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# ***European Union RTD on Hydrogen and Fuel Cells : current activities and future prospects***

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**European Fuel Cell Conference**

Rome 14-16 December 2005



# Presentation outline

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- European Union (EU): Key Energy Challenges and RTD policy drivers
- The 6<sup>th</sup> EU Framework Programme (FP6)
- RTD on Hydrogen and Fuel Cells in FP6
- A Strategy for Europe: The European Hydrogen and Fuel Cells Technology Platform
- Energy Research in the 7<sup>th</sup> EU Framework Programme (FP7): *Joint Technology Initiative* for hydrogen and fuel cells



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# European Union: Key Energy Challenges and Policy Context

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# Key challenges in the EU Energy Scenarios

- Global **energy demand** predicted to increase by 60% over the next 30 years
- EU **energy dependency** could rise from 50% to 70% by 2030; damaging volatility of oil prices and geopolitical instability
- Over 90% of EU **CO2 emissions**, causing climate change, are attributable to energy
- Global **energy investments** of €12 trillion required up to 2030 – huge opportunity for EU industry



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# EU Energy Policy Context

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- **Security of EU energy supply**
- **Reduction of EU greenhouse gases and pollutant emissions (Kyoto and beyond)**
- **Improve EU industrial competitiveness**
  - ✓ Increase share of renewable energy (from 6 to 12% in 2010)
  - ✓ Improve energy efficiency, reduce energy intensity (save 20% energy consumption by 2020)



# Main EU Energy Policy Measures

| DOCUMENT                                                              | Main messages                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WHITE PAPER ON <i>RENEWABLE ENERGY SOURCES</i> (RES) (1997)           | <b>12% final total energy</b> consumed in the EU from renewable origin in <b>2010</b>                                                                                                                                                    |
| GREEN PAPER ON <i>SECURITY OF ENERGY SUPPLY</i> (2000)                | Outlines EU <b>long-term energy strategy</b> to rebalance its supply and demand policy. Priority to <b>fight against global warming</b> : new and renewable energies are the key to change.                                              |
| DIRECTIVE ON <i>PROMOTION OF ELECTRICITY FROM RES</i> (2001)          | <b>21% total electricity</b> in the EU from <b>RES</b> en <b>2010</b>                                                                                                                                                                    |
| DIRECTIVE ON <i>ENERGY PERFORMANCE OF BUILDINGS</i> (2002)            | No specific objectives for RES but big impulse to the <b>integration of RES in buildings</b>                                                                                                                                             |
| DIRECTIVE ON <i>COGENERATION</i> (2004)                               | No specific objectives for RES but big impulse to the <b>use of RES in cogeneration</b>                                                                                                                                                  |
| DIRECTIVE ON <i>BIOFUELS FOR TRANSPORT</i> (2003)                     | <b>6% of automotive fuels</b> in the EU will be <b>biofuels</b> in 2010                                                                                                                                                                  |
| PROPOSAL FOR DIRECTIVE ON <i>ENERGY SERVICES</i>                      | Provide a framework to promote the market both for <b>energy services</b> and for <b>energy efficiency</b> measures in general in major energy end-use sectors                                                                           |
| GREEN PAPER ON <i>ENERGY EFFICIENCY: "Doing more for less"</i> (2005) | Save <b>20% of energy consumption</b> by <b>2020</b> (i.e. <b>€60 billion</b> of EU energy bill) in a cost effective way. This will help EU to achieve the goals of the <b>Lisbon Strategy</b> and to meet its <b>Kyoto</b> commitments. |



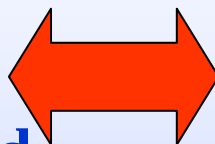
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# RTD policy drivers

**LISBON**  
(March 2000)

**Most competitive and  
dynamic knowledge-  
based economy by  
2010**



**BARCELONA**  
(March 2002)

**Need to boost RTD  
Aim: 3% of EU GDP  
by 2010 (2/3 private)**

**BUILDING THE EUROPE  
OF KNOWLEDGE**  
European Research Area



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# Public funding of RTD in Europe

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- ✗ RTD activities in Europe are funded at different levels: EU, national and regional.
- ✗ The main instrument for EU funding of RTD activities since 1984 is the **Framework Programme** (FP).
- ✗ The overall RTD budget of the EU is less than 6 % of all public (non-military) national and regional programmes
- ✗ The previously fragmented EU RTD efforts (15+1!) in many areas are now better coordinated and having an overall common strategy (ERA-NETs)



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# The 6<sup>th</sup> EU Framework Programme (FP6)

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# RTD Framework Programmes (FP)

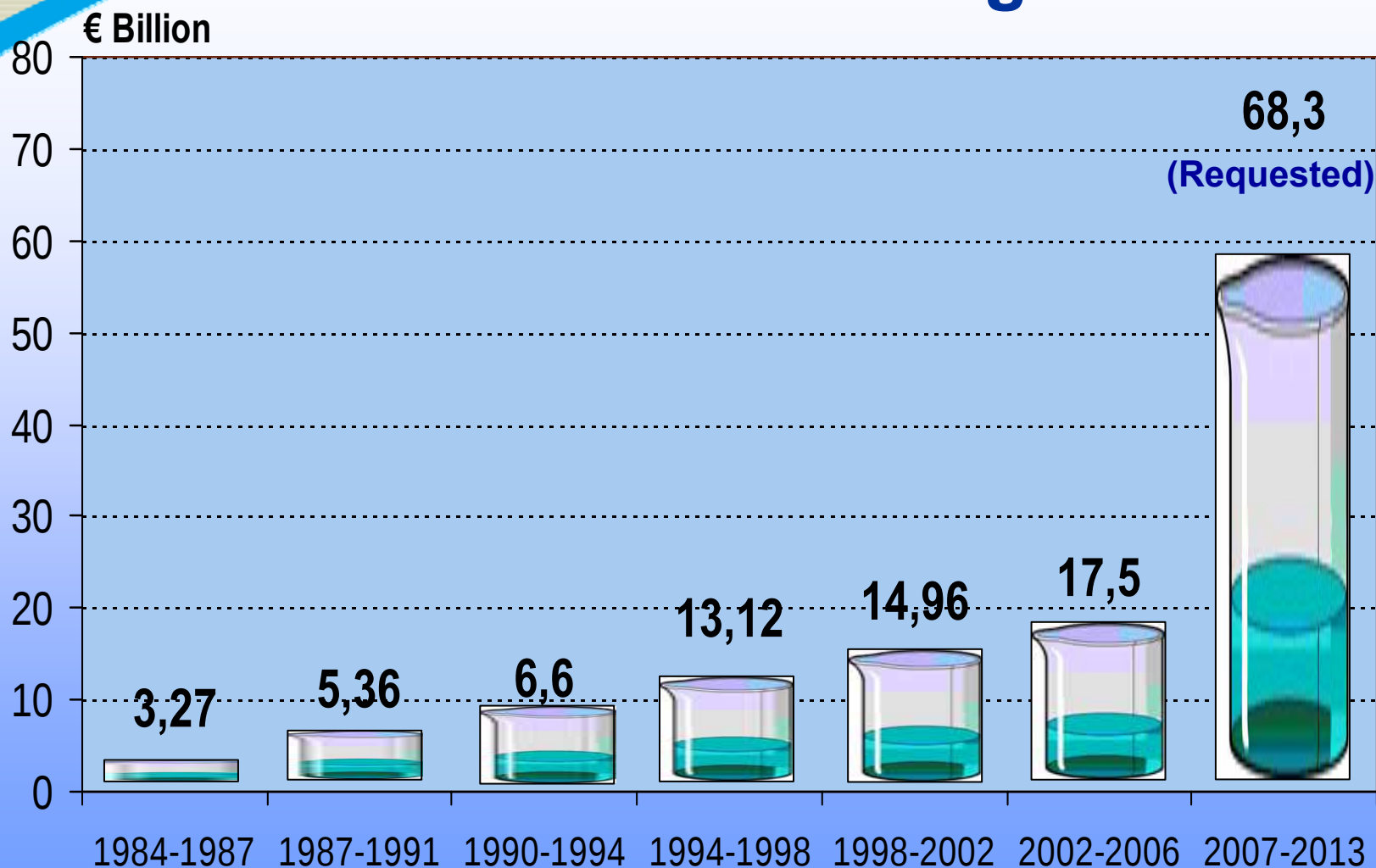
- ✕ Multi-annual (4 years)
- ✕ Pre-competitive
- ✕ Multi-partner, trans-national co-operation
- ✕ Competitive calls for proposals
- ✕ Evaluation by independent experts based on published selection criteria
- ✕ Partners from outside the EU are welcome
- ✕ FP6 budget: 17 500 M€ with 890 M€ for energy (2002 – 2006)



