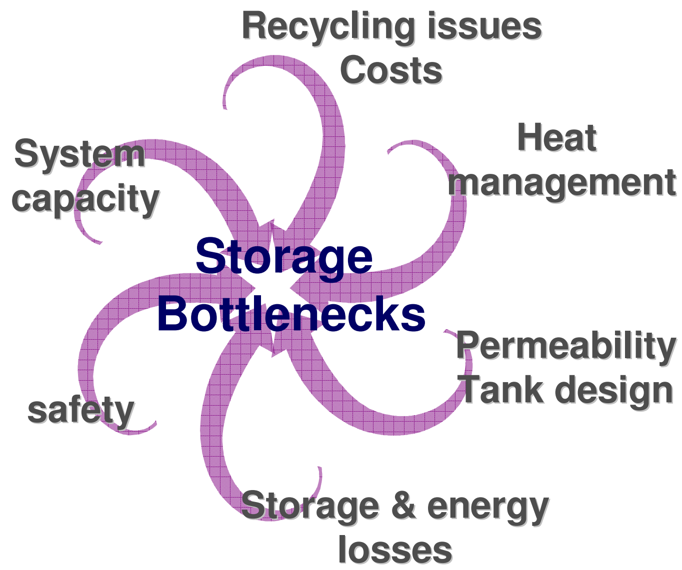
- **"Operating P-T window": 1-10 atm, 25-120ºC**
- **Storage/release kinetics that can meet FreedomCar targets**

*Refuelling rate > 1.5 kg/min*

*Flow rate > 4 g/s*

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007 10-11 October 2007, Brussels, Belgium

## In spite the progress, none of the storage routes meets the targets




**Still room for exploration of potential of theoretical simulations for finding novel materials**
with practical storage capacities & thermodynamics & addressing engineering tasks

**Lack of a basic understanding of materials properties is limiting progress** – ageing & associated failure in C-$H_2$ Storage gas cylinders, search of insulating materials for lessen boil-off rate of L-$H_2$, improvement of $H_2$ sorption properties of C-cone materials via understanding of the H-C interactions

**NEED for a deeper fundamental understanding of materials properties, & for basic research**

# Fuel Cell Systems & Applications – strategic topics & materials issues :



- **Reducing the cost** & **Improving the performance, durability, safety, reliability :** for competing with conventional combustion technologies
  - **materials** & process **development – a challenge! = to reconcile**
    - **enhanced lifetimes, high performance # electricity flow vs. corrosion, morphological changes, building of resistive layers & exhaustion of catalytically active components, degradation**
    - **& lower costs (& high volume manufacture – see PEFC); minimising the use of precious metals in the stack**
  - optimisation & simplification of FC components & sub-systems
  - modelling, testing, characterisation protocols
  - meeting durability requirements - tolerance to impurities: see sulphur & ammonia
  - packaging & weight – fuel stack & BOP; incl. miniaturised systems
  - thermal, air & waste management – advances in heat exchange systems & ability to maintain the water balance, required!
- **Validation & Demonstration activities:** to gain experience & give feed back to techn.development /deployment + training to stakeholders & end users

***Long term goal: Commercial viability by 2020 for many applications***

## REAL-SOFC = "Realising Reliable, Durable, Energy Efficient and Cost Effective SOFC Systems"

**Aim**: to solve persisting generic problems with planar Solid Oxide Fuel Cells (SOFC) in a concerted action of the European fuel cell industry & research institutions – achieve: enhanced lifetime, ease of operation, cost effectiveness, sustainability

**Co-ordinator: FZ JUELICH GMBH**

**26 partners - 12 European countries**

**Duration: 01/02/04 → 31/01/2008**

**Budget: 18.26 M€**
**EC contribution: 9.0 M€**

REAL SOFC

**http://www.real-sofc.org/**

| | |
|---|---|
| • Main goal: Understanding and reducing ageing<br>• Reduction of degradation to 0.5% / 1,000 hrs.<br>• Extension of stack lifetime above 10,000 hrs. | Enhanced lifetime |
| • Tolerance against impurities<br>• Operation with dry methane | Ease of operation |
| • Standard formats and testing routines | Cost & reproducibility |
| • Life Cycle Analysis & environmental impact analysis | Sustainability |

