



# European Prospects for Fuel Cells in the 6th Framework Programme

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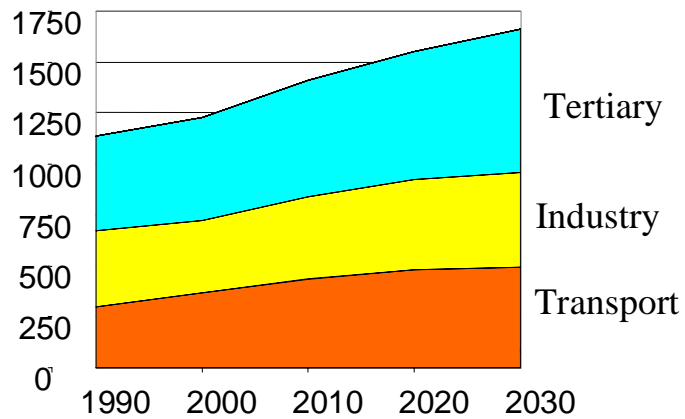
# Presentation Outline

- **EU Energy Policy and Market context**
- **Fuel cells in the 5th RTD Framework Programme**
- **The new EU RTD Framework Programme (FP6)**
- **Prospects for EU/US cooperation in the field of Fuel Cells**

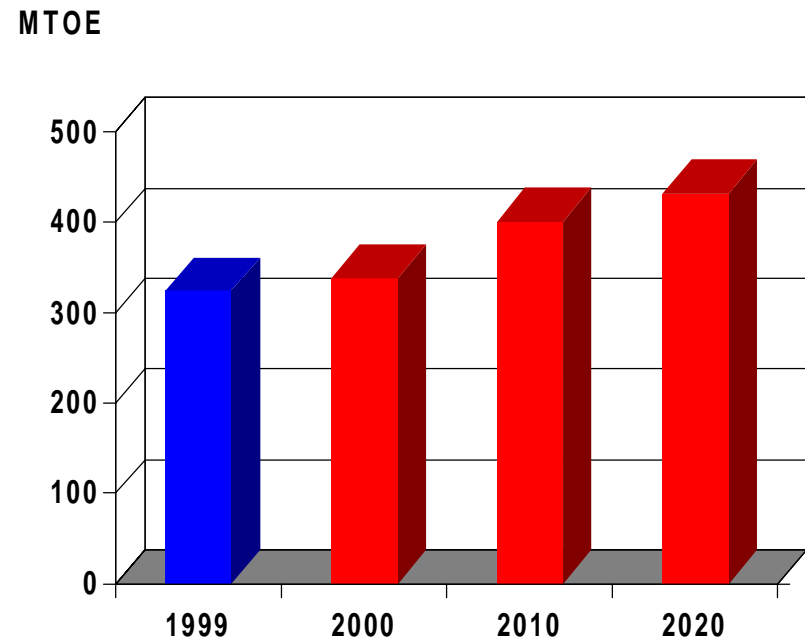


# EU energy... Basic facts

*EU-28: final energy consumption (in mtoe)*

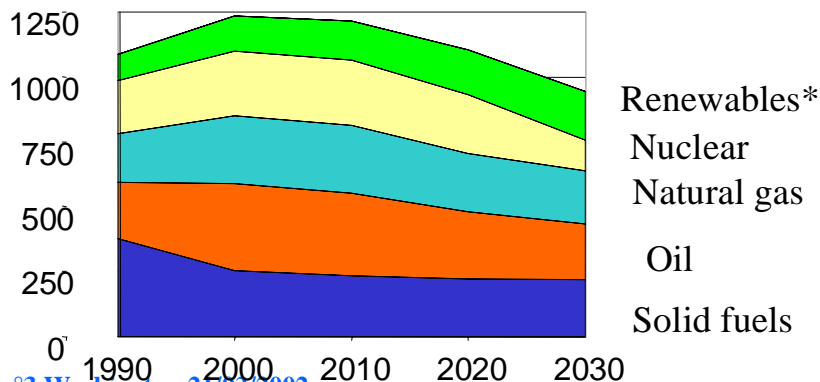


Projected demand  
Natural Gas (EU-15)