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# Budgets of the EU Framework Programmes



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## FP6: Objectives, priorities and budget

- ✓ The main objective of FP6 is to contribute to the creation of a true “***European Research Area***” (ERA).
- ✓ The total **budget** for FP6 is **€17.5 billion**, i.e. an increase of 17% respect to FP5. It represents close to **4% of the EU’s overall budget** (2001), and **5.4% of all public** (non-military) research spending in Europe.
- ✓ The biggest part of FP budget (12, 585 M€) is spent on **8 thematic priority areas** (see next overhead). The rest is spent in activities to strengthen and structuring the *ERA*.



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Framework Programme 2002-2006 (FP6)

***“Focussing and Integrating European Research”***

## Thematic Priorities

1. **Genomics and biotechnology for health (2,255 M€)**
2. **Information Society technologies (3,625 M€)**
3. **Nanotechnologies, intelligent materials and new production processes\* (1,300 M€)**
4. **Aeronautics and space\* (1,075 M€)**
5. **Food safety and health risks (685 M€)**
6. **Sustainable development and global change \* (2,120 M€)**
7. **Citizens and governance in a knowledge-based society (225M€)**
8. **Specific activities covering a wider field of research \* (1,300M€)**

***(\*) Priorities in which hydrogen and fuel cells RTD is being funded***



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# RTD on Hydrogen and Fuel Cells in FP6

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## FP6 – Thematic priorities addressing hydrogen and fuel cell technologies

Most of the RTD activities under FP6 related to **hydrogen and fuel cell technologies** are sponsored in Thematic Priority 6 (“*Sustainable Development, Global Change and Eco-systems*”):

- **6.1 Sustainable Energy Systems (810 M€)**
- **6.2 Sustainable Surface Transport (610 M€)**
- **6.3 Global Change and Eco-systems (700 M€)**

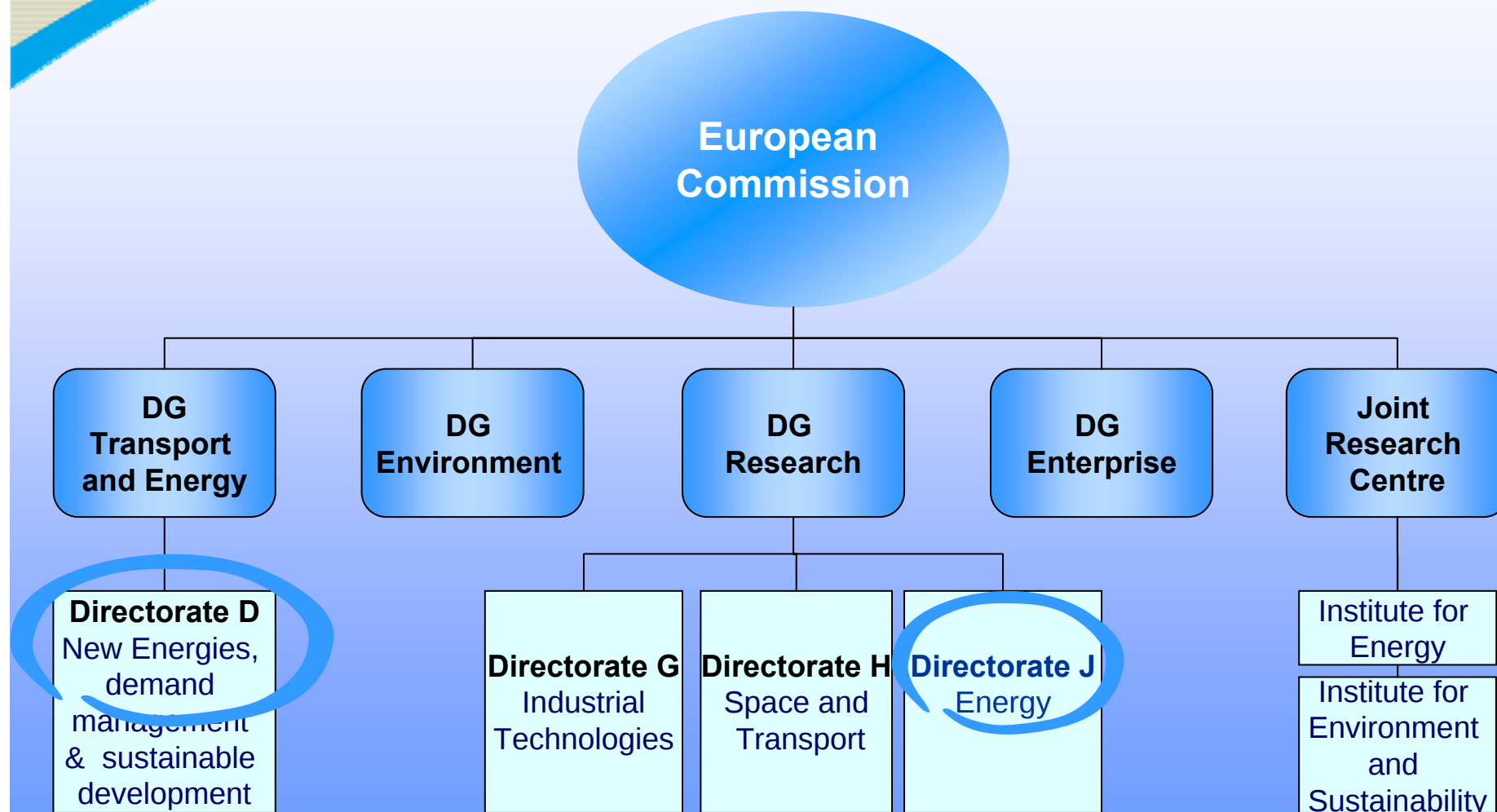
particularly in sub-priority 6.1



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# Directorates-General involved in Hydrogen and Fuel Cells RTD



