“Fuel Cells and Hydrogen Research in the European Union”

Vienna, 31 March 2004

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Presentation outline

- ✓The EU policy drivers and vision
- ✓Driving forward the vision: European Hydrogen and Fuel Cell Technology Platform
- ✓Next steps: FP6, Quick Start

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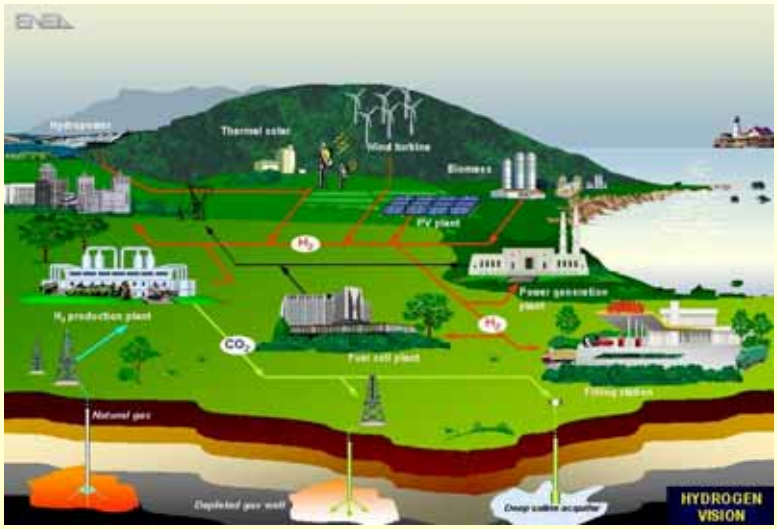
European Hydrogen Technology Platform
General Assembly Meeting,
Brussels, 20th January 2004

- President Romano Prodi: **"....our objective is to realise a step-by-step shift, towards a fully integrated hydrogen economy, based on renewable energy sources, by the middle of the century. .... .We must focus on technologies that can sustain economic growth, neutralise the debate on climate change and eliminate harmful pollution forever..... In achieving this goal we shall contribute to quality of life, peace and stability the world over".**

- Vice President L. De Palacio: **"Hydrogen as a potential new universal energy carrier has attracted our special attention. An integrated development for energy and transport sectors is particularly important to take full profit of common technologies. Hydrogen also can break the monopoly of oil in the transport sector and give it access to all energy resources".**

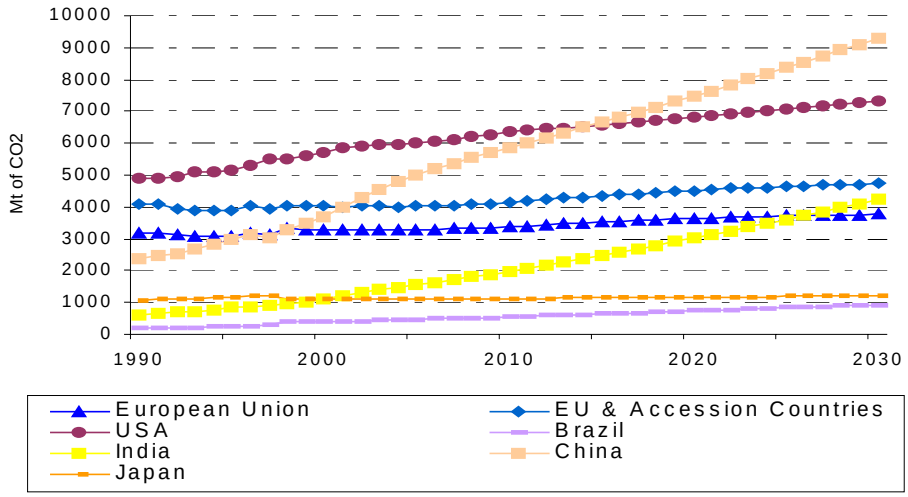
- P Busquin, Commissioner for Research: **"The implications of climate change go way beyond our lifetimes and what we choose to do now will have dramatic consequences for many generations to come. It is therefore imperative that we start now to develop experience of implementing these sustainable energy systems"**