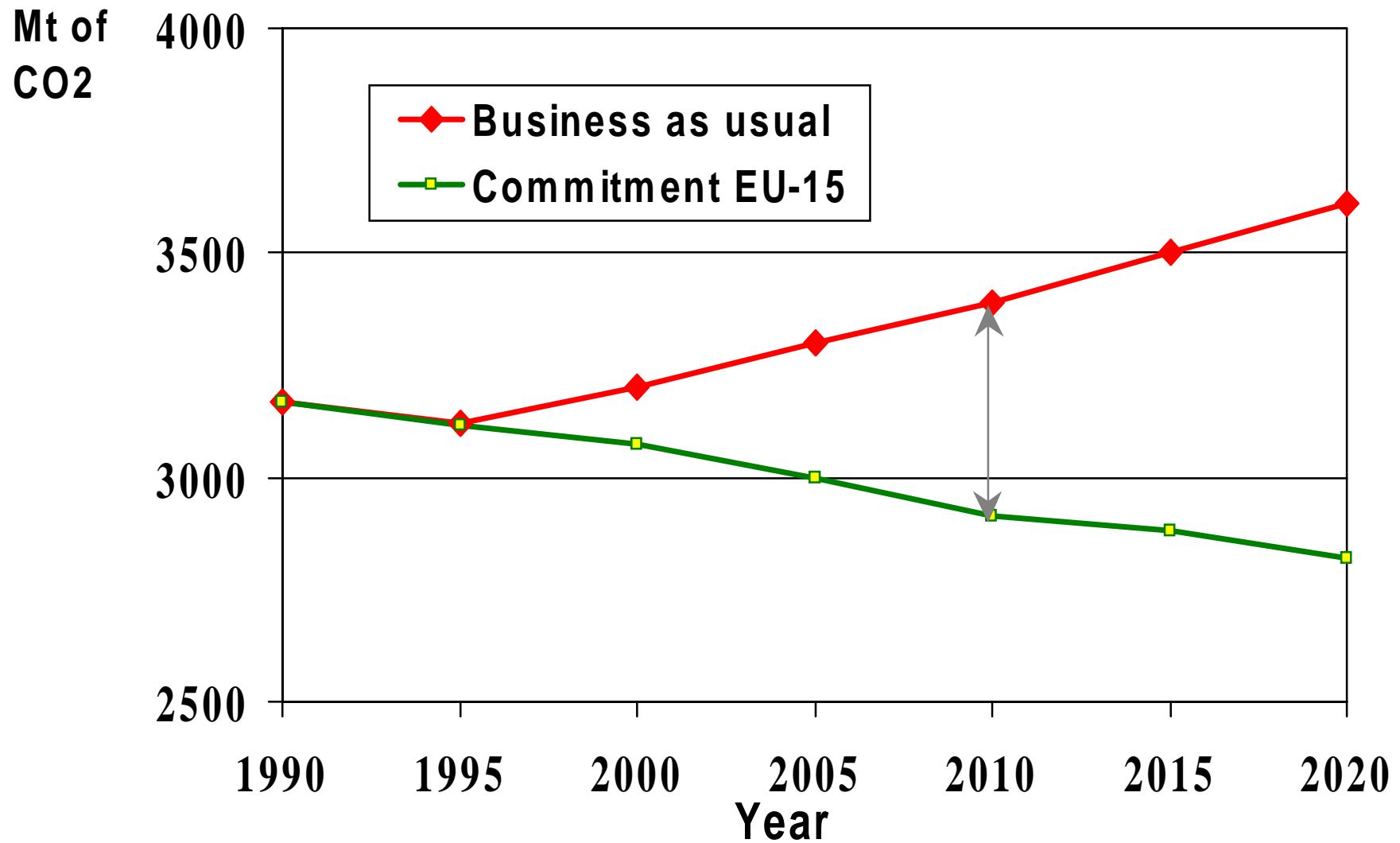
Market share: 22%, increasing to 27%  
Strongest increase in power generation

*EU-28: domestic production, reference scenario*





# Kyoto challenges





# Policy Objectives

## and some ongoing actions

### → Meeting EU Kyoto Commitments

8% CO<sub>2</sub> reduction by 2008-12 compared to 1990

Much deeper reductions required by 2015-2025...