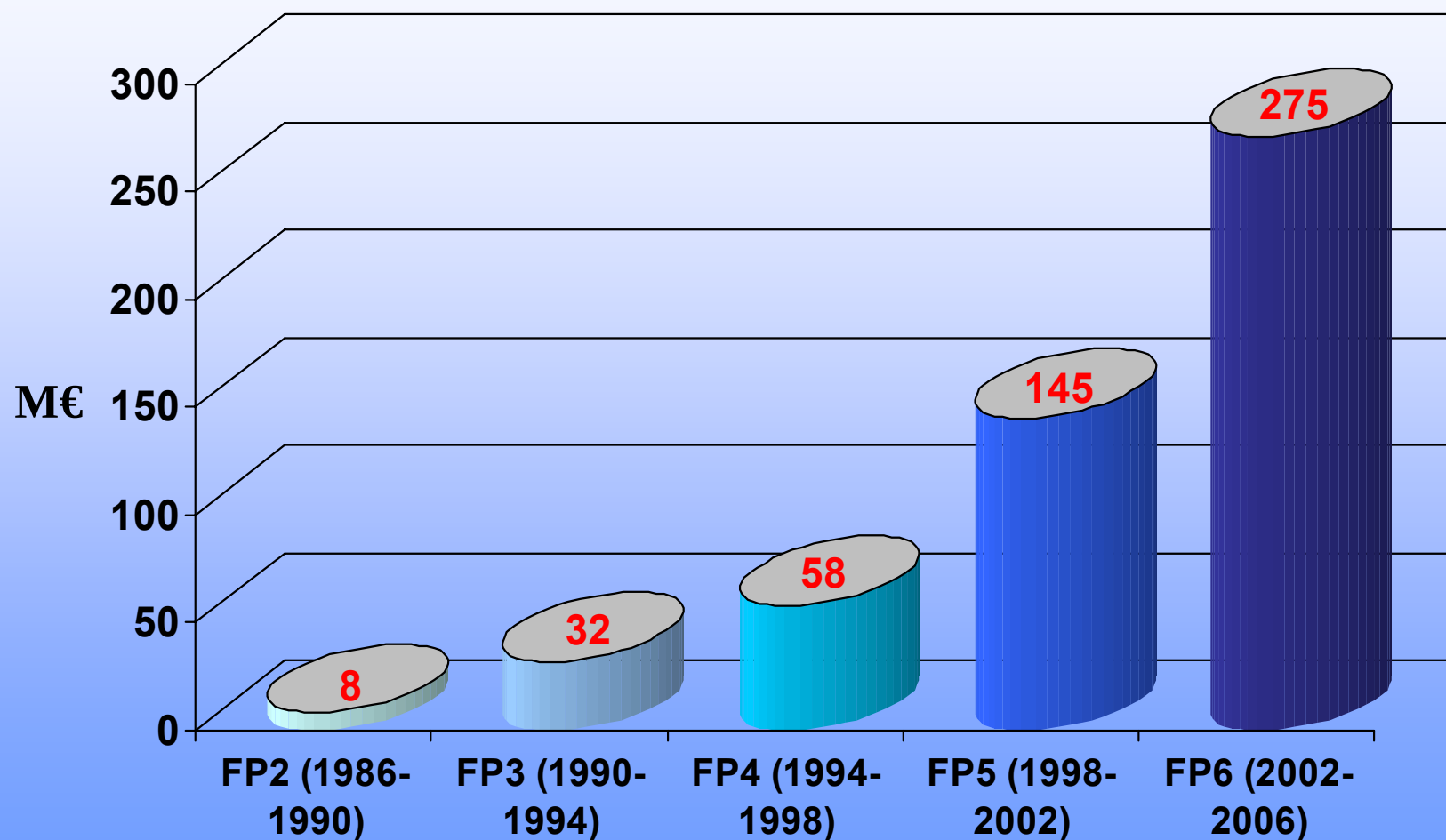
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# EC Support to Fuel Cell and Hydrogen RTD in Framework Programmes



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## FP6 Budget Breakdown for H2/FCs

