

# FP5 (1999-2002) - The Energy Content - Overview

## Clear Policy Targets:

- Energy oriented by doubling the Share of Renewable Energy Sources (from 6% to 12% in 2010 versus 1998) also contributing to the security of our energy supply;
- Environmental incentives to meet the Kyoto Objectives (8% CO<sub>2</sub> reduction between 2008 and 2012 compared to 1990 level);
- Socio-economic measures recognising the impact of energy systems on competitiveness, employment, cohesions of regions,...





# Why Fuel Cells is so important ?

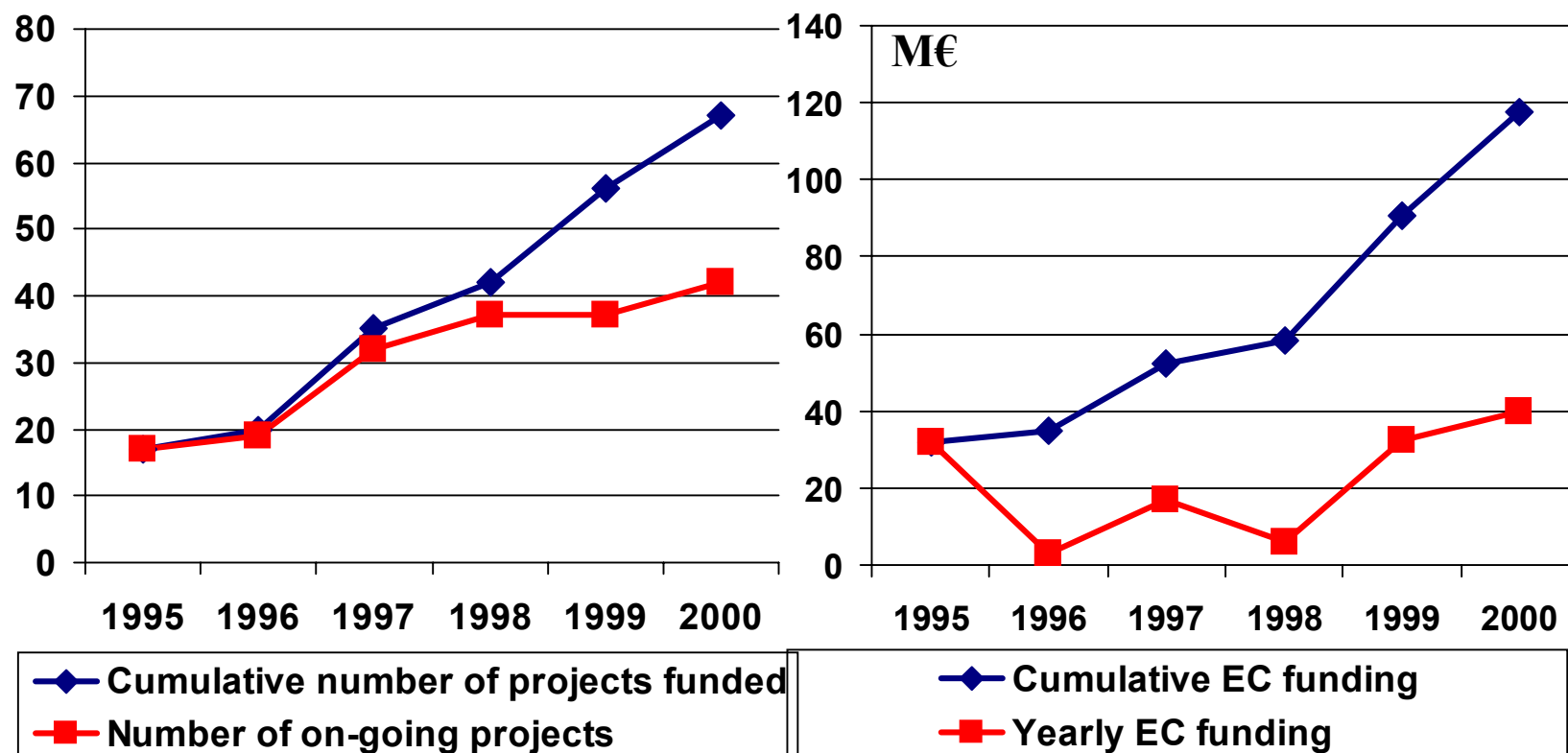
## A Cleaner and more efficient technology:

- Superior to combustion technologies (Automotive industry, power generation, heat and electricity supply in homes, commercial/business buildings and industries, portable devices);
- Contribution to the EU Energy policy (energy savings, environment respectful, sustainable and security of energy supply especially with hydrogen;