### → Maintaining Security of Supply

Green Paper of Nov. 2000 launched debate

### → Promoting Industrial Competitiveness

#### → Improving Energy Efficiency

Target: 18% from 1995 to 2010)

#### → Increasing the Share of Cogeneration

Target: 12% of EU-15 electricity by 2010

#### → Doubling the Share of Renewable Energies

Target: 6 to 12% of final energy (Eurostat)



# Fuel Cells: goals and targets in FP5

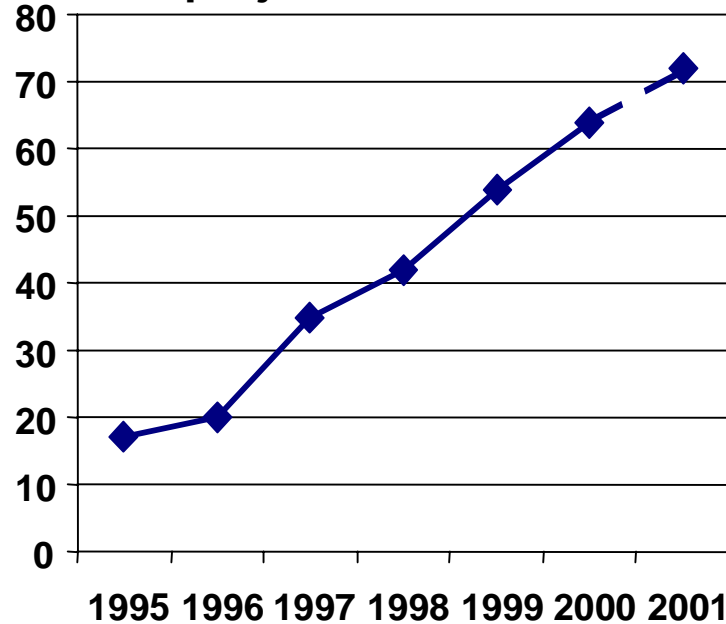
- **Qualitative** :
  - Cost reduction**
  - Improve life time of critical parts**
  - Contribute to solve the fuelling options**  
(fuel choice and re-fuelling infrastructure)
  - Pre-normative / socio-economic**
  
- **Quantitative** :

	<b>Stationary</b>	<b>Transport</b>
– System cost	<b>&lt; 1.000 EUR/kW</b>	<b>&lt; 100 (50) EUR/kW</b>
– life time	<b>50.000 - 100.000 hrs</b>	<b>&gt; 5.000 (10.000) hr</b>

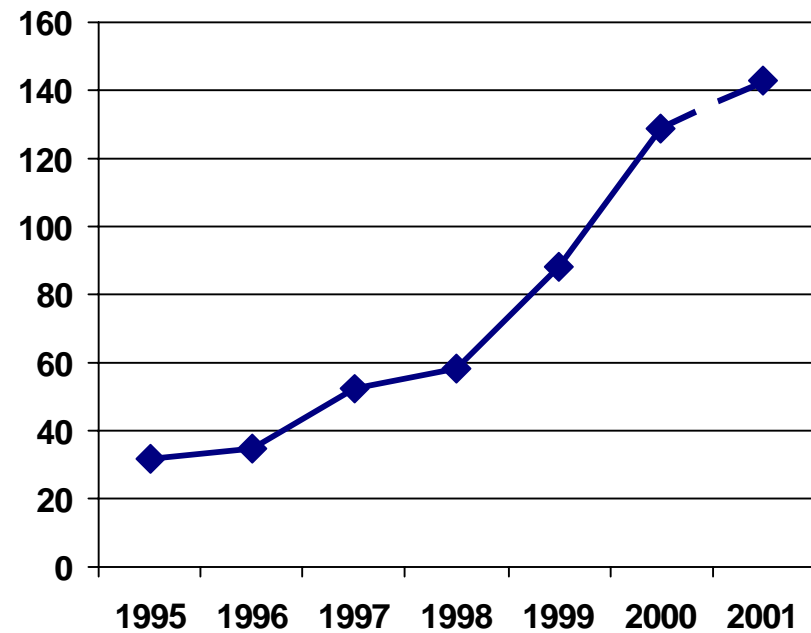


# FP4 & 5 Public Support to Fuel Cell/Hydrogen projects (Demonstration and Research)

Number of projects



M•





# European fuel-cell programmes

## Scale of public funding

DE	FR	NL	ES	IT	DK	UK	SE	NO	CH	Sum MS*	EC	Total
8	11.5	3	3	2.3	2.7	2	0.7	0.6	1	~35	~35	~70
SO MC PEM	SO MC PEM PA	SO PEM	MC PEM	SO MC PEM	SO	SO PEM	SO MC PEM	SO PEM	SO PEM PA		all types in (short-term)  SOFC PEM DMFC (long-term)	

(\*): Member & Associated States + Switzerland. 1999/2000 estimates.