### Total EC Contribution ~275 M€

**H2 production**

**15%**

**H2 storage**

**8%**

**H2 distribution**

**4%**

**Pathways, roadmaps, socio-economic analyses,  
coordination of National programmes**

**9%**

**Safety, regulations and standards**

**4%**

**High temperature FC - basic research**

**6%**

**Low temperature FC - basic research**

**8%**

**Stationary and portable applications**

**6%**

**Transport applications (including FC hybrid vehicles)**

**21%**

**Validation and demonstration**

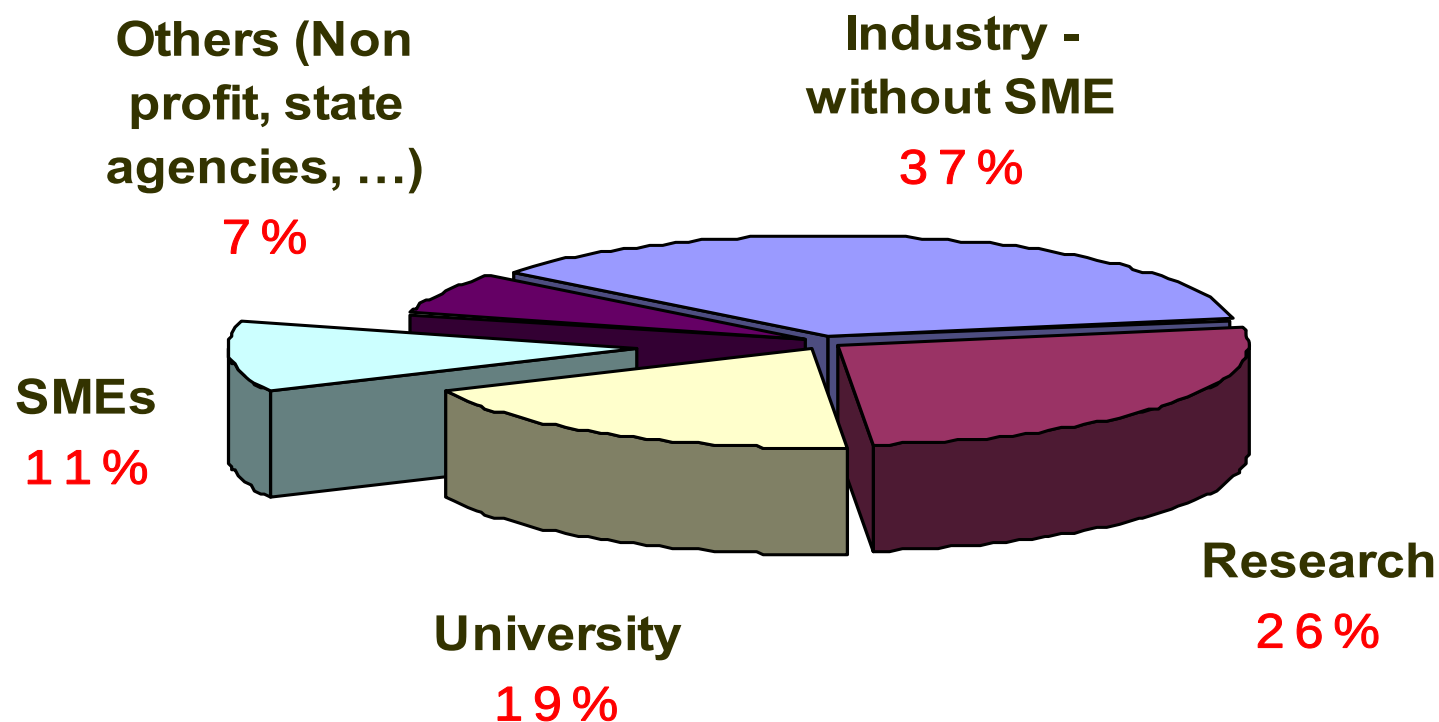
**19%**



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## FP6 activities related to H2/FCs: EU funding by sector





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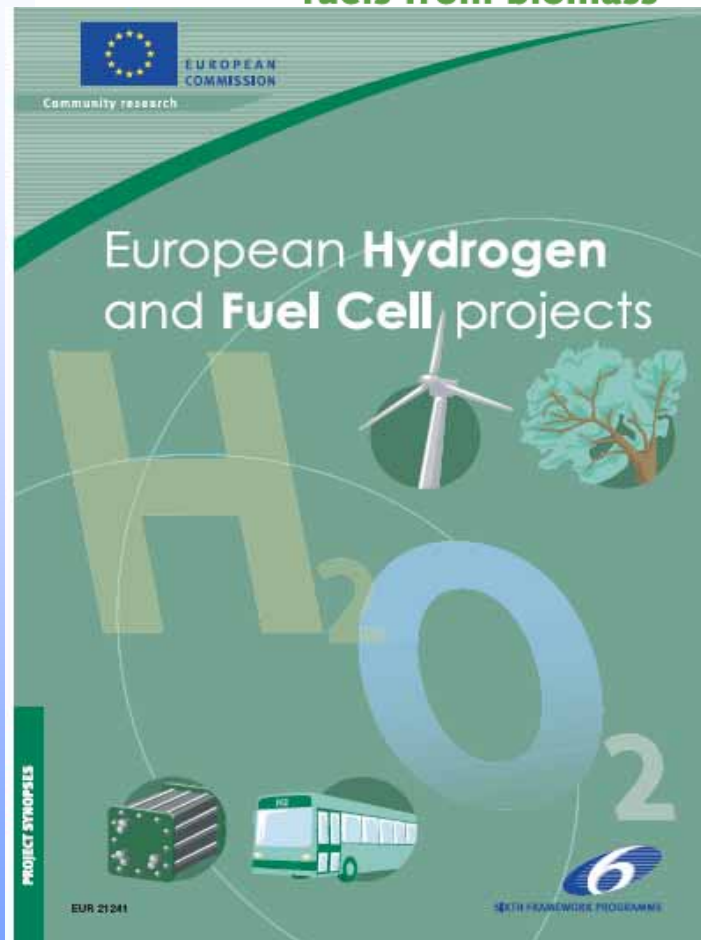
# Important FP6 Projects



HyICE

FURIM

**CHRISGAS»**  
fuels from biomass



**HyWays**  
Hydrogen Energy in Europe



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## ***FURIM: Further Improvement and System Integration of High Temperature Polymer Electrolyte Membrane Fuel Cells***

### **Overall Objective:**

Developing a High Temperature Membrane Electrode Assembly for a FC Stack in order to overcome problems of water management, CO poisoning and large cooling devices.

### **Specific objectives**

- ☞ A **2kW<sub>el</sub> HT-PEMFC** stack operating in a temperature range of **120-220°C**.
- ☞ **Single cell** performance: **0.7 A/cm<sup>2</sup> at 0.6 V**.
- ☞ Durability: **> 5,000 hours**.
- ☞ A **hydrocarbon reformer** and a **catalytic burner** integrated with the stack.

**Total cost: ~ 6.2 M€**

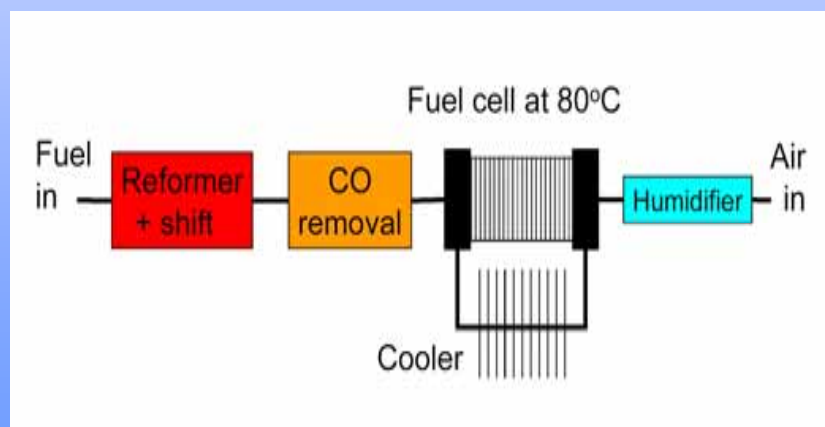
**EC contribution: ~ 4 €**

**Duration: 48 months**

**Coordinator: Denmark technical University**

**Project web site: <http://www.furim.com>**

**Consortium: 13 partners comprising important actors of polymer development**





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## *Hydrogen and Fuel Cell Technologies for Road Transport*

### Main objective:

**Development of two automotive fuel cell systems for powertrain and APU's**

### Core technologies:

- ☞ Innovative **80 kW direct hydrogen** stack with strong weight and volume reduction, increased efficiency, durability and start-up time, and with innovative MEAs
- ☞ Innovative **5 kW reformate stack**, introducing novel catalysts and electrode structures with very high CO concentrations allowed
- ☞ Variable **displacement compressor**
- ☞ Innovative **humidification/dehumidification**
- ☞ **Heat exchanger** and radiator customised for the application
- ☞ **Micro-structured** diesel steam reformer and gas purification units

**Instrument:** Integrated Project

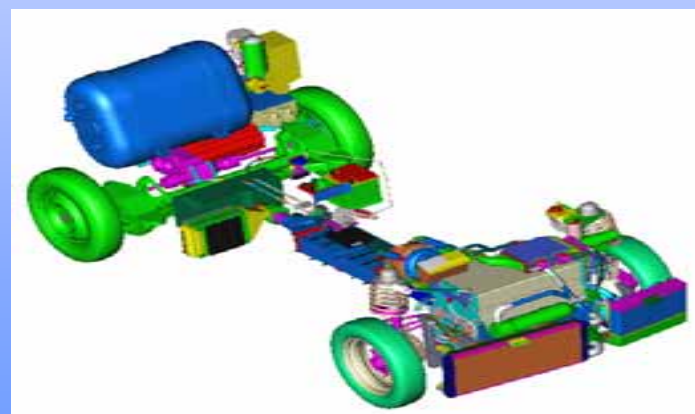
**Project total cost:** **16.8 M€**

**Maximum EC contribution:** **8.8 M€**

**Coordinator:** **Volvo**

**Partners:** CRF, Renault, VW, DC, DAF, Nuvera, JM; Opcon, Tenneco, WPT, Adrop, RWTH Aachen, ECN, Politecnico di Torino, PSI, IMM, ICSTM, Envipark