The current challenge still remains  
"Cost Reduction"

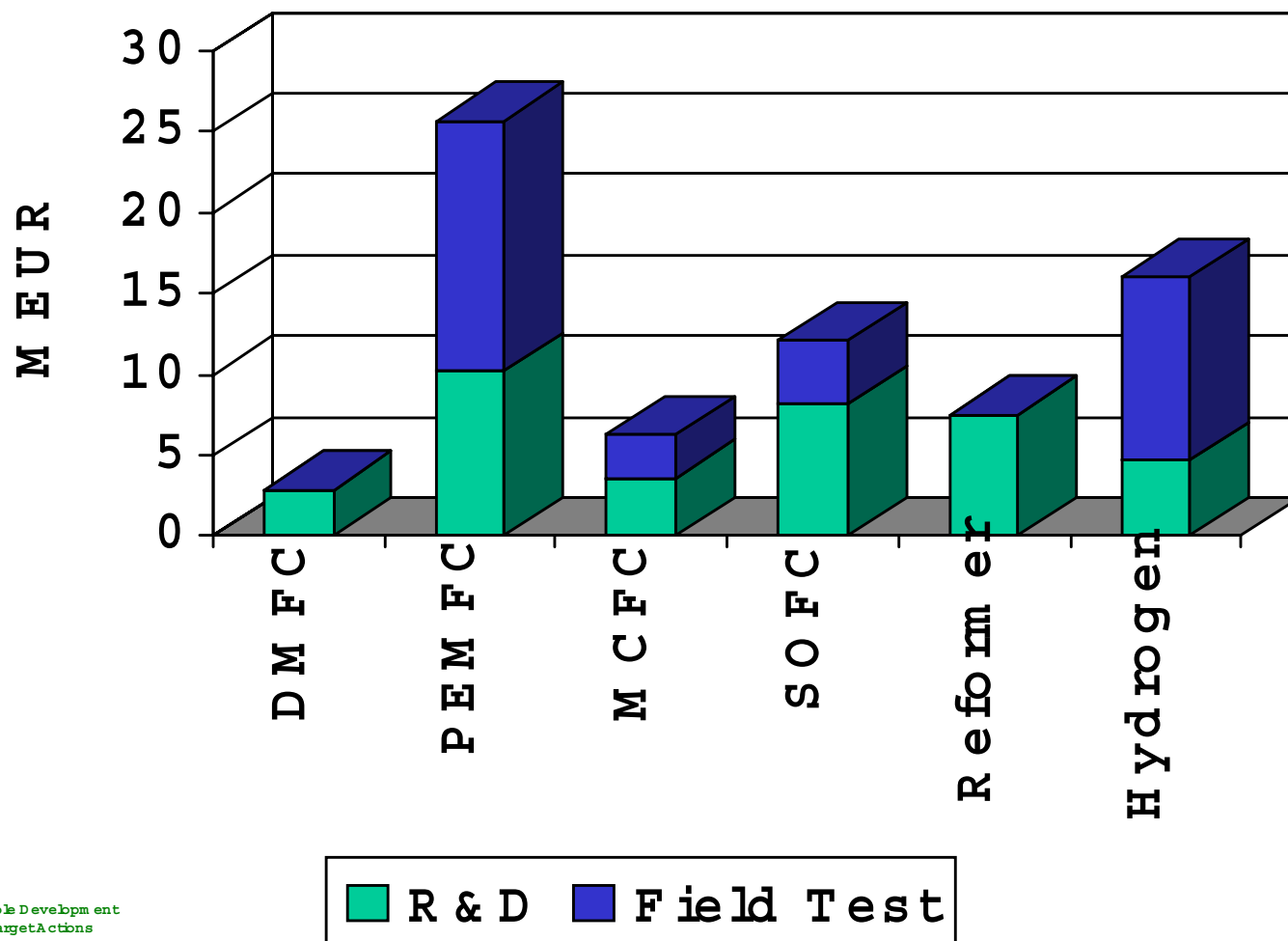


# Dynamic of the Fuel Cell EU support since 1995



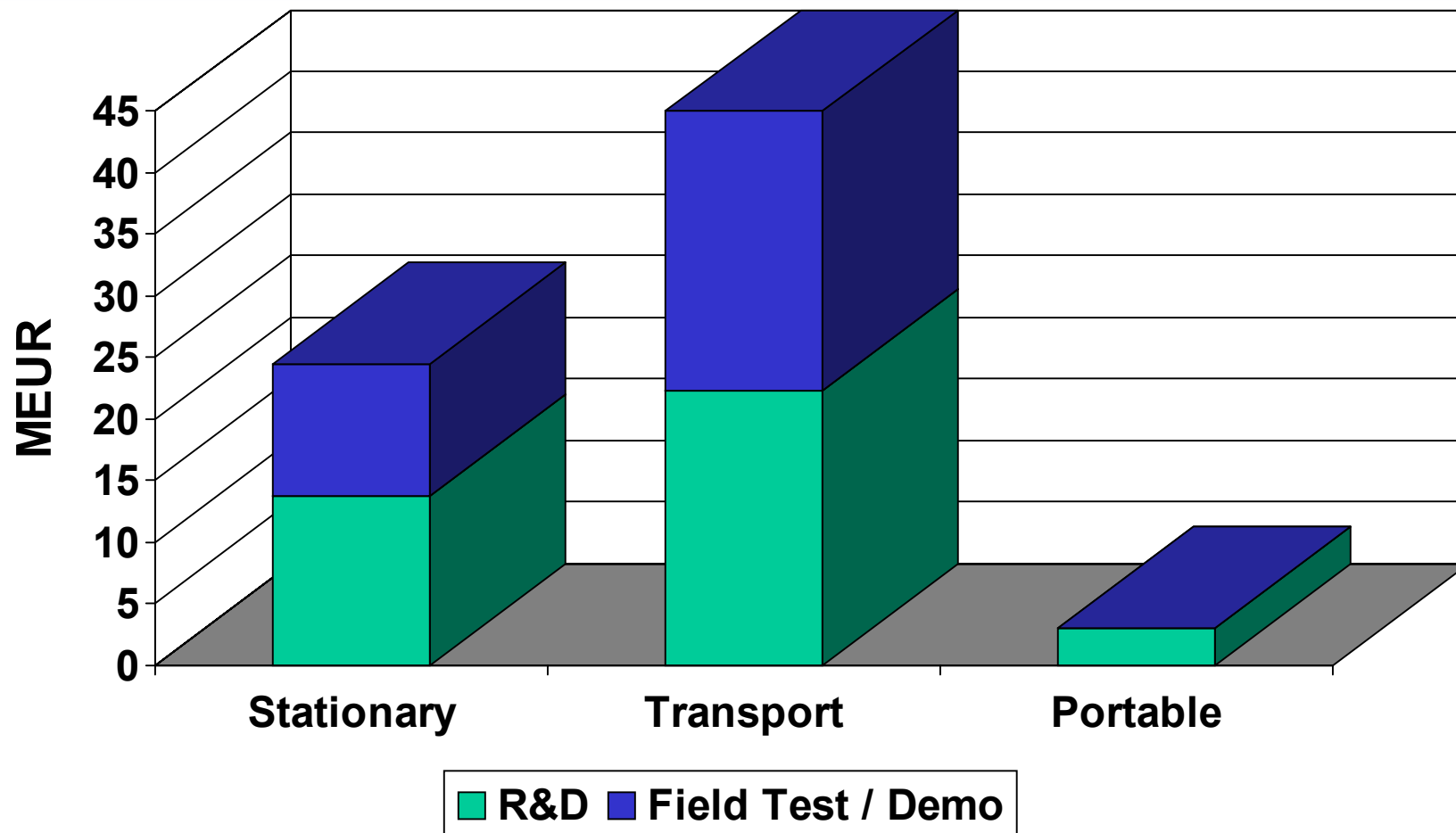


# EC support to Fuel Cell and Hydrogen technologies 1999-2000





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# Overview of Fuel Cell yearly public funding in Europe (All types)

DE	FR	ES	IT	DK	UK	SE	SW	Total MS <sup>(1)</sup>	EU (EC)	Total (EU)
MEUR	MEUR	MEUR	MEUR	MEUR	MEUR	MEUR	MEUR	MEUR	MEUR	MEUR
8	11,5	3	2,3	2,7	2 <sup>(2)</sup>	0,7	1	~31	~30	~61
SOFC MCFC PEMFC	All types	PEMFC MCFC	SOFC, MCFC, PEMFC	SOFC	SOFC, PEMFC	SOFC, MCFC PEMFC	SOFC, PEMFC PAFC		SOFC, PEMFC DMFC in M/LT  All types in ST	