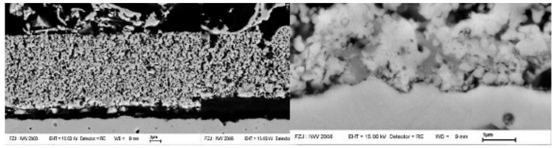
## MATERIALS issues – on centre stage

**feedback loop for developing 2nd & 3rd generation of cells & stacks with lifetime of 10 000 h**

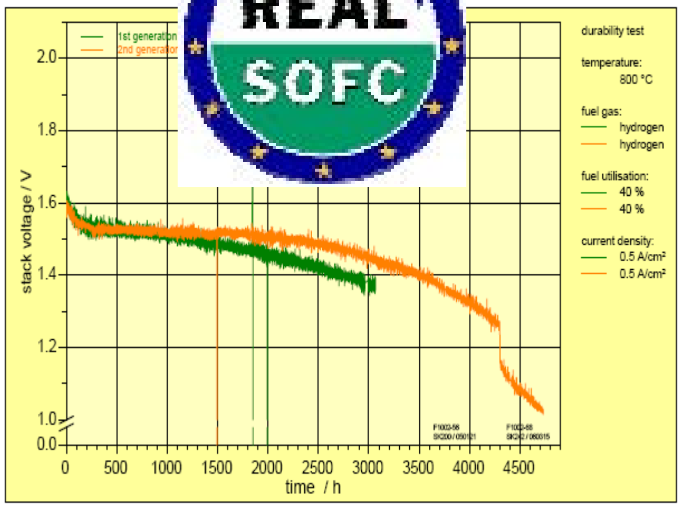
Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007 10-11 October 2007, Brussels, Belgium

# REAL-SOFC ACTIVITIES

**Chromium Poisoning: Microscopic Findings**



- ✓ Chromium is deposited at the interface cathode/electrolyte within the cathode layer where Cr can be detected
- ✓ The crystallographic structure of the modified parts is not clear
- ✓ The microstructurally modified part of the cathode is thicker at the air-out side of the cell than at the air-in side




**G2 vs. State-of-the-Art**

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007
10-11 October 2007, Brussels, Belgium

## (I) MATERIALS & COMPONENT Development Standardisation issues

-<u>co-ordinated testing programme</u>: mobilised a vast testing capacity throughout Europe

- <u>Testing conditions</u> for stacks <u>standardised</u>

➔**ensure comparability** between different labs results **- essential for shared testing resources**

➔ **reproducibility** (stability) of components and results

➔ **Standard definitions of requirements and of indicators** (degradation)