**Project web site :** [www.hytran.org](http://www.hytran.org)





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# **Realising Reliable, Durable Energy Efficient and Cost Effective SOFC Systems**



## **Main goals:**

### ***Materials (ceramics, steels)***

- durability, low ageing, tolerant to fuel & air impurities
- thermal and redox cycling
- cost reduction

### ***Cells***

- high power density vs. reduction of operating T
- improved mechanical properties
- industrial manufacturing processes

### ***Stacks***

- thermal cycling (sealing materials)
- weight and volume reduction

### ***Manufacturing***

- cost efficient manufacturing of all components

### ***Systems***

- cost reduction
- efficient Balance of Plant (BoP) components
- simplification / integration / packaging

### ***Modelling***

- understanding of E-M and thermodynamical processes
- prediction of cell, stack and system performance
- understanding of ageing processes

Total cost: 18,2 M€

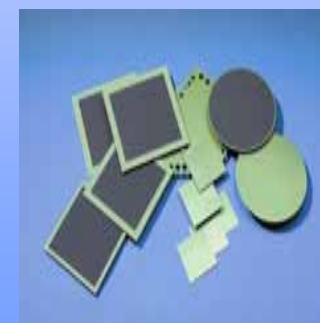
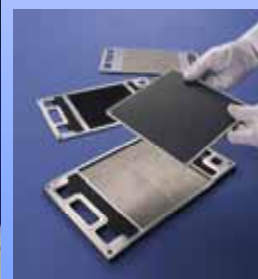
EC contribution: 9M €

Duration: 48 months

Coordinator: FZJ Germany

Web site: <http://www.real-sofc.com>

Consortium: 26 partners  
comprising most of the  
important actors in European  
SOFC technology





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# BICEPS: *Biogas Integrated Concept a European Program for Sustainability*

## Objective:

Bringing the **next generation** of cost-competitive renewable energy-technologies to the European market and optimizing the **production of electricity from biogas**

## Main Targets:

- × Development of a purification- / media-supply-unit suitable for all kind of biogases (digester, landfill...)
- × **Development of 1-MW Molten Carbonate Fuel Cells (MCFC)** for use of biogases
- × **Demonstration of two 1 MW MCFC-systems** operating on biogases (landfill and sewage gas)

## Core Technologies

- × Purification of biogas from BASF
- × 1 MW MCFC Solution from AFco and MTU-CFC
- × Engineering from NAVANTIA

*The two main European developers of MCFC are working together*

Project (IP) under negotiation

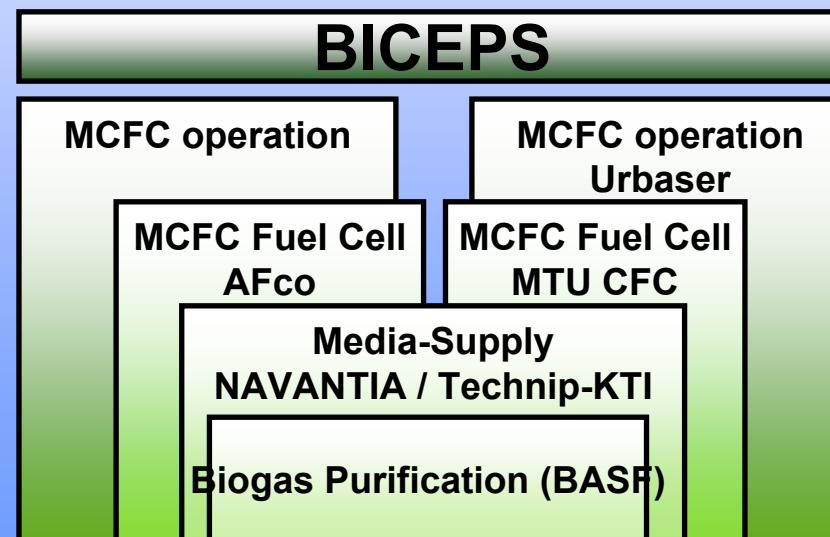
Coordinator: **BASF Germany**

Type: Integrated Demonstration

Total cost: ~17.5 Mio. € (6.9 from EC)

Duration: **3 Years** (2006 – 2008)

Consortium: **10 partners**



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# *"HYDROGEN FOR TRANSPORT"* *(Demonstration Projects in FP6)*

## Buses

### HyFLEET:CUTE



## Cars

### ZERO REGIO



Zero Regio  
H<sub>2</sub>-MotorFuel



## Mini:Transport

### HyCHAIN



### PREMIA

### HyLights

Monitoring and Preparation of « Lighthouse projects »

Coordination action European Fuel Cell Conference

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# Call FP6-2005-Energy-4

**Budget: 20M€** (expected 50% RES; 50% H<sub>2</sub>/FCs & CO<sub>2</sub>)

Three main themes for the content of the call:

1. Preparing the transition to FP7 and **support** to the running of **technology platforms**
2. Enhancing strategically important **international cooperation initiatives**
3. Strategically relevant **topics not well covered by running projects**

**Call close:** 10 January 2006 at 17.00h (Brussels time)

**Call documents:** <http://fp6.cordis.lu/fp6/calls.cfm>



# Call FP6-2005-Energy-4

## Topics related to H2 & FCs

- × Networking and coordination of **RTD** on fuel cells: (i) **High temperature MEAs for PEM**; (ii) **SOFC systems** (especially large scale) (**CA**)
  - × Support to **Technology Platform (SSA)**
- 
- × Enhancing strategically important cooperation initiatives to facilitate and enhance the **International Cooperation** dimension of running FP6 projects (**STREP or SSA**)
- 
- × **Research** to support the development of **permitting guides** for the installation of (small-sized) **stationary hydrogen** and **fuel cell-based** systems (**STREP**)
  - × Assessing the potential for a **hydrogen-oriented economy** in the **new Member States** and **Accession Countries (SSA)**
  - × Assessing system integration, development, test and validation of new generation, small distributed **domestic PEMFC CHP** systems (**STREP**)



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# **A Strategy for Europe: The European Hydrogen and Fuel Cells Technology Platform**