**US:** ~ 120 M\$, including 30 from U.S. DoD field-test programs.

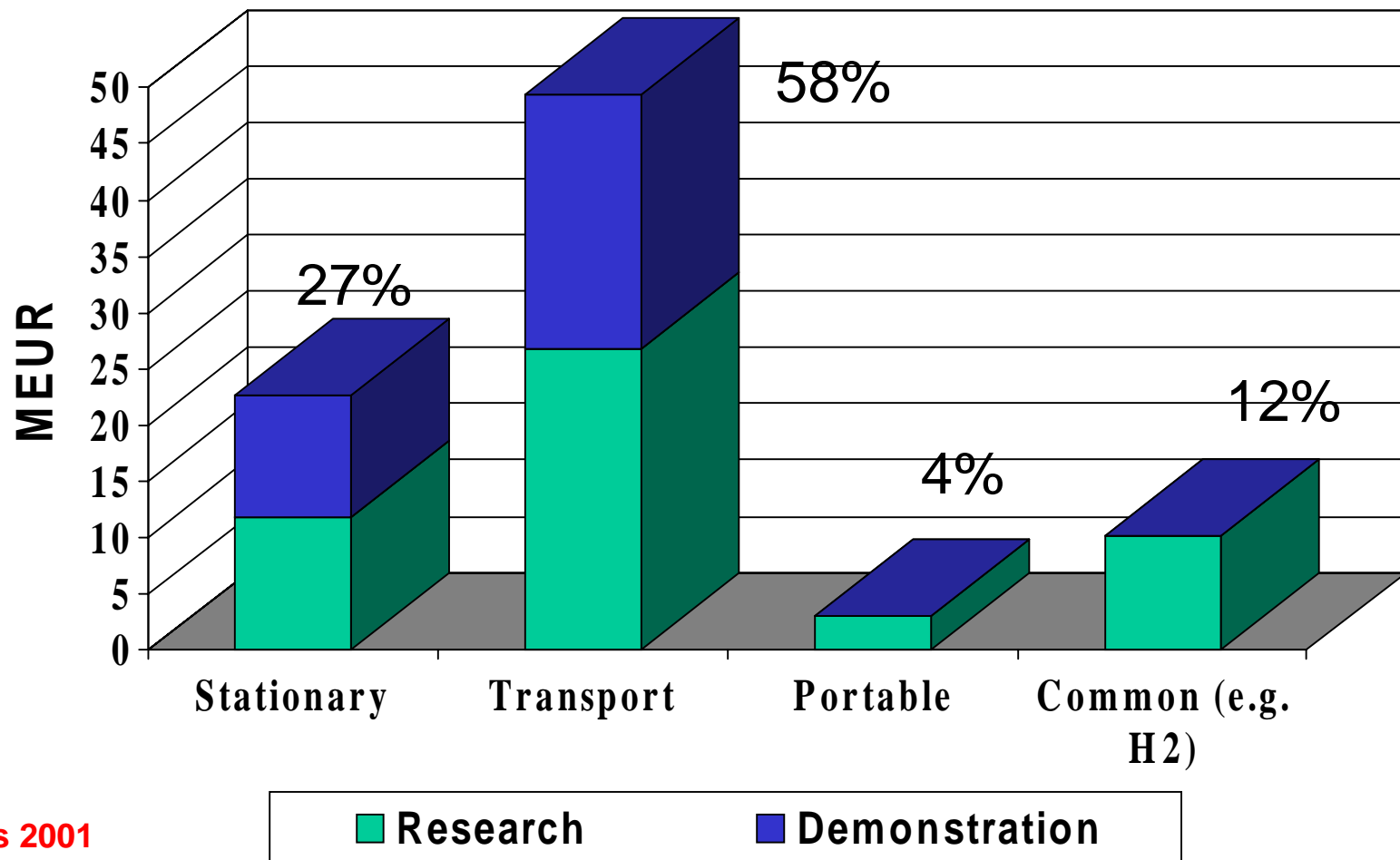
**Japan:** 117 M\$ (75 PEM, 22 MCFC, 7 SOFC +13 M\$ for GTL)