➔Quality standards & assurance

## (II) MATERIALS ENVIRONMENTAL IMPACT

**Analysis &** early addressing of health hazards in workplace and at point-of-use

## (III) TRAINING Programme

# Hydrogen Energy Research at JRC

EUROPEAN COMMISSION

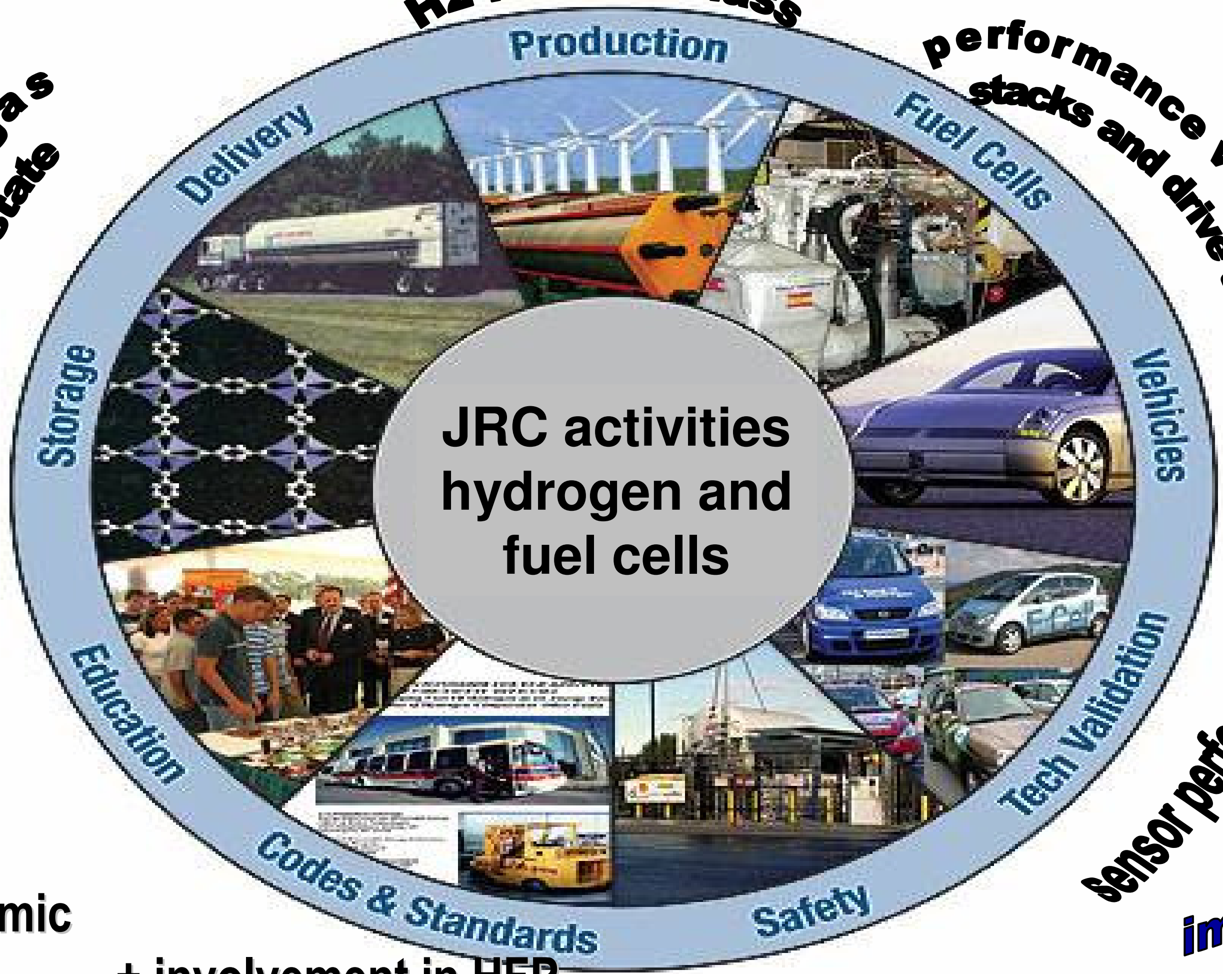
Institute for Energy

## Emphasis on performance assessment
## Validation / Benchmarking for harmonised test methods/protocols

H2 from biomass

high pressure gas and solid state

performance validation of stacks and drive trains




sensor performance

implemented through networking

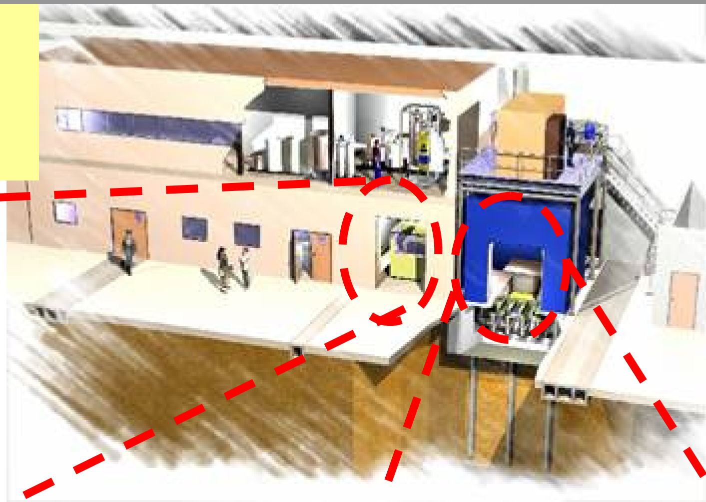
+ techno-economic assessments

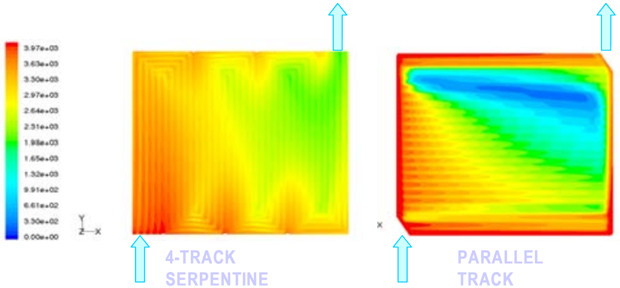
+ involvement in HFP
+ international outreach: IPHE, IEA-HIA, CEN, ISO, ….