(1) : European Member States

(2) : New programme 2001-2005 starting



# Status of SOFC development in Europe

## Planar

One cell per planar surface		Many cells (matrix or series) per planar surface		
Metallic inter-connectors		Ceramic inter-connectors	Metallic inter-connectors	Ceramic inter-connectors
Thick electrolyte	Thin electrolyte	Thick electrolyte	Thick electrolyte	Thick electrolyte
<b>Sulzer Hexis</b> (1 kWe, 2000, 70 cells, 270 mA/cm <sup>2</sup> 0.175 W/cm <sup>2</sup> 900°C, x% NG)  <b>ECN</b> (0.09 kW, 2000, 5 cells, 250 mA/cm <sup>2</sup> , 950 °C, steam ref. NG at SCR=2.5)	<b>Forshungs Zentrum Juelich</b> (1.6 kW, 2000, 10 cells, 610 mA/cm <sup>2</sup> , 800°C, 44% H <sub>2</sub> )  <b>ECN</b> (0.054 kW, 2000, 3 cells, 250 mA/cm <sup>2</sup> , 800°C, 4g/hr/cell ref CH <sub>4</sub> )  <b>Risø</b> (0.47 W/ cm <sup>2</sup> , 1999, 1 cell, 560 mA/cm <sup>2</sup> , 0.7 V 850°C, 97% H <sub>2</sub> )	<b>Risø</b> (0.5 kW, 1995, 50 cells, 300 mA/cm <sup>2</sup> , 1000°C, 40% H <sub>2</sub> )	<b>Siemens (stopped)</b> (7.2 kW, 1998, 2 stacks of 50x4x4 cells, 400 mA/cm <sup>2</sup> , 900°C, 30% H <sub>2</sub> )	<b>Rolls Royce</b> (1 kW, 2000, 27x 20 cells 385 mA/cm <sup>2</sup> , 970°C, x% H <sub>2</sub> )

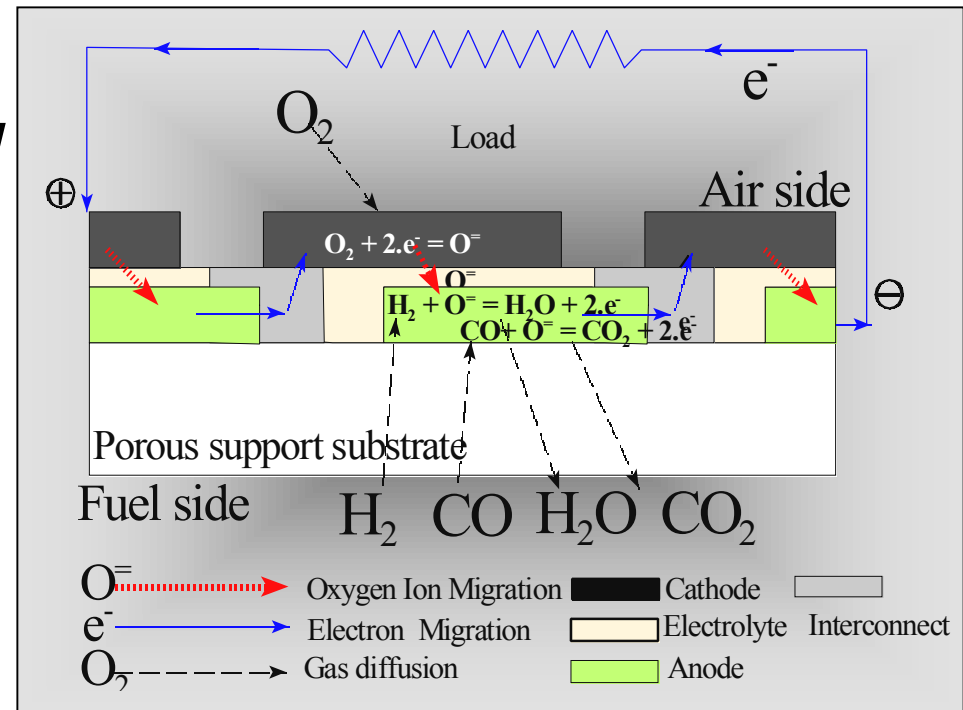
# A 5 kWe scale SOFC stack PProof of Concept (PROCON)

- Investigate critical issues for a 20 kW system
- Develop and test of a 5 kW stack
- Anode supported-cells ( $\sim 800^{\circ}\text{C}$ )
- Period : 2000-2002
- **EU support : 1,5 M€**