# Fuel Cells

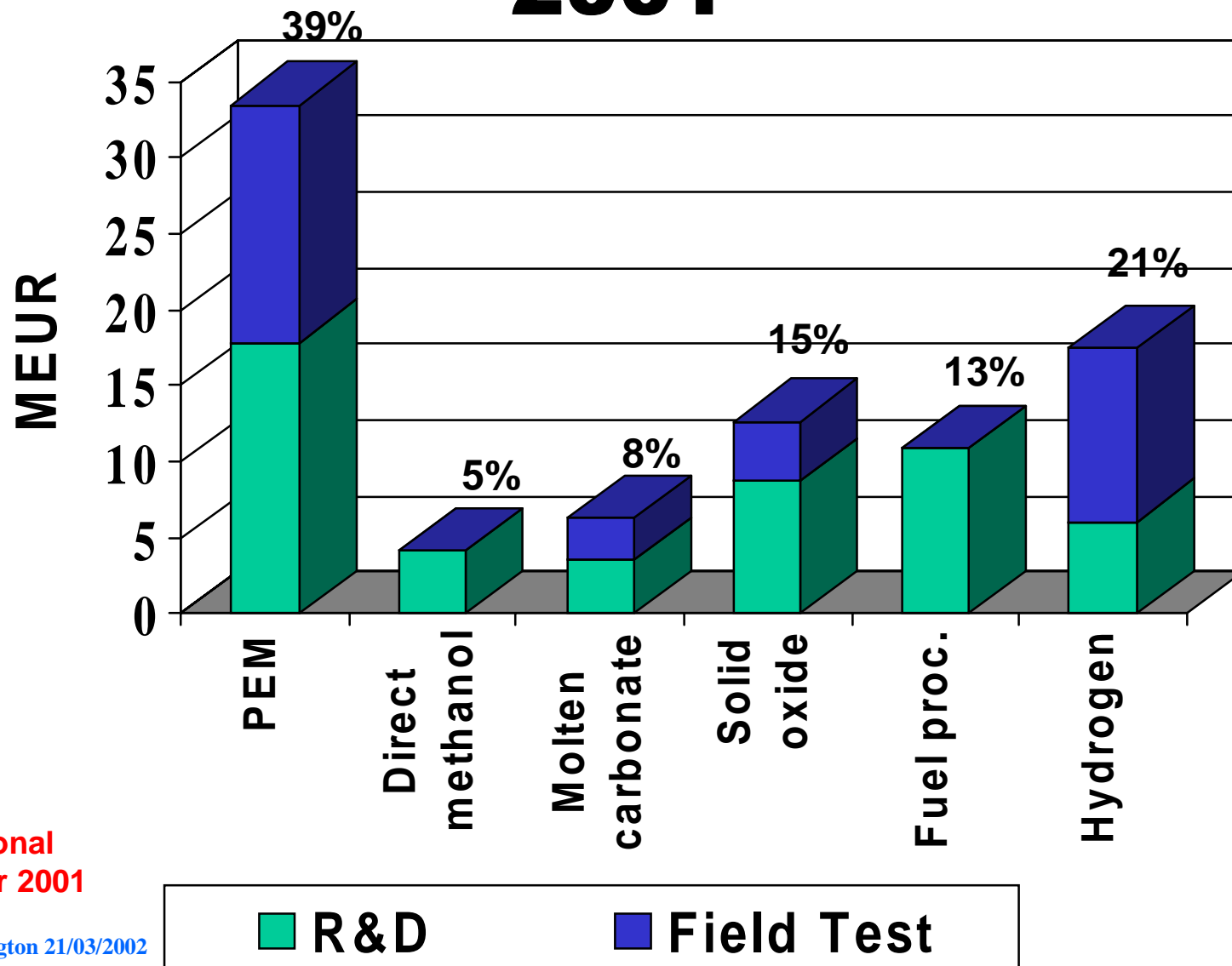
## EC support 1999-2001\*, by Application sector