Reference: adapted from US-DoE picture

# FCPOINT = Fuel Cell POwer Integration & Testing

**Environmental and vibration testing of FC systems and their performance**






**CFD modelling of FC performance & modelling validation**

## ALSO

**CATALYSTS TESTING ➔ Study PEFC anode catalysts - adsorption properties of novel materials under FP6 FCANODE screened alloy materials 'LIBRARIES'**

- **PEFC DEGRADATION MECHANISMS: FP7 DECODE project PEFC: operating modes, selection of materials &components**

***Standardised test methods for fuel cells & FC systems under simulated service conditions***

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# JRC-IE $H_2$ STORAGE (SYSAF) Activities

Institute for Energy



## High Pressure $H_2$ Storage

***GasTeF***

Safety bunker for Stationary & cyclic testing facility up to 800 bars.

## Solid-state $H_2$ Storage

***SolTeF***

Laboratory for storage capacity characterisation

*H Sorption Measurements*

## On-board safety sensors

***SenTeF***

Laboratory for H sensor testing

Reaction-, life-time, (cross-) sensitivity (to other gases), environmental factors

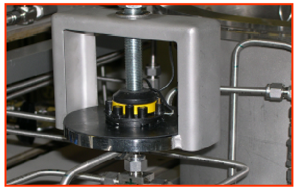
## Modeling H2 release

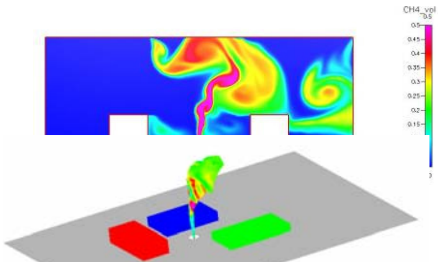
***2D and 3D CFD codes***

Material aspects – see tank design

*Compressor and tank testing "bunker":*

- 1 m thick composite walls; 3 meters sand
- 40 tons sliding door
- Interior filled with $N_2$ during experiments
- **Full-scale vehicle tanks permeation & High pressure cycling testing**





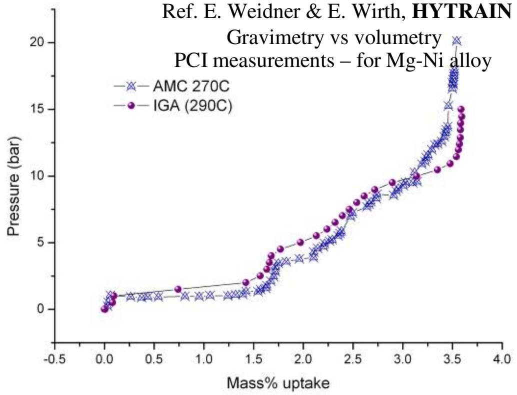
***CFD modelling of operating conditions & accidental hydrogen release*** *(from pipelines) scenarios*

Wilkening, H. & Baraldi, D

**SYSAF = SYstemS for Alternative Fuels**

# Exploring & identifying the most appropriate **measurement methodologies**

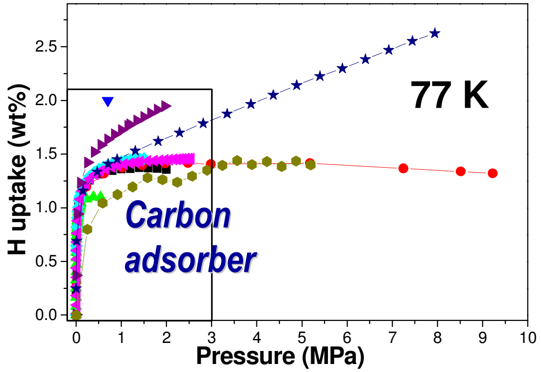
➔ ***Repeatability, Reproducibility, Reliability, Accuracy in measurement***

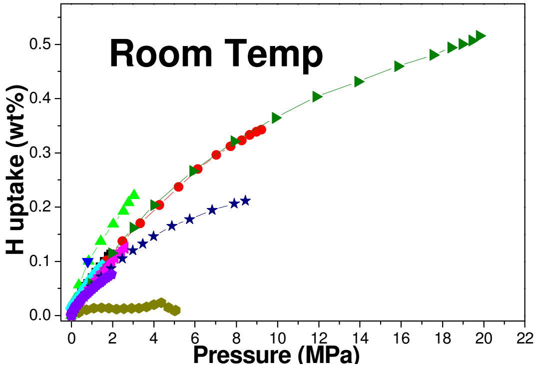



➔ **Inter-comparison of techniques/instruments**

## Further supporting standardisation:

☑ **Inter-lab comparisons & RRT Coordination** (identify the cause of deviation between labs & harmonise data)