High Level Group : A visionary energy outlook



World (energy) CO_2 emissions

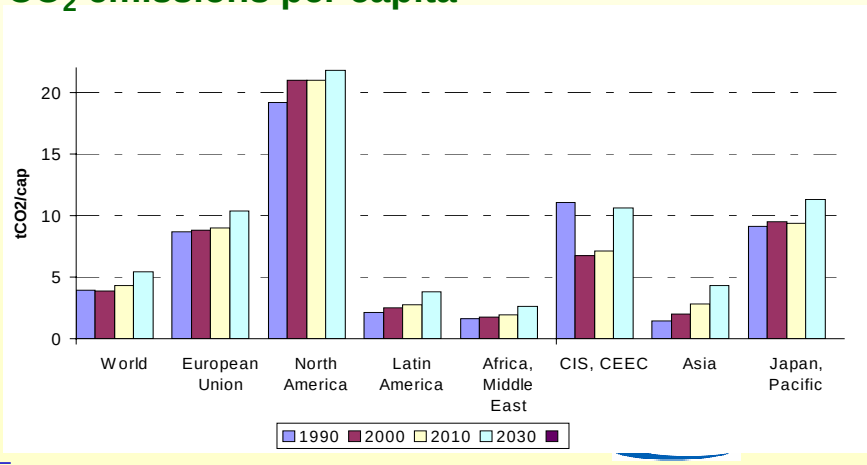
Scenarios and Projections (source : WETO)



Energy Policy Context

Scenarios and Projections (source : WETO)

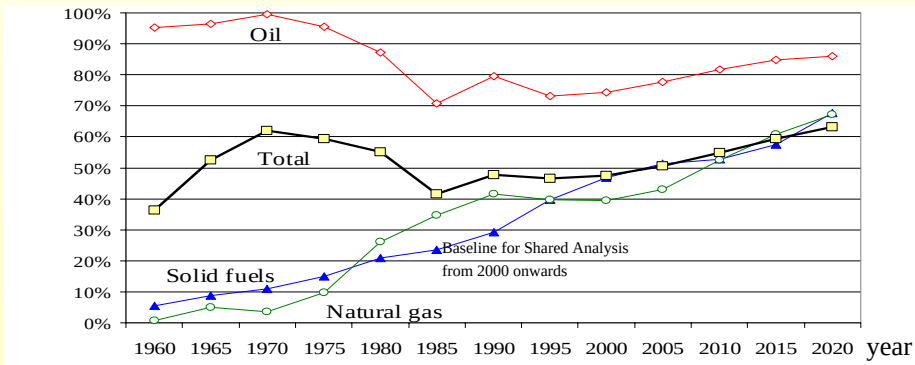
CO_2 emissions per capita



Green Paper: „Towards a European Strategy for the Security of Energy Supply“ European Commission, (2001)

Energy self sufficiency is difficult to achieve

EU – import share (%)

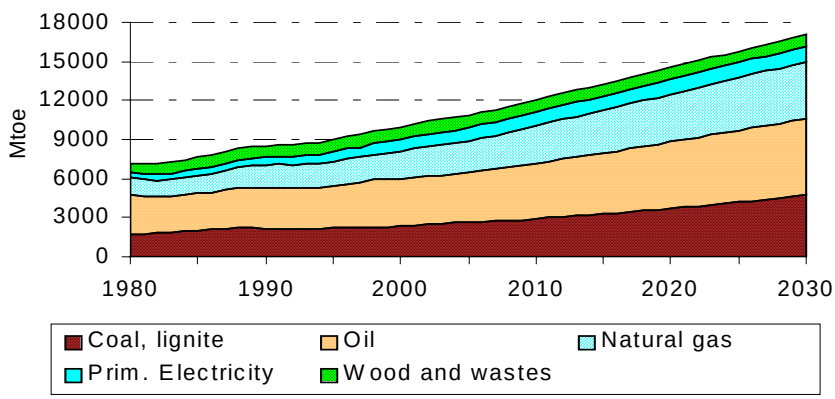


- *major player on the world market (~15% of energy consumption)*
- *no clout in world energy pricing*
- *unsatisfactory policy for preventing supply crises*

Energy Policy Context

Scenarios and Projections (source : WETO)

Still 90% fossil fuels worldwide by 2030



Convergence of prospective and scenarios on

- **Doubling of energy demand and GHG**
- **Fossil fuels ≅ 90 % of supply**
  - **Oil dominant**
  - **Dash for gas**
  - **Coal production to double**
- **Rising prices of oil and gas**
- **Less nuclear, very little renewables**
- **More and more electricity**

till 2030

EU Policy Actions

Action Plan on energy efficiency
➔Improving Energy Efficiency: + 18% from 1995 to 2010
➔Increasing the Share of Cogeneration: 12% of EU-15 electricity by 2010