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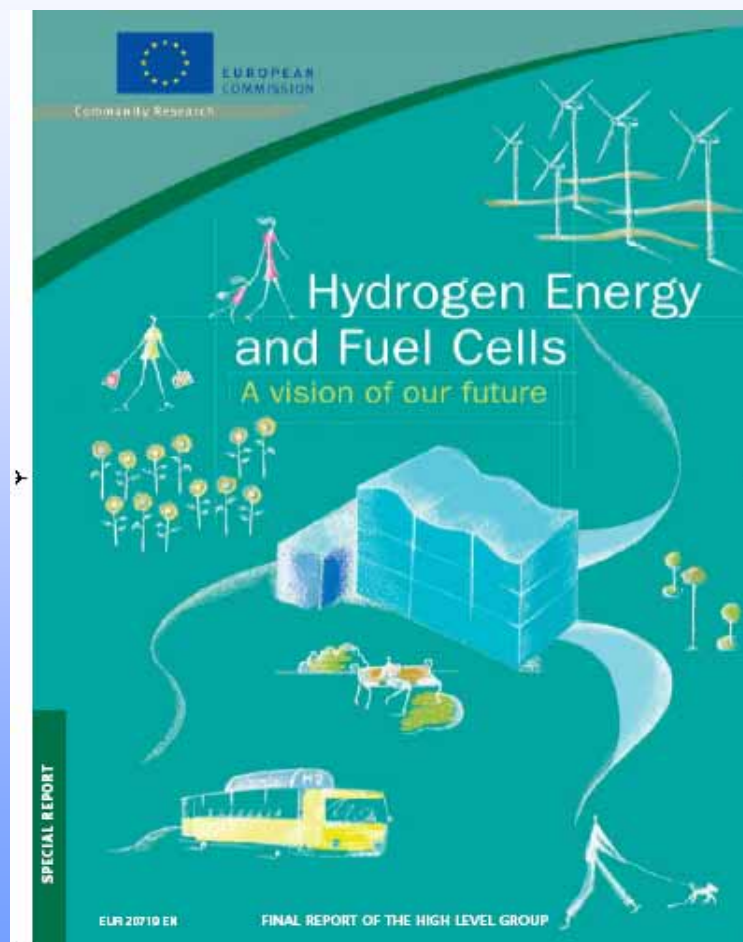


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# The European Hydrogen and Fuel Cell Technology Platform

- **High Level Group H2 and FCs (2002-2003)** - Vision report : *"Hydrogen energy and Fuel Cells – A vision of our future"* – June 2003
- European Hydrogen and Fuel Cell Technology Platform (January 2004) involving main stakeholders
- Two key foundation documents: *"Strategic Research Agenda"* and *"Deployment Strategy"* – Endorsed in March 2005 at Platform General Assembly
- *Strategic Overview* of the above 2 documents – June 2005
- *"Operations Review Days"* - December 2005



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Vision

Commission H/FC Project Team  
(Inter-service Group)

# H2/ FC TECHNOLOGY PLATFORM

Member States'  
Mirror Group

Advisory Council  
(incl. Executive Group)

TP Secretariat  
Information Office  
IT Support Service

Steering  
Panels :

Strategic  
Research Agenda

Deployment  
strategy - LHP

Initial  
Group



Projects and initiatives (EC + MS national)

GENERAL ASSEMBLY

(Bi-)annual Technology Platform Forum

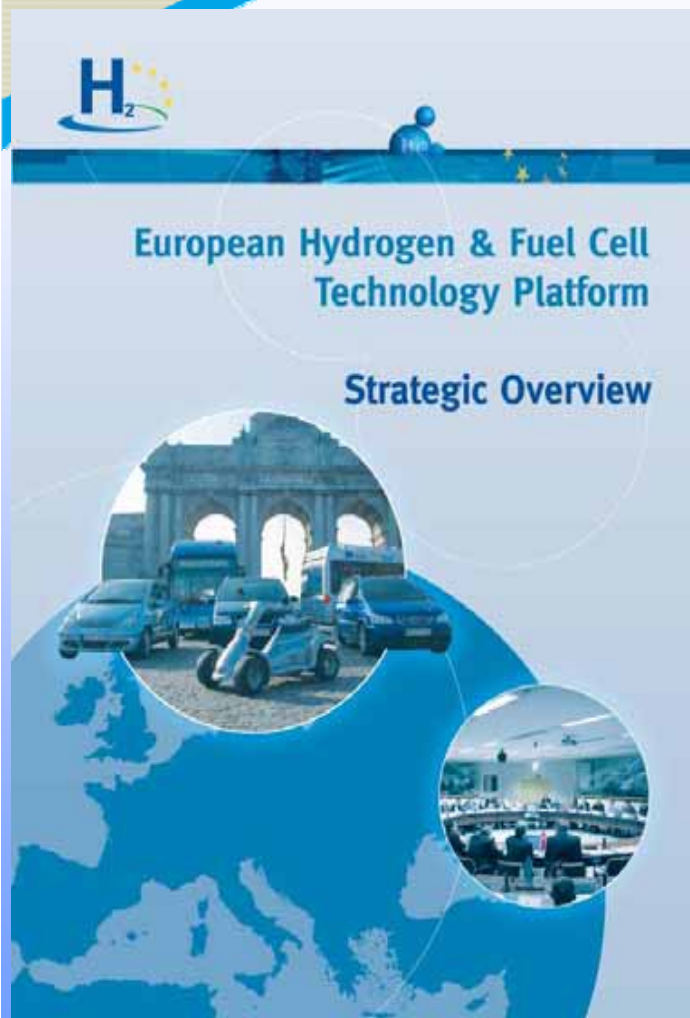
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# Key points of Strategic Overview



## Need for a highly focused, 10 year RD&D programme:

- reduce **FC system costs** by a factor **10** (100 for transport applications);
- **enhance performance** and **durability** of FC systems by a **factor  $\geq 2$**
- **reduce costs of hydrogen** delivered by a **factor  $\geq 3$**
- Pursue **novel hydrogen storage** materials that meet vehicle operating range and packaging requirements

Need to combine private and public investment at EU scale  
– including EU, MS and regions – to **double** present effort

Need to develop Policy frameworks and financial schemes

Integrated RTD + D programme including large-scale demonstrations («**Lighthouse Projects**») to bridge the gap between R&D and commercialisations.

Goals for commercialisation: **portable** applications by **2010**, **stationary** applications by **2015**, and **mass transport** applications by **2020**