Ref. NESSHY

☑ **Web-enabled Database**: material H sorption & physical/engn data

☑ **Safety** aspects investigation

# HI2H2 project under Hydrogen Production & Delivery

**Topic: study of a high-temperature water electrolysis (HTE) system for H2 production ➔ 'Solid Oxide Electrochemical Converter (SOEC)'**

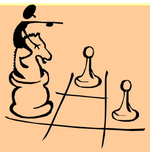
**Project status: completed (2004 – 2007)**

Such cells

- use solid oxide electrolytes similar to SOFCs; are operated thermo-neutrally; no need for noble metal electrodes; material problems are different

- 👍 **achieved high durability & performance of single cells**
- 👎 **degradation of the cells, probably due to sealant problems**

**HEAT MANAGEMENT – an issue in MW scale plants**

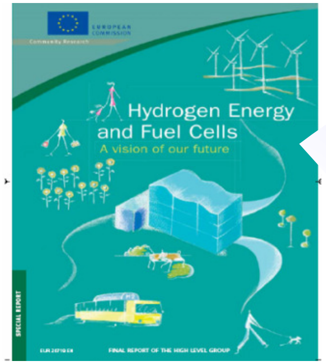


to do ...?

- Large HTE project
- Fundamentals for materials & electrodes

# Strategic documents of the European Hydrogen and Fuel Cell Technology Platform (HFP)





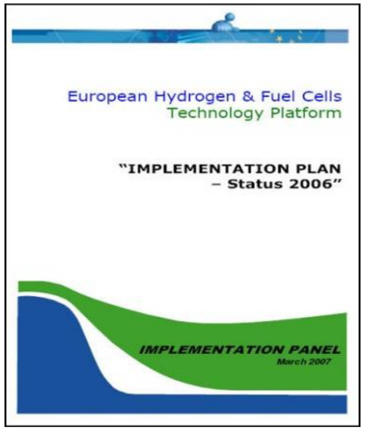

**VISION**
Hydrogen Energy And Fuel Cells (2003)



**STRATEGY**
- Strategic Research Agenda
- Deployment Strategy
- Strategic Overview (2005)

**100 Stakeholders invested more than € 10 m for the JTI preparation**

**IMPLEMENTATION**
**Implementation Plan (March 2007)**

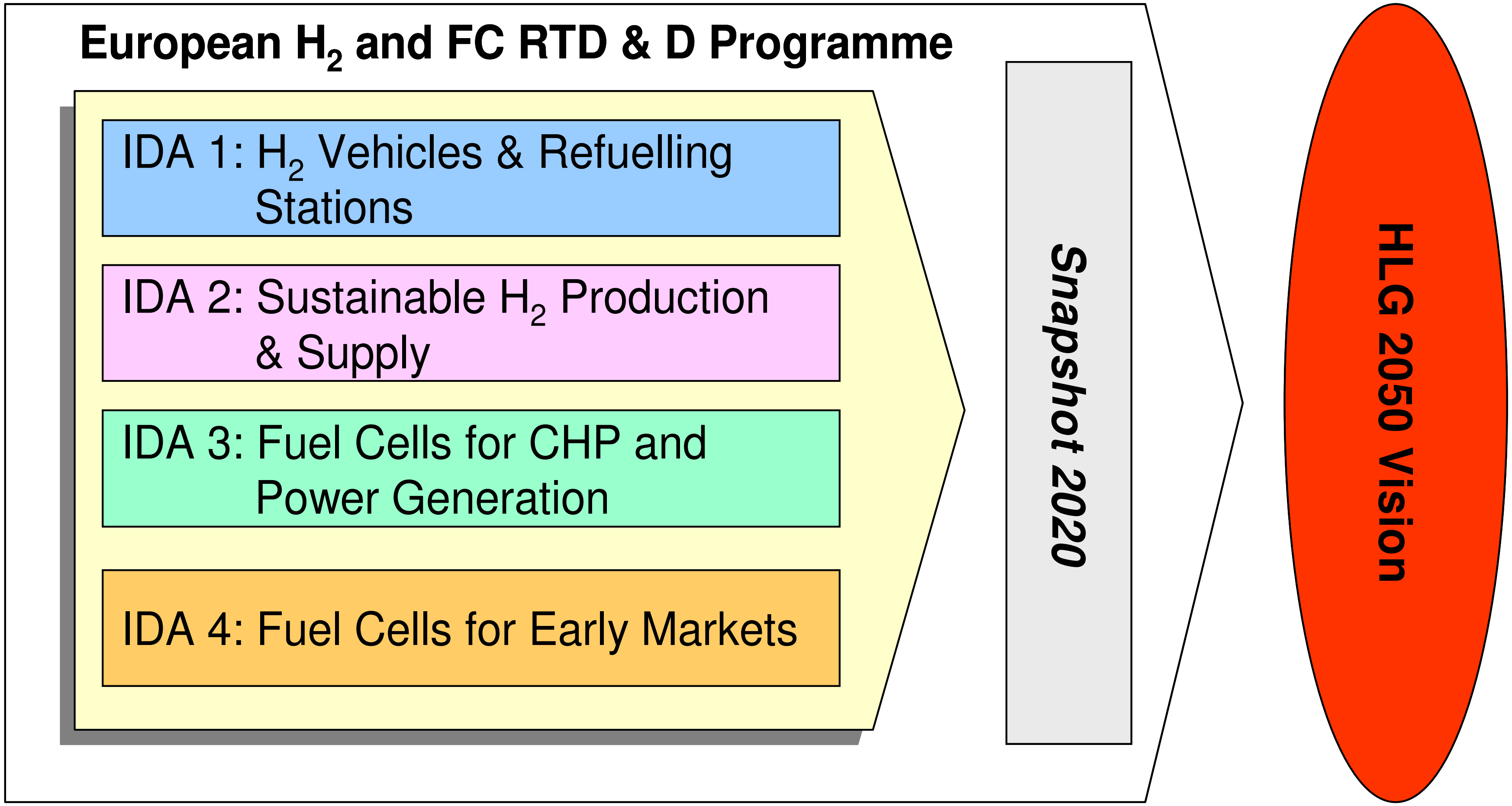



**Documents available at: www.hfpeurope.org/hfp/keydocs**

EUROPEAN COMMISSION

# HFP Implementation Plan*: 4 Innovation & Development Areas (IDAs)






**(*) Integrated RTD&D programme requiring 7.4 Billion Euros for 2007-2015**

# HFP - Reference market scenario for Implementation Plan: "*Snapshot 2020*"



| | **Portable FCs** for handheld electronic devices | **Portable Generators & Early Markets** | **Stationary FCs** Combined Heat and Power (CHP) | **Road Transport** |
|---|---|---|---|---|