# A 20 kWe Multi-Functional SOFC stack (MF-SOFC)

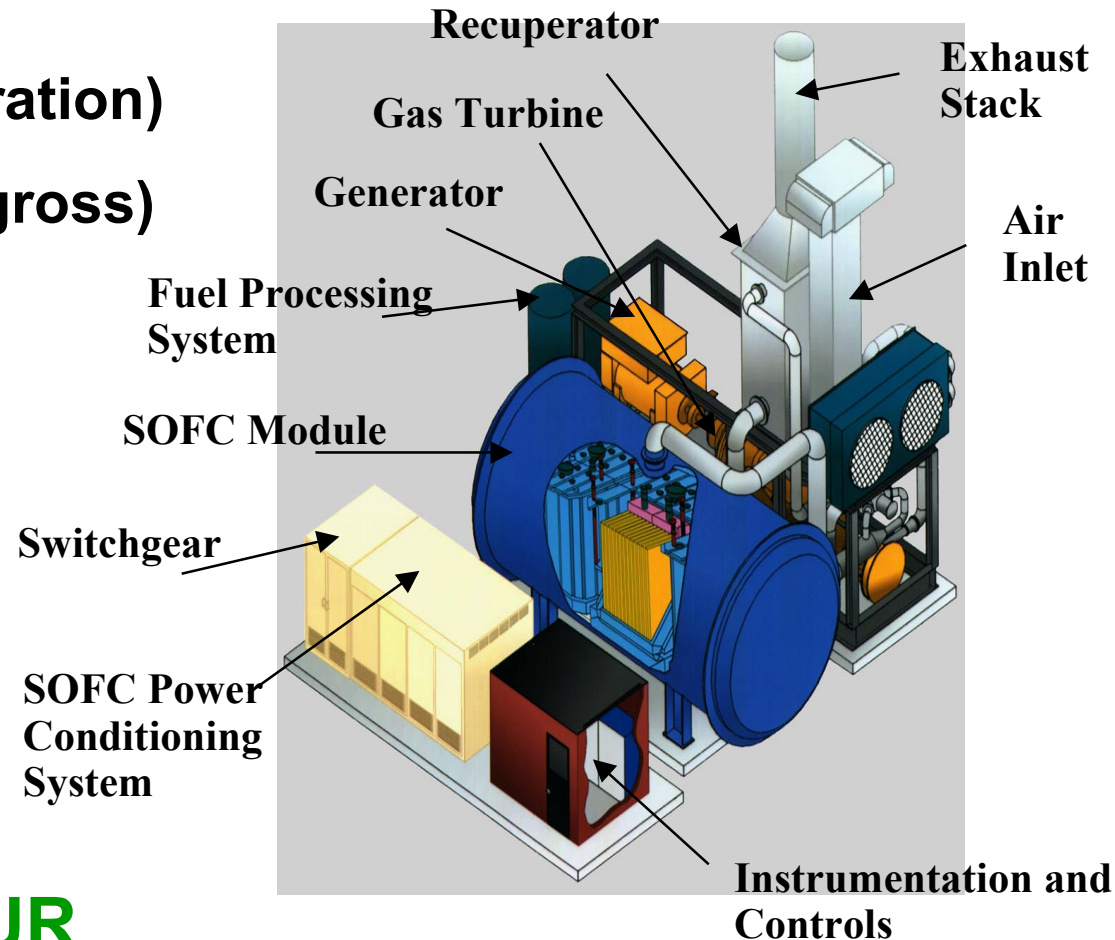
- Design of a power system : 200 - 500 kW
- Develop and test of a 20 kW stack
- Modularity of stack
- Period : 2000-2003
- **EU support : 3,5 M€**



# 1 MWe Hybrid SOFC/ $\mu$ GT

- Demo (EU/US co-operation)
- Efficiency > 55 % (gross)
- Power system
- 3 bar Pressure
- Period : 2000-2003