(\*): Figures 2001  
provisional



# EC support by FC technology 1999-2001



Provisional  
figures for 2001



# Some on-going **Research** Projects: SOFC's for stationary Heat & Electricity

<p>Integrated modelling study</p> <p><b>IM-SOFC-GT</b></p> <p><b>INDUSTRIAL DEVELOPMENT</b></p> <p><b>Rolls-Royce</b></p> <p>Turbec</p> <p>ABB Turbo</p> <p>Alstom Power</p> <p>Turbomeca</p> <p>Sydskraft</p> <p>Enel</p> <p><u>Applied Research</u></p> <p>Univ. Genova</p> <p>Univ. Lund</p>	<p>SOFC Materials</p> <p>-</p> <p><b>CORE-SOFC</b></p> <p><b>INDUSTRIAL DEVELOPMENT</b></p> <p><b>Rolls-Royce</b></p> <p>Haldor Topsøe</p> <p>-</p> <p>-</p> <p>-</p> <p>-</p> <p><u>Applied Research</u></p> <p>ECN</p> <p>RISØ</p> <p>FZ Jülich</p>	<p>SOFC System</p> <p>-</p> <p><b>MF-SOFC</b></p> <p><b>INDUSTRIAL DEVELOPMENT</b></p> <p><b>Rolls-Royce</b></p> <p>Advanced Ceramics</p> <p>Gaz de France</p> <p>-</p> <p>-</p> <p>-</p> <p>-</p> <p><u>Applied Research</u></p> <p>RISØ</p> <p>Imperial College</p>	<p>SOFC System</p> <p>-</p> <p><b>PROCON</b></p> <p><b>INDUSTRIAL DEVELOPMENT</b></p> <p><b>Alstom</b></p> <p>Prototech</p> <p>-</p> <p>-</p> <p>-</p> <p>-</p> <p><u>Applied Research</u></p> <p>FZ Jülich</p> <p>-</p>	<p>Mass Deployment of cheap and reliable modules</p>
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# FP6 - A wider range of better differentiated instruments

- ➔ **Integrated projects**
- ➔ **Networks of excellence**
- ➔ **Article 169** (*joint implementation of national programmes*)
- ➔ **As a “stairway of excellence”**
  - ✓ **specific targeted research projects**
  - ✓ **co-ordination actions**
- ➔ **Specific support actions**



# Energy RTD in FP6

## ➔ Sustainable Energy Systems (810 Mio EURO)

- Reduction of greenhouse gases and pollutant emissions
- Security of energy supply
- Increased use of renewable energy
- Achieve an enhanced competitiveness of European industry

## ➔ EURATOM (940 Mio EURO)

- Controlled thermonuclear fusion (740 M•)
- Management of radioactive waste ( 90 M•)
- Radiation protection ( 40 M•)
- Nuclear technologies and safety ( 40 M•)



## FP6

# Sustainable Energy Systems

➔ **Research priorities for the short and medium term**

### Objective:

To curb unsustainable patterns of development, characterised by the growing dependence on imported fossil fuels, by supporting integrated actions (e.g. new legislation, new renewable technologies and demand management instruments) aiming to change consumer behaviour:

- Clean energy, in particular renewable energy sources and their integration in the energy system, including storage, distribution and use
- Energy savings and energy efficiency, including those to be achieved through the use of renewable raw materials
- Alternative motor fuels



## FP6

# Sustainable Energy Systems

➔ **Research priorities for the medium and long term**

### **Objective:**

Support the development of technologies for affordable and clean energy sources, carriers and conversion systems, which can be well integrated in a long term sustainable energy supply and demand context.

- Fuel cells, including their application
- New technologies for energy carriers/transport and storage, in particular hydrogen
- New and advanced concepts in renewable energy technologies
- Capture and sequestration of CO<sub>2</sub> associated with cleaner fossil fuel plants



## FP6

# Sustainable Energy Systems

## ➔ Fuel Cells, including their applications

### Objectives:

- Replace in the long term a substantial proportion of combustion based systems.
- Contribute to the development of an Hydrogen Economy

### RTD focus on:

- Cost reductions in fuel cells production and in application to buildings, transport and decentralized electricity production
- Advanced materials for low and high temperature fuel cells





# FP6 - Sustainable Energy Systems

## Implementation of FC RTD activities

### ➔ Networks of Excellence

- ✓ High Temperature PEMFC
- ✓ Low temperature SOFC
- ✓ Socio-economic and pre-normative research

### ➔ Integrated Projects

- ✓ Small scale (mainly low °T) FC for CHP and air conditioning
- ✓ Large scale power generation, including hybrid systems
- ✓ Auxiliary Power Units
- ✓ Small road vehicles applications
- ✓ Heavy duty road, marine and railway applications
- ✓ Balance of Plant and components developments



**FP6 - Sustainable Energy Systems**  
**Invitation to submit**  
**“Expressions of Interest”**  
**for Integrated Projects and Networks of**  
**Excellence**

**The EoI announcement, a guide for submitters,  
Help and Information Desk addresses and  
further information relevant to this invitation  
to submit expressions of interest can be found  
at:**