| ***EU*** H2/ FC units sold per year projection 2020 | ~ 250 million | ~ 100,000 per year (~ 1 $GW_e$) | 100,000 to 200,000 per year (2-4 $GW_e$) | 0.4 million to 1.8 million |
| ***EU*** cumulative sales projections until 2020 | n.a. | ~ 600,000 (~ 6 $GW_e$) | 400,000 to 800,000 (8-16 $GW_e$) | 1-5 million |
| ***EU*** Expected 2020 Market Status | **Established** | **Established** | **Growth** | **Mass market roll-out** |
| Average power FC system | 15 W | 10 kW | <100 kW (Micro HP) >100 kW (industrial CHP) | 80 kW |
| FC system cost target | 1-2 €/ W | 500 €/kW | 2.000 €/kW (Micro) 1.000-1.500 €/kW (industrial CHP) | < 100 €/kW (for 150.000 units per year) |

***Extracted from Deployment Strategy doc → what is needed to move technology from prototype through demonstration to commercialisation***

# Fuel Cells & Hydrogen Joint Technology Initiative



## JTI's objectives

- Establish long-term **public-private partnerships** in research at European level
- Co-ordinate research efforts and respond to **industry needs**
- Focus on fields of high **industrial and policy relevance**

## JTI's criteria

- Added value of **European-level** intervention
- Degree and clarity of **definition of objective**
- Strength of commitment from **industry,** industrial lead
- **Scale of impact** on industrial competitiveness and growth
- Importance of contribution to broader **policy objectives**
- Capacity to attract **additional** national **support** and leverage industry **funding**
- **Inability of existing instruments** to achieve objective

Located in **Brussels**

The **Research community** may establish a representative association and also become a member of the JU

It will operate in **2008 – 2013** (2017) with a **multiannual/annual programming** (Implementation Plan **as the starting point)**