- EU support : 4 MEUR



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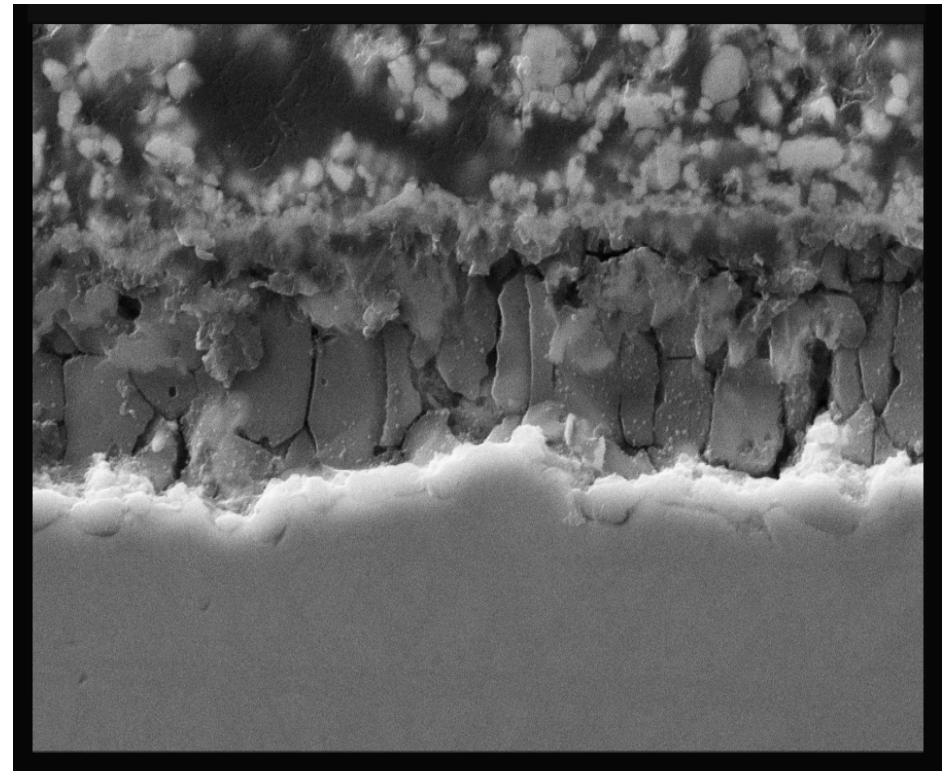
# Integrated Modelling Study of Fuel Cell/Gas Turbine Hybrids (IM-SOFC-GT)

- Assessment of product requirements and viability by combining market understanding and integrated modelling capabilities
- Obtain specifications for FC stack and turbo-machinery + key BoP components
- Sub-MWe high efficiency distributed generation systems, 1-3 MWe systems for cogeneration, 20-30 Mwe high efficiency systems
- Period : 2001-2003
- **EU support : 1.2 MEUR**

# Component Reliability Of SOFC Systems for Commercial Operation

**CORE****SOFC**

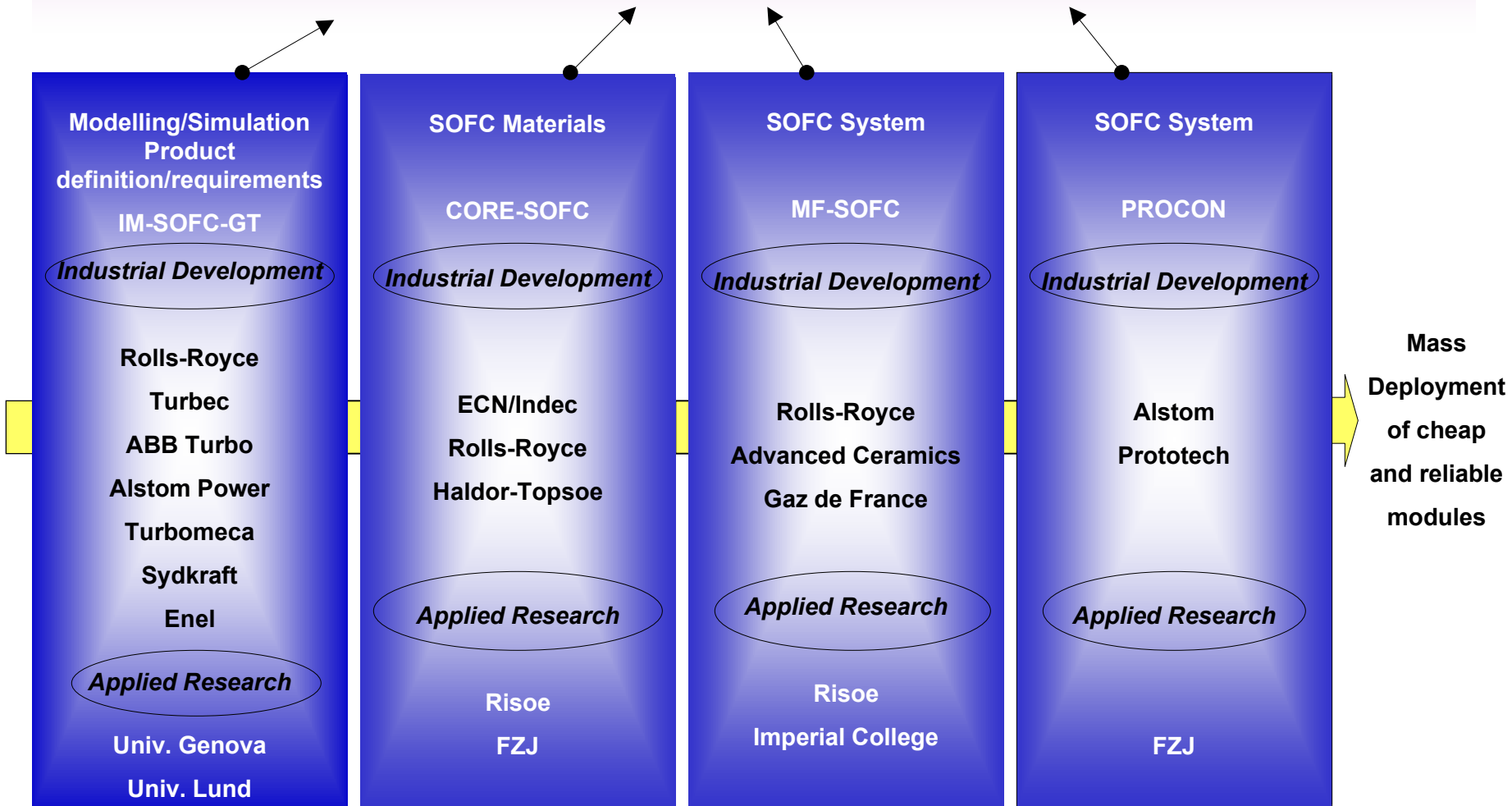
- Planar with ferritic steels as interconnects
- Degradation rate  
 $< 0.75 \%$  per 1000 hrs
- Thermal cyclability  
 $< 0.75 \%$  degradation after 20 temp. cycles
- Period : 2001-2004
- **EU support : 2 M€**