**[www.cordis.lu/fp6/eoi-instruments](http://www.cordis.lu/fp6/eoi-instruments)**

**➔ For more information: Help-Desk: “RTD-Sustainable@cec.eu.int”**



# EU/US co-operation

## key actions and events

- **S&T Agreement: FP5, including NNE**
- **Results in FP5 (EU/US joint proposals):**
  - 16 Proposals in EU FP5 (< 1%)
  - 4 joint projects on-going (SOFC, biomass, CO<sub>2</sub> storage, climate assessment)
- **Implementing Arrangement on Non Nuclear Energy (May 2001)**
  - **Modalities**: Reciprocity, exchange of info/scientists/materials /equipment, meetings, joint studies for projects, others
  - **Financing**: EU funding limited to EU partners and vice-versa



# EU/US co-operation on SOFC

## The point of view of 13 key EU organisations

- **Industrial key players**
  - Market penetration analysis
  - field testing of stand-alone systems
  - research on BoP optimisation, low temp. SOFC, improvement of key materials, modelling & simulation, cell& stack manufacturing
- **End-users**
  - technology mapping, market penetration analysis, pre-normative research, system optimisation
- **National lab.**
  - Steel optimisation for interconnects / dev. of SOFC for APU
- **Academia**
  - Low temperature SOFC, BoP optimisation & modeling, improved key materials



# Possible areas for EU/US co-operation

Organisation profile		Industrial Manufacturer	National Laboratories	Academia	End-User / Utility
<b>Potential interest</b>					
Pre-normative research to support the development of standards and norms for :	- safety, - quality, - test procedures, -performance measurements...				
Technology mapping					
Market penetration analysis					
Other(s) :					
<b>Field testing</b>					
Stand-alone SOFC					
Advanced hybrid fuel cell system (SOFC/GT)					
Auxiliary Power Units					
Residential fuel cell system					
Other(s) : UPS					
<b>Applied Research</b>					
Optimization of system integration					
Low temperature Solid Oxide fuel Cells					
Anode stability					
Improvement of key materials					
Modeling and simulation					
Power electronics					
Cell & stack Manufacturing					
Other(s) :					
Interconnects					
Specialist GTs for fuel cells recuperators					



# EU/US workshop - 14 Sept. 2001

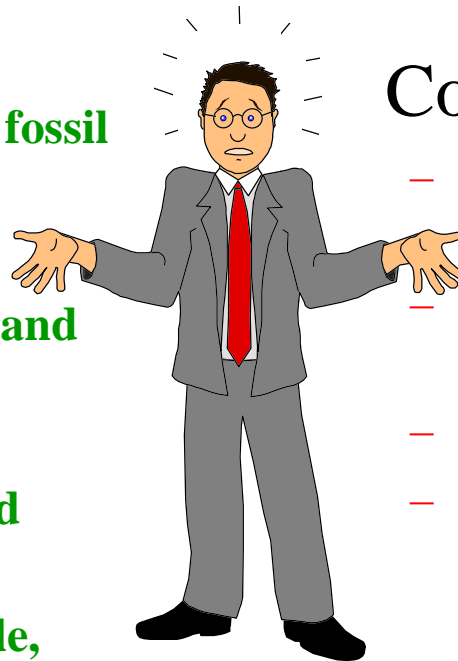
- **Overall, a success with 85 participants (35 US) !**
- **4 themes (DMFC/PEMFC, SOFC/hybrids, APUs, bus demos) raised major interest;**
- **Focus on joint studies, joint networks** (US partner contractually bounded or not with EU contract model) **and coordinated projects**
  - Each side submits separate cross-referenced proposals to own program;
  - Evaluation, selection independent on both sides;
  - Proceed to contract negotiation independently (may proceed with contract signature depending on whether cross-participation is on critical path;
  - Separate contracts linked by a common Consortium Agreement
- **IPR and legal issues to be solved on a case by case**