➔ provisions on evaluation and selection of proposals

➔ information and dissemination of activities

…..based on principles of **transparency** and **openness**

**Financing**

**Budget : 470 M€ from FP7** (Energy, Transport, Materials and Environment) matched by at least **470 M€** from the **private sector**

**Administrative costs** shared 50/50 between the private and public sectors (cash contributions)

**Operational costs** (project funding) shared between the private and public sectors (in-kind contributions and cash contributions respectively)

Close **follow-up of in-kind contributions** to monitor the principle of 50/50 financing

# What's next?



The proposal for the Regulation will be discussed by the **Council** and the **European Parliament**; their comments will probably result in an amended proposal

A ”**bridging structure**” (a co-ordination and support action under FP7) is being put in place to ensure a quick start-up of the activities

**Adoption** by the Council is foreseen by summer 2008

First JTI **call for proposals** is planned by summer 2008 just after adoption of the Regulation

*Watch this space!*

New Energy World IG
fuel cells & hydrogen for sustainability

JRC
EUROPEAN COMMISSION

# Staying Informed

Institute for Energy


**Energy Research web site & Energy Helpdesk**
*http://ec.europa.eu/comm/research/energy/index_en.html*
*rtd-energy@ec.europa.eu*

**European Hydrogen and Fuel Cells Technology Platform (HFP)** *https://www.hfpeurope.org/*

**New Energy World Industry Grouping (NEW-IG))**
*http://fchindustry-jti.eu/*

New Energy World IG
fuel cells & hydrogen for sustainability

## JRC-IE contact point

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**Institute for Energy,**
**Cleaner Energies Unit**

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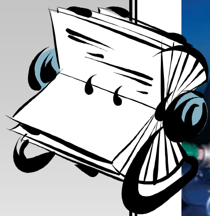



**http://www.jrc.nl/**

# ONLY BACK_UP SLIDES

# EU institutions & …our coordinates



European Court of Auditors

Court of Justice

European Parliament

Council of Ministers

Committee of the Regions

Economic and Social Committee

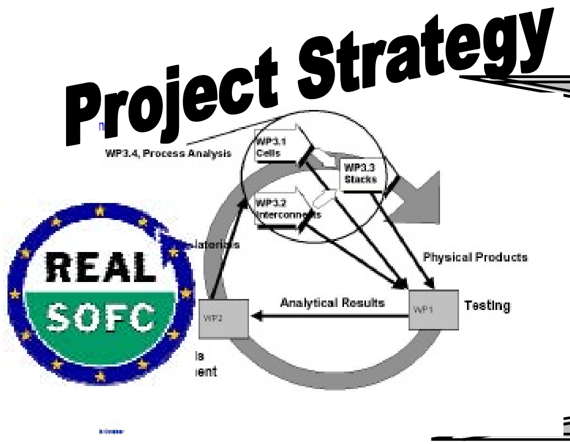
**European Commission**
(27 Commissioners)

SG. … RELEX … ENTR … ENV …. TREN … RTD …. JRC …

IES IPSC IPTS IE ITU …..

***TACKLE Lifetime and long-term degradation** by:*

- *gaining more understanding of degradation processes through an extensive testing programme*
- *finding solutions to reduce ageing, & developing new processing methods and improved materials that show less ageing➔ integration of these developments into cells and stacks by industrial partners & further testing.*




**feedback loop for developing 2nd & 3rd generation of cells & stacks with lifetime of 10 000 h under standardised testing conditions.**

**LIFETIME & IMPURITIES: a concern! Analysis & need for countermeasures**

- Lifetime & effects of transient conditions like load, thermal and re-oxidation cycles, as well as sub-optimal fuel composition - impurities like sulphur or lack of water in methane operation leading to coke formation

## Materials

- ☞ **best performing** materials already known (no surprises); must optimise processing & **cost!**
- ☞ **Lifetime** is insufficient (but: trade-off with cost)
- ☞ **Contacting and protective layers** are imperative

Reference: extracted from the coordinator's presentation at the European Hydrogen and Fuel Cell Review Days 2007 10-11 October 2007, Brussels, Belgium

## RTD challenges

- ☞ **low-cost**, standardised, mass-production oriented manufacturing extended **lifetime** of components, **robustness**
- ☞ sufficient testing capacity for **predicting materials performance** rapidly (**optimisation**!)
- ☞exploiting the opportunities: multi-fuel capability,**versatility**, high performance