(Not satisfying interface between interconnect and ceramic)



# Stationary small to large scale Heat & Electricity Production, power generation"





# 'Strategy' Goals for RTD - 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	< 1.000 EUR/kW	< 100 (50) EUR/kW
– life time	50.000 - 100.000 hrs	> 5.000 (10.000) hr
– Modularity	< 300 kW	



# **A FUEL CELL RESEARCH, DEVELOPMENT & DEMONSTRATION STRATEGY up to 2005 (2)**

- All fuel cell types are in principle considered (application and problem solving oriented programme);
- Applications for Low temperature FC will address in transport the road, rail, marine + hybrid vehicles and in stationary the co-generation in buildings and decentralised electricity production and portable devices;
- Applications for high temperatures FC (including the combination with turbines) will address de-centralised electricity production and co-generation in buildings and process industry, large scale power generation in stand alone or grid connected mode + possibly APU;



# **A FUEL CELL RESEARCH, DEVELOPMENT & DEMONSTRATION STRATEGY up to 2005 (3)**

- In transport, research should address the fuel choice problem (methanol, NG, gasoline-naphta, diesel) and infrastructure.
- In stationary electricity production and co-generation, the multi-fuel capability and flexibility should be addressed and explored as well as the capture of CO<sub>2</sub> + reversible electrolysers;
- In buildings, special attention should be given to fuel cell applications for co-generation and HVAC, adapting heat and electricity supply to the demand including the integration with heat pumps, electrolysers, storage systems,...
- Socio-economic and pre-normative research



# 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					



# Possible areas for EU/US co-operation on SOFC

- Interest from 13 key EU organisations (IN, nat. lab., Univ. End-users);
- 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



# Forms of possible co-operation

- Coordinated or joint research projects;
- joint studies,
- joint organisation and participation in workshops, seminars with exchange of informations
- setting-up of trans-national networks or setting-up of coordinated platform between US and EU existing or new coming alliances or networks
  - April-may 2001 : signature of a EU/US implementing arrangement
  - EU financial support to EU organisations still possible (14/12/01) - see [www.cordis.lu](http://www.cordis.lu)



# Innovative approach for 2001-2002

- ❑ Concentration of ~60% of budget around a core set of Target Actions (including FC)
- ❑ General call (covering all types of Fuel Cells) with identification of a limited number of priorities of strategic importance for EU (~40% of budget being part of a general call)
- ❑ clear differentiation on problems and technologies to be used within short term (less than 5 years) and medium-to-long term

**(\*) : TA and the general call concern RTD projects, TN and**

**CA.**



# Target Actions - FP5 (1999-2002)

## Short-term

(Results exploited < 5 years - demo)