# Will fuel cells **REALLY** power the future?

## Pros

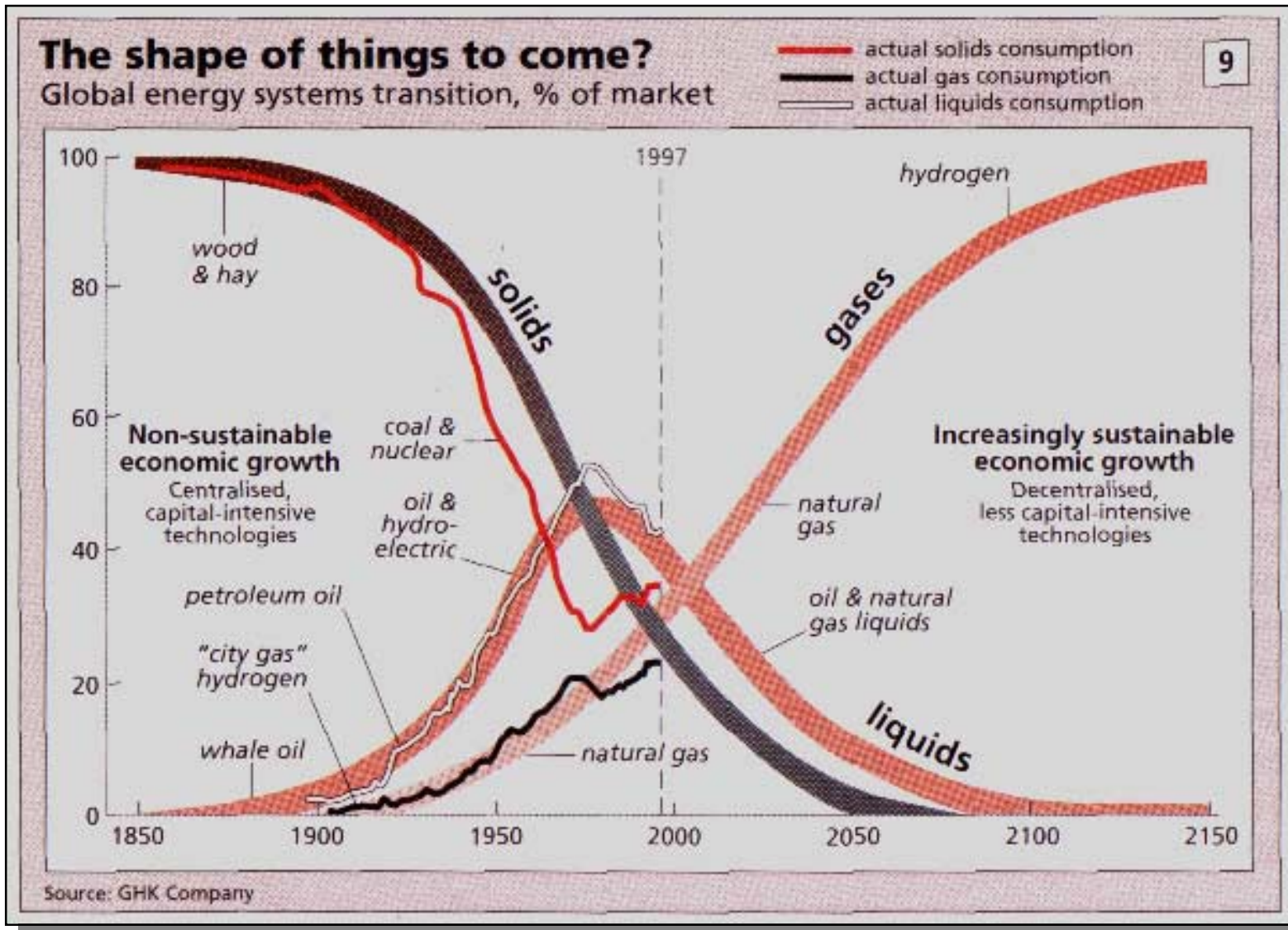
- **FC's a critical link between fossil & RE energy systems**
- **H<sub>2</sub> is the logical bridge**
- **Intrinsically clean, efficient and quiet technologies**
- **Liberalisation creates new opportunities, game changed**
- **Huge market potential: Modular solutions for mobile, residential, buildings, CHP... if cost targets can be met !**



## Cons

- **Strong price competition in free & decentral market**
- **E&E case must still be proven beyond doubt**
- **No regulatory framework**
- **Are Human resources for technical development the limiting factor?**
- **Infrastructure remains « chicken and egg »...**

- RTD and demonstration needed to establish present capabilities, cost/benefits, hurdles, future potential...
- Separate (legitimate) enthusiasm from reality: Timelines!
- Biggest challenge yet to established industry structures...



Source: IPCC (Nakicenovic et al.) as quoted in *The Economist* March 2001