## Codes and Standards

- **Comparability of testing results - essential for shared testing resources**
- Reproducibility (stability) of components and results
- **Standard definitions of requirements and of indicators** (degradation)
- Quality standards & assurance
- Cost reduction through standardised and categorised products

## Looking into Environmental Issues

- Cost reduction ←early addressing of health hazards in workplace and at point-of-use
- Global picture of environmental impact of materials

# SYSAF = SYstemS for Alternative Fuels

## Safety, efficiency & performance of H storage & distribution systems

**OBJECTIVE:**

- ✓ To harmonise, validate / verify & standardise test procedures & measurements for the safety of hydrogen storage and distribution systems
- ✓ To benchmark their operational performance

**WORK PLAN:**

- To upgrade & operate reference laboratories for the testing &verification of hydrogen storage and distribution components
- To carry out underpinning R&D research
- To provide at European level independent technical expertise on performance, efficiency, safety of competing hydrogen storage systems
- To participate to the works of European and International bodies on Regulations, Codes, Standards (RCS) for the hydrogen economy

☞ During FP6 – design & construction of state-of-the-art testing facilities

# FCPOINT = Fuel Cell POwer Integration & Testing

## OBJECTIVE:

- ✓ **critical assessment of the performance of fuel cell systems** particularly in terms of efficiency and emissions and on the integration of fuel cells into the power chain using the test facilities of the Institute as framed within the EU projects FCTESQA and DECODE.
- ✓ **validation & benchmarking of harmonised test methods and protocols** on performance of fuel cells in transport and stationary applications ➔ input to standards drafted by ISO TC 197 & IEC TC 105
- ✓ **establishment of a reference centre for pre-normative research (PNR) verification of FC power chain testing**

## WORK PLAN:

- **Fuel Cell Power Chain Integration and Testing: experimental characterization and evaluation of performance and optimized integration**
- **EU policy support, networking & RCS activities**
- **Underpinning research on fuel cells and their components in support of testing and validation of test procedures and methodologies.**
- ☞ **During FP6 – design & construction of state-of-the-art testing facilities**

# HFP Implementation Plan – IDA's Goals





1. **Hydrogen Vehicles & Refueling Stations** - *Improve and validate hydrogen vehicle and refuelling technologies to the level required for commercialisation decisions by 2015 and a mass market-rollout by 2020*

2. **Sustainable $H_2$ Production and Supply** - *10-20% of the Hydrogen supplied for energy applications to be CO2 lean or free by 2015*

3. **FCs for CHP and power generation** - *> 1 GW capacity in operation by 2015*

4. **FCs for Early Markets** – *X000 commercial early market FC products in the market by 2010 (200MW – 20000 units not later than 2012)*

# JTI Background



## JTI's objectives

- Establish long-term **public-private partnerships** in research at European level
- Co-ordinate research efforts and respond to **industry needs**
- Focus on fields of high **industrial and policy relevance**

- Already identified in the **Council decisions** concerning FP7
- To be established by a Council Regulation as a "**Joint Undertaking**", according to **Article 171** of the EC Treaty.
- Build on European **Technology Platforms** (ETPs)
- EC budget to be drawn from FP7 "Cooperation" Programme"
- Commission submitted proposals for **6 JTIs**, including **Fuel Cells and Hydrogen**

# Joint Technology Initiatives

Hydrogen and Fuel Cells for a Sustainable Energy Future

Global Monitoring for Environment and Security

Aeronautics and Air Transport

Innovative Medicines for the Citizens of Europe

Towards new Nanoelectronics Approaches

Embedded systems

# Energy - Staying informed

## Energy Research web site & Energy Helpdesk

http://ec.europa.eu/comm/research/energy/index_en.html
rtd-energy@ec.europa.eu


## Energy Policy

http://ec.europa.eu/comm/energy/index_en.html

RESEARCH

## Seventh Framework Programme

http://cordis.europa.eu/fp7/

SEVENTH FRAMEWORK PROGRAMME

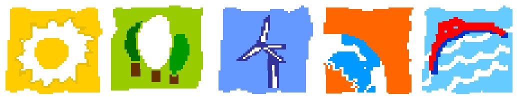
## Calls for proposals

http://cordis.europa.eu/fp7/

## Conferences, proceedings, Newsletter

http://ec.europa.eu/comm/research/energy/gp/gp_events/action/article_2790_en.htm
http://ec.europa.eu/comm/research/energy/pdf/renews5.pdf

## National Contact Points




CORDIS