<https://www.hfpeurope.org/hfp/keydocs>

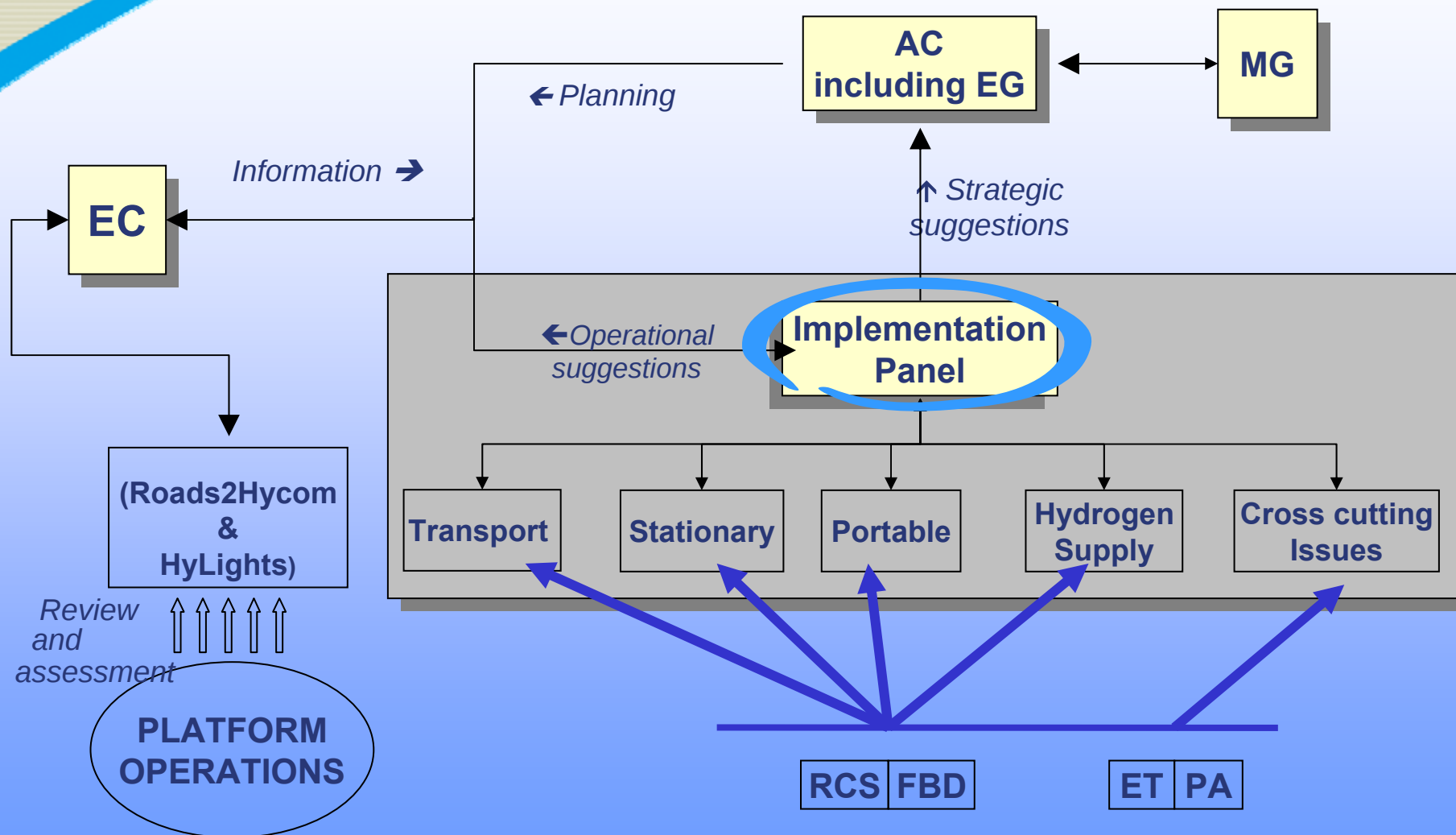
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# HFP New Structure – meeting the present needs & future challenges



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# **Energy Research in the 7th EU Framework Programme (FP7): Joint Technology Initiatives**

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## WHAT'S NEW in FP7 (as proposed by the Commission)

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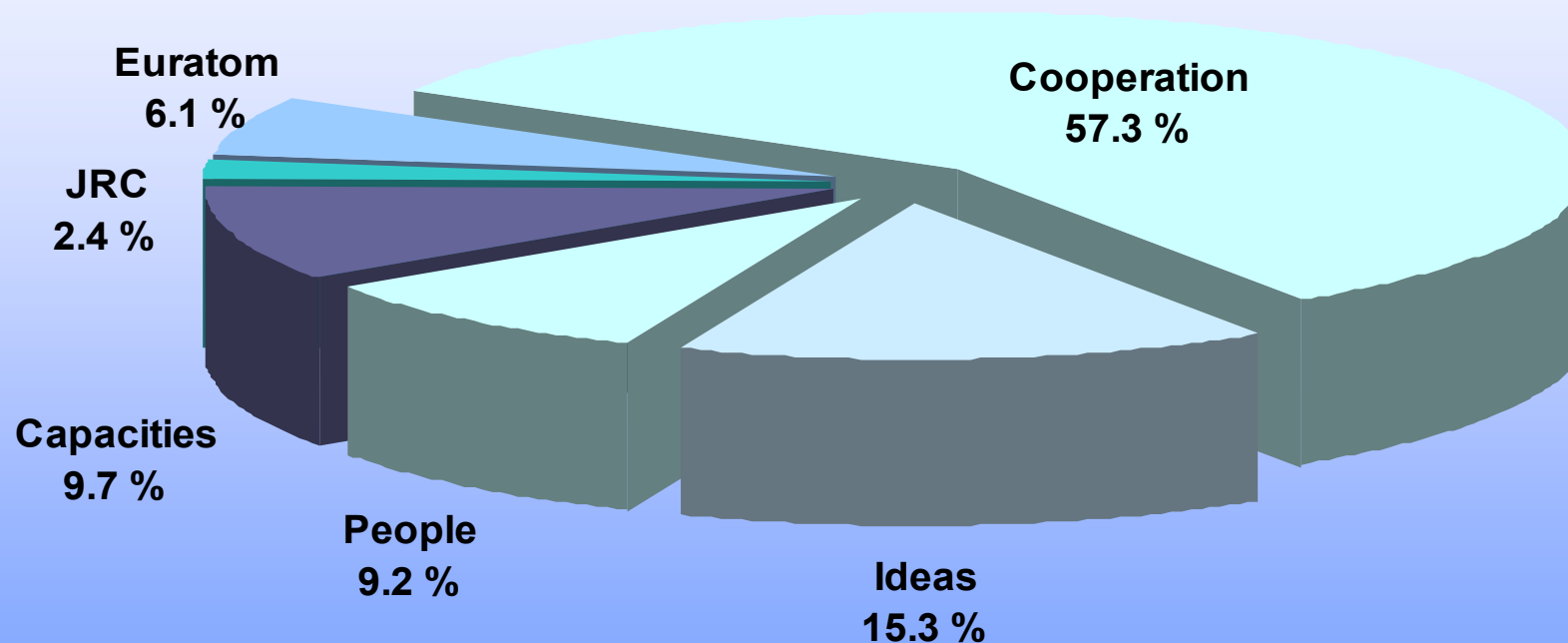
- **Annual budget doubled (EUR 5 billion ► 10 billion)**
- **Emphasis on RTD themes rather than on “instruments”**
  - Continuity.
- **Significant simplification of its operation**
- **Focus on developing research that meets the needs of European industry, through the work of Technology Platforms and the new *Joint Technology Initiatives***
- **Basic research - Establishment of a *European Research Council***
- **Other new topics: Research Infrastructures, Regions of Knowledge, Risk-Sharing Facility (EIB).**
- **Programme length: 7 years**



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## Seventh Framework Programme Commission proposal (68,284 M€, 7 years)



### Simplified timetable

- × FP7 proposal of the Commission – April 2005
- × FP7 adopted by Council and Parliament – summer 2006
- × First calls for proposals – late 2006

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## FP7 (2007-2013) 'Cooperation' proposed budget breakdown per theme

| Theme                                         | Budget<br>Breakdown<br>(% of total) |
|-----------------------------------------------|-------------------------------------|
| 1. Health                                     | 18.7                                |
| 2. Biotechnology, food and agriculture        | 5.5                                 |
| 3. Information society                        | 28.5                                |
| 4. Nanotechnologies, materials and production | 10.9                                |
| 5. Energy                                     | 6.6                                 |
| 6. Environment                                | 5.7                                 |
| 7. Transport                                  | 13.4                                |
| 8. Socio-economic research                    | 1.8                                 |
| 9. Security and space                         | 8.9                                 |



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# Energy Research in FP7

## OBJECTIVE

Transforming the current fossil-fuel based energy system into a more **sustainable** one based on a diverse portfolio of energy sources and carriers combined with enhanced energy efficiency, to address the pressing challenges of **security of supply** and **climate change**, whilst increasing the **competitiveness** of Europe's energy industries.