- ☐ **Application driven fuel cells**
- ☐ **Bio-electricity**
- ☐ **Sustainable Communities**
- ☐ **Clean Urban Transport**
- ☐ **Eco-buildings**
- ☐ **Gas Power Generation**

## Medium to long-term

(Results exploited > 5 years - R&D)

- ☐ **Fuel Cells and H<sub>2</sub>**
- ☐ **Bio-energy**
- ☐ **Integration**
- ☐ **Cleaner fuels for transport**
- ☐ **Storage**
- ☐ **PV**



# Indicative timetable and budget

## Target Actions

60% of total budget (~ 290 MEUR)

### Short-Term

50% of total Target Action budget

4th call: ID "TA-ST"

1st closing date: 15.03.2001

Budget: ~70 Meuro

2nd closing date: 14.12.2001

Budget: ~75 Meuro

Topics covered:

- Application Driven Fuel Cells
- Bio-electricity
- Eco-buildings

### Medium to Long-Term

50% of total Target Action budget

5th call: ID "TA-MLT"

1st closing date: 15.02.2001

Budget: ~70 Meuro

2nd closing date: 14.12.2001

Budget: ~75 Meuro

Topics covered:

Fuel Cells and hydrogen

- Bio Energy
- Integration
- Cleaner fuels for transport
- Storage
- Photovoltaic



## Short-term (FP5)

# Application driven fuel cells

- Demonstrate technical and economical viability of innovative FC concepts and of new energy systems combining FC, RES and H<sub>2</sub> infrastructure
- introduction of FC systems in intermediate markets (niche, islands,...); use of FC in industry (CHP, peak shaving, on-site premium power, ... benefits due to BoP simplification and on maintenance ); domestic/commercial (distributed Fuel Cell networks)
- test-beds for various re-fuelling infrastructures including H<sub>2</sub> (production, distribution, storage, safety, standards)





medium to long-term (FP5)

# Fuel cells and hydrogen

- Introduction of fuel cells in a RES and H<sub>2</sub> based supply scenario by reducing cost
- RTD on Proton Exchange Membrane Fuel Cell and related Direct Methanol Fuel Cell and Solid Oxide Fuel Cell and related technologies (reformers, H<sub>2</sub> storage) for stationary, portable and mobile applications (cells, stack, BoP)
- Fuel choice and infrastructure (cost, emissions, safety,...)
- Multi-fuel capability and fuel flexibility for stationary fuel cells
- socio-economic and pre-normative research (norms and standards on safety, regulation, testing procedures,...)





# Indicative timetable and budget

## General Call

40% of total budget (~ 215 MEUR)

### Short-Term

50% of total Target Action budget

6th call: ID "GEN-ST"

1st closing date: 15.03.2001

Budget: ~45 Meuro

Topics covered: short-term actions covering all areas of the WP

2nd closing date: 14.12.2001

Budget: ~50 Meuro

Topics covered: short-term actions covering all areas of the WP

### Medium to Long-Term

50% of total Target Action budget

7th call: ID "GEN-ML"

1st closing date: 15.02.2001

Budget: ~45 Meuro

Topics covered: Medium to long-term actions covering all areas of the WP

2nd closing date: 14.12.2001

Budget: ~75 Meuro

Topics covered: Medium to long-term actions covering all areas of the WP



# Priorities of Strategic importance to the EU

- **Management of Greenhouse Gases emissions and climate change**
- **Exploiting the potential of new ICTs in energy RTD including e-science issues**
- **Socio-economic research related to energy technologies and their impact**
- **International co-operation, co-ordination with MS research programmes and EU wide research networks**
- **Pre-normative research of interest at EU level**



# The New Framework Programme (2003-2006)

## ➤ Designed to promote the setting up of ERA

- ☐ Status : EC proposal to EU Parliament and Council
- ☐ Overall budget : 16,3 BEUR
- ☐ Fuel Cell content : in Sustainable Development and Global Change (Budget 1,7 BEUR)
  - ☐ short term :
    - RES, energy economies, energy efficiency (urban environment and clean transport)
    - intelligent transport (rebalancing and integration of intermodality)
  - ☐ long term :
    - **Stationary & Mobile Fuel Cells**
    - Hydrogen technologies
    - solar photovoltaic technologies & biomass

# The New Framework Programme (2003-2006)

➤ **Designed to promote the setting up of ERA  
with 3 main instruments**

- ☐ **Networks of excellence**
- ☐ **Large-scale integrated projects (> 10 MEUR)**
- ☐ **Participation of EU in MS research programmes**
  - ☐ **with stimulation of International co-operation with third countries (particularly S&T agreements)**