White Paper on Renewable Energies
➔Doubling the Share of Renewable Energies from 6 to 12% of final energy

White Paper on EU transport policy
➔20 % substitution of diesel and gasoline by alternative fuels by 2020

Communication on Alternative Fuels
➔Hydrogen : 5% of road transport fuel by 2020
➔Alternative motor fuels contact group report 2003
See http://europa.eu.int/comm/energy_transport/en/fa_en.html

Support development of sustainable energy technologies including RTD on hydrogen and fuel cell technologies

EU Policy Objectives

- ✓ **Meeting EU Kyoto Commitments**
  8% CO_2 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 on a future EU energy strategy addressing both demand and supply sides
- ✓ **Promoting Industrial Competitiveness**
  Hydrogen and fuel cell technologies forecast as paradigm shift in way we produce and use energy

European Hydrogen and Fuel Cell Technology Platform: A brief history….

- **High Level Group – October 2002**
- **Conference (HLG vision report) – June 2003**
- **President's Communication – September 2003**
- **Advisory Council – December 2003**
- **Platform Launch – January 2004**
- **Member States Mirror Group – February 2004**
- **Steering Panels and Initiative Groups – March, April 2004**

Initiative for Growth – Dec '03

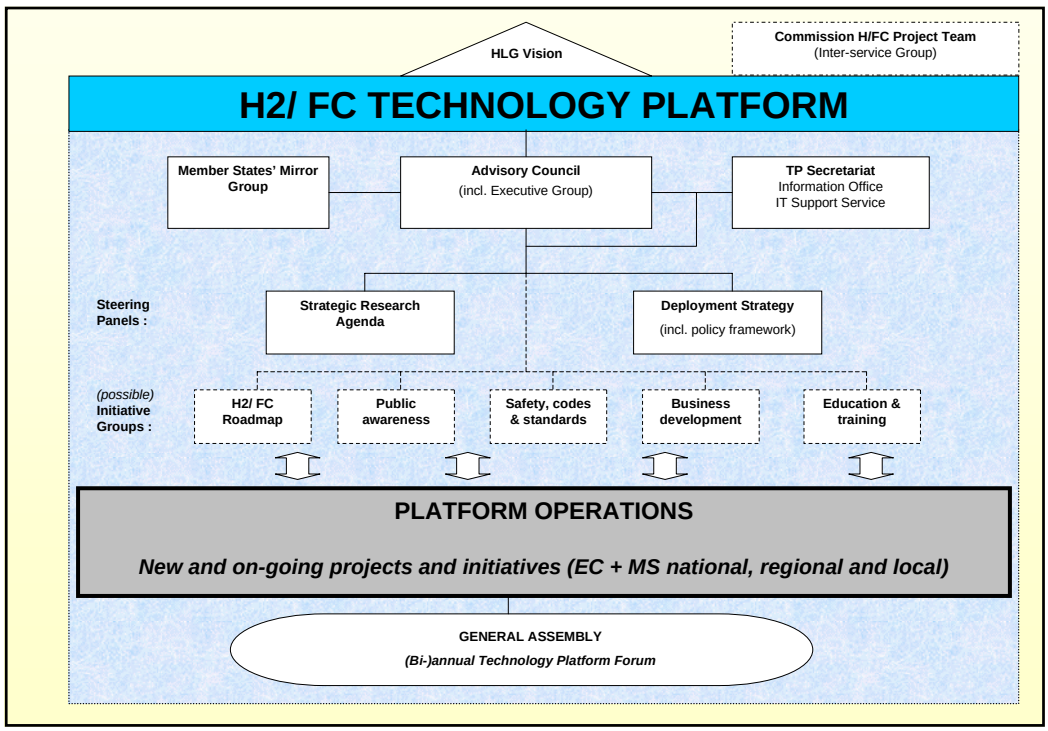
High Level Group Report: Main Recommendations

Five "Actions"

- ✓ **European Political Frame for fostering new hydrogen and fuel cell technologies;**
- ✓ **Strategic Research Agenda;**
- ✓ **Deployment Strategy;**
- ✓ **A European Hydrogen and Fuel Cell Technology Partnership, steered by Advisory Council;**
- ✓ **European Roadmap for Hydrogen and Fuel Cells.**

The H2/FC Technology Platform: Structure and Participants

- **Participants:**
  - **Research Community, Industry, Public Authorities, Financial Community, Users and Consumers, Civil Society**
- **Platform Operations: General Assembly**
  - **On-going and future projects, networks and initiatives, supported by EC, national and regional programmes**
- **Steering and support structures:**
  - **Advisory Council (and Executive Group),**
  - **Steering Panels and Initiative Groups,**
  - **Member States' Mirror Group,**
  - **Commission Inter-service Hydrogen Project Team**
  - **Secretariat**



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The H2/FC Technology Platform: Status (1/2)

- **Advisory Council** established December 2003 (35 members); two meetings held.
- **Member States Mirror Group** – established February 2004 (First meeting 29/03/2004). ERA-NET proposal submitted in March 2004 (under evaluation)
- **EC "Project Team"** – Work in progress (8 active DGs - RTD, TREN, JRC, ENTR, ENV, ECFIN, INFSO, SG). Established November 2003
- **General Assembly** (20/21 January 2004) - launch of TP - More than 400 participants
- **TP Secretariat** – proposal retained in response to Call --- Negotiation in progress.

The H2/FC Technology Platform: Status (2/2)

- Steering panels:
  - ✓ Chair/Vice-chairs appointed (Draft) Terms of Reference under discussion
  - ✓ Quick-off meetings planned:
    - SRA 29/03/2004
    - D. Strategy: 27/04/2004
  - ✓ First deliverables by end of 2004: inputs to FP7 and growth quick-start initiative
- Initiative groups being launched:
  - ✓ Regulations and standards
  - ✓ Financing
  - ✓ Education and training
  - ✓ Public awareness

  } Leaders appointed, ToR under discussion
- IG's under consideration:
  - ✓ Role of SMEs
  - ✓ H2 and renewable energy
  - ✓ Business development

EC Role in the platform

- **Initiator** – but not owner
- Three seats on the **Advisory Council** (DGs RTD, TREN and JRC)
- **Financial support** to secretariat and mirror group
- **RTD Framework Programmes** – co-financing projects
- Close association with **Steering Panels** and **Initiative Groups**
- EC-wide **Project Team** to ensure coherence
- Currently acting **Secretariat**

General Assembly Conclusions

- Still too early to make technology choices; Investment on technology development needs to be reinforced;
- Hydrogen Roadmaps: a lot of work done individually by companies and countries (esp. US, Canada, Japan). There are similarities but also differences;
- Major challenge to define transition strategies to 'clean hydrogen' from fossils and RES;
- H2 production technology is not biggest challenge : 5% of EU vehicles could be fuelled using ~25% of the hydrogen industrial production;
- Other important challenges: public awareness and acceptance, lack of clear policy, regulations & standards, safety issues,…need to be addressed by TP!

General Assembly Recommendations: Hydrogen Production

- Different levels of maturity and timelines for available technologies.
- Currently, large scale methane steam reforming is the most competitive technology; but strong debate on CO2 sequestration.
- Much effort on production of "clean" hydrogen from RES (i.e. wind, solar, biomass); strong public support; need cost reductions.
- High Temperature thermochemical cycles could produce large amounts of carbon-free hydrogen but are capital intensive and dependent on other technological developments (i.e. High Temperature Reactors).
- Novel "*Biohydrogen*" routes (i.e. photobiological processes) seem theoretically attractive; demonstration will require big efforts

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General Assembly Recommendations: Hydrogen Storage

- Storage is a key enabling technology for hydrogen economy.
- Main challenges related to the next generation of "conventional" on-board storage systems addressed in EC "StorHy" project.
- Solid storage addressed in several EC projects with emphasis on particular metal hydrides (Mg, Alanates). Substantial challenges still remain (e.g. improve kinetics, thermodynamics, energy density); incremental improvements are not enough.
- Pessimism on carbon nano-structures prospects
- Basic research needed to identify innovative materials and processes that provide breakthroughs

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General Assembly Recommendations: Hydrogen Delivery

- For early wide scale distribution, one possible way is the use of NG pipelines to transport H2 mixtures; EC project "NATURALHY" will address the feasibility of this route.
- Alternatively on site production either via electrolysers or compact fuel reforming. Both available but have significant challenges: "energy equation" for the electrolysers and the CO2 issues for the compact reformers.
- Local community acceptance is key to deciding on locating infrastructure like hydrogen fuelling stations and pipelines – "Not in my back yard!"

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General Assembly Recommendations: Technology Challenges for Fuel Cells

- **Hurdles to deployment:**
  - Fuel cells: stack cost and lifetime
  - Hydrogen storage: energy density
  - Market acceptance and introduction
  - Capital investment requirement
- **Corresponding RTD priorities**
  - High temperature membrane
  - New polymers – no/ low humidification
  - Catalysts – low noble metal loading
  - Component reduction and system simplification
  - Fuel cell oriented vehicle design

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General Assembly recommendations concerning Regulations, Codes and Standards

- **Permanent group of experts needed, with a long-term mandate and commitment, to work on regulatory and standardisation matters related to hydrogen and fuel cells: identified lack of resources**
- **Need commitment from industry, member states and the European Commission**
- **Use existing knowledge and experience from demonstration projects as well as from ongoing regulatory and standardisation activities**
- **Allocate resources where the real obstacles are: co-operation and co-ordination a bigger obstacle than resolving technical issues**
- **Europe needs to speak with one voice in the international arena**
- **European pre-normative RTD needed to support standards making**

EC support (in M€) to Fuel Cell and hydrogen RTD in FP5 (1999-2002)

	FC technology acquisition (1)	FC applications			Hydrogen infras-tructure	Total
		Stationary	Transport	Portable		
Mid-long term R&D	22.4	12.1	28.0 (2)	8.4	23.6	94.5
Demonstration & benchmarking (short term)		16.8	26.5(3)		6.9	50.3
Total	22.4	28.9	54.5	8.4	30.5	144.8

(1) Includes generic FC development for stationary, transport and portable applications;
(2) Approximately 19 million € devoted to projects related to fuel processing;
(3) 18 M€ for fuel cell bus demonstration project CUTE.

Actions supporting the Technology Platform Sixth Framework Programme: H2/Fuel Cell Projects (starting now…)

Hydrogen : **(6 Integrated Projects,2 Specific Targeted Research**

Projects,1 Network of Excellence for a total of 61m€ EU support)

- **Hydrogen Production, distribution and storage**
- **Hydrogen Safety**

Fuel Cells: **(3 Integrated Projects, 3 Specific Targeted Research**

Projects, for a total of 30m€ EU support)

- **SOFC, PEM for stationary and transport applications**
- **DMFC for portable applications**

Call FP6-2003-ENERGY 1 ML
Retained projects - Hydrogen

Area	Project Acronym	Type of Action	Topic	EU Indicative funding[2] (M€)	Co-ordinator
H2 production	HYTHEC	STREP	Water splitting through High Temperature thermochemical cycles	1,9	CEA (France)
	CHRISGAS	IP	H2 rich gas from biomass	9,5	Växjo University, (Sweden)
	Hi2H2	STREP	High temperature solid oxide water electrolyser	0,9	EDF (France)
H2 pathways	HYWAYS	IP	Elaborating a European Hydrogen Roadmap	4	L-B-Systemtechnik, (Germany)
	NATURALHY	IP	Investigating infrastructure requirements for H2 and natural gas mixes	11	Gasunie, (The Netherlands)
H2 storage	STORHY	IP	Next generation storage technologies for on-board applications	10	Magna Steyr Fahrzeugtechnik, (Austria)
H2 safety	HYSAFE	NOE	Networking research in safety issues	7	FZK Forschungs - zentrum Karlsruhe (Germany)
H2 end use	ZERO REGIO	IP	H2 FC fleet demonstration	7,5	INFRASERV (Germany)
	PREMIA	SSA	Effectiveness of demonstration initiatives	1	VITO (Belgium)
	HYICE	IP	Internal combustion Engines	9	BMW (Germany)

Call FP6-2003-ENERGY 1 ML
Retained projects - Fuel Cells

Area	Project Acronym	Type of Action	Topic	EU indicative funding (M€)	Co-ordinator
High Temperature Fuel Cells	Real-SOFC	IP	Next generations SOFC planar technology	9	Forschungs-zentrum Jülich (FZJ) (Germany)
	BIOCELLUS	STREP	Biomass Fuel Cell Utility System	2,5	TU Munich (Germany)
	GREEN-FUEL-CELL	STREP	SOFC fuelled by biomass gasification gas	3	CCIRAD (France)
Solid Polymer Fuel Cells	HYTRAN	IP	Innovative systems and components for road transport applications	9	Volvo (Sweden)
	FURIM	IP	High temperature polymer electrolyte membrane (PEM)	4	DTU, Technical University of Denmark
Portable applications	MOREPOWER	STREP	Compact direct (m)ethanol fuel cell	2,2	GKSS Forschungs-zentrum Geesthacht (Germany)

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FP6 Integrated Projects
Hydrogen
CHRISGAS

- ✓ **Objectives:** to develop a large scale biomass gasification process to produce a clean rich in hydrogen which can be used for the production of transport fuel
- ✓ **Consortium**: 22 partners
- ✓ **Coordinator**: Växjö University
- ✓ **EU indicative support**: 9.5 million € (under negotiation)

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NATURALHY

FP6 Integrated Projects
Hydrogen
NATURALHY

- ✓ **Objectives:** to define the technical and socio-economic conditions to inject hydrogen in natural gas and to use the existing infrastructure in a transition to the H2 economy
- ✓ **Consortium**: 48 partners including major EU gas utilities
- ✓ **Coordinator**: Gasunie
- ✓ **EU indicative support**: 11 million € (under negotiation)

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FP6 Integrated Projects
Hydrogen
HyWays

- ✓ **Objectives**: **to build an European Hydrogen Roadmap**
  - →**Investigate and model the impact of different hydrogen pathways and associated technologies into a wide range of sectors**
- ✓ **Consortium: about 40 partners**
- ✓ **Coordinator**: **L-B-Systemtechnik GmbH**
- ✓ **EU indicative support**: **4 million €** **(under negotiation)**

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FP6 Integrated Projects
Hydrogen
STORHY

- ✓ **Objectives: to develop the next generation of compressed and liquefied hydrogen storage and metal hydrides**
- ✓ **Consortium: about 40 partners including EU car industry**
- ✓ **Coordinator: Magna Steyr Fahrzeugtechnik AG & Co KG**
- ✓ **EU indicative support: 10 million €** (under negotiation)

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FP6 Networks of Excellence
Hydrogen
HYSAFE

- ✓ **Objectives:**
  - →To develop a common approach to address safety issues, in particular risk assessment and codes & standards
  - →To integrate experience and knowledge on hydrogen safety and handling hydrogen as an energy carrier
- ✓ **Consortium**: **about 25 partners**
- ✓ **Coordinator**: **Forschungszentrum Karlsruhe GmbH**
- ✓ **EU indicative support: 7 million €** (under negotiation)

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FP6 Integrated Projects
Hydrogen
HYICE*

- ✓ **Objectives: to improve the efficiency of hydrogen internal combustion engines by advanced injection**
- ✓ **Consortium: 9 partners**
- ✓ **Coordinator: BMW**
- ✓ **EU indicative support**: 5 M€ (under negotiation)

*** Financed by the Sub-Programme "Sustainable Surface Transport"**

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FP6 Integrated Projects
Hydrogen
ZERO REGIO

- ✓ **Objectives:** to demonstrate the viability of H2 Fuel cell powered fleets in various EU **regions**
- ✓ **Consortium:** 16 partners
- ✓ **Coordinator:** INFRASERV
- ✓ **EU indicative support:** 7.5 million € (under negotiation)

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FP6 Integrated Projects
Hydrogen
ZERO REGIO

- ✓ **Objectives:** to demonstrate the viability of H2 Fuel cell powered fleets in various EU **regions**
- ✓ **Consortium:** 16 partners
- ✓ **Coordinator:** INFRASERV
- ✓ **EU indicative support:** 7.5 million € (under negotiation)

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FP6 Integrated Projects
Fuel Cells
HYTRAN

- ✓ **Objectives:** to develop and integrate components and sub-systems into
  - ✓ a direct H2 PEMFC powertrain (80 kW)
  - ✓ APU Diesel reformate PEM (10 kW)
- ✓ **Consortium:** about 20 partners including EU car industry
- ✓ **Coordinator:** Volvo Technology Corporation
- ✓ **EU indicative support:** 9 million € (under negotiation)

* Financed by the Sub-Programme "Sustainable Surface Transport"

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FP6 Integrated Projects
Fuel Cells
Real SOFC

- ✓ **Objectives:**
  - → to raise the durability of the planar SOFC stacks to a level acceptable for stationary applications
  - → to find materials, manufacturing routes and standards suitable for low cost production
  - → to reduce specific weight and volume of SOFC stacks
- ✓ **Consortium:** about 25 leading research and industrial organisations
- ✓ **Coordinator:** Forschungszentrum Jülich GmbH
- ✓ **EU indicative support:** 9 million € (under negotiation)

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FP6 Integrated Projects Fuel Cells FURIM

- ✓