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# FP7 – Proposed Priority Topics in Energy

**Hydrogen and fuel cells**

**Energy savings and energy efficiency**

**Renewable electricity generation**

**CO2 capture and storage technologies for zero emission power generation**

**Renewable fuel production**

**Clean coal technologies**

**Renewables for heating and cooling**

**Smart energy networks**

**Knowledge for energy policy making**

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# NEW for FP7 - Joint Technology Initiatives

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The JTI is a new management structure that will allow a more efficient organisation of the R&DD resources in Europe in fields of major European public interest and will have the necessary critical mass



## JTI Key features

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- ✗ Establishment of a dedicated legal structure –(**Joint Undertaking ?**) under **Art. 171 EC** (EU Council adopts)
- ✗ **Context/ rationale** – the efficient execution of Community research programmes (FP7)
- ✗ **Purpose** of the JTI – to define and execute an integrated, target-orientated programme of industrial research, technological development and demonstration
- ✗ **Scope** – a large proportion of the industrial research effort in FP7 will be channelled through the JTI (apart from some more upstream research)



# Possible content of a Hydrogen JTI

- ✗ European **fuel cell** development programme – focussed R&D programme with key milestones, related to quality gates in lighthouse demos
- ✗ Sustainable **hydrogen supply** programme – accelerated development of the critical technologies of hydrogen production, storage and distribution
- ✗ **Lighthouse** demonstration programme – phased approach, with stepwise improvements in technologies and increasing number of sites and demonstrators / quality gates to select the most promising technologies
- ✗ **Market framework** preparatory activities (cross-cutting) – proactively fostering business opportunities and early market applications in Europe and removing non-technical barriers



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# Members of the JTI

- ✗ The European Community, represented by the Commission
- ✗ Industry  
*and, as appropriate,*
- ✗ Leading research providers
- ✗ Regional authorities (especially those with H2 programmes willing to host large-scale demonstration actions)
- ✗ Member States?

Members will have to satisfy defined criteria and **contribute financially** to the JTI

**Associate Membership** may also be created to broaden the influence of the JTI



## Some key issues

- ✗ Confirmation of **industry commitment** and **MS** support for JTI
- ✗ Need for a coherent, well-structured, balanced **EU programme with critical mass**, jointly addressing **key shared objectives**
- ✗ **Criteria for membership** of the JTI legal structure – full transparency required
- ✗ **Financial and legal rules** governing the JTI operation – to achieve a more efficient, more flexible, less fragmented implementation of research budgets. IPR issues crucial
- ✗ Statutes of the **Joint Undertaking** (must meet industry and MS expectations) – but need to avoid conflicts of interest
- ✗ Capacity to **leverage financing** from other sources



# Timeline for the JTI

- ✗ **Already included in the Commission proposal for the Seventh Framework Programme**
- ✗ **The political discussion with the Council and the European Parliament is on-going**
- ✗ **Preparations for a EU Council Regulation defining JTI legal structure, operational rules and content are underway**
- ✗ **Submission of EC proposal to Council in early 2006**
- ✗ **The target would be to have the JTI management structure established by the end of 2006.**



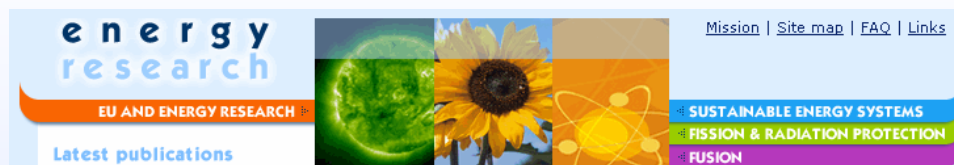
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# Staying informed

**Energy Research web site and Energy Helpdesk:**

[http://europa.eu.int/comm/research/energy/index\\_en.html](http://europa.eu.int/comm/research/energy/index_en.html)  
[rtd-energy@cec.eu.int](mailto:rtd-energy@cec.eu.int)



**Energy Policy**

[http://europa.eu.int/comm/energy/index\\_en.html](http://europa.eu.int/comm/energy/index_en.html)

**Calls for proposals**

<http://fp6.cordis.lu/fp6/calls.cfm>



**Towards Seventh Framework Programme**

[http://europa.eu.int/comm/research/future/index\\_en.html](http://europa.eu.int/comm/research/future/index_en.html)

**Newsletter, Information days and similar events, conferences**

<http://europa.eu.int/comm/research/energy/pdf/renews4.pdf>

[http://europa.eu.int/comm/research/energy/gp/gp\\_events/action/article\\_2790\\_en.htm](http://europa.eu.int/comm/research/energy/gp/gp_events/action/article_2790_en.htm)



**European Hydrogen and Fuel Cell Technology Platform**

[www.HFPeurope.org](http://www.HFPeurope.org)



**Joint Research Centre**

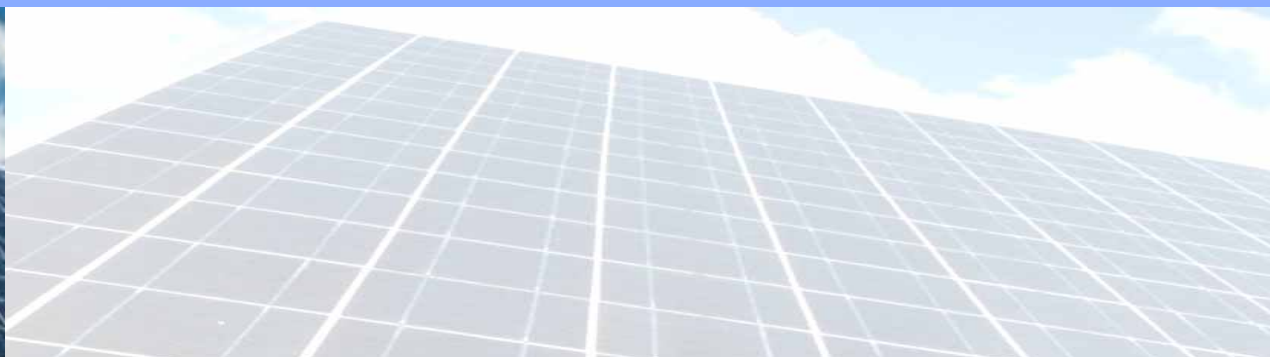
<http://www.jrc.cec.eu.int>



**European Fuel Cell Conference**  
Rome 14-16 December 2005



**Thank you  
for your attention**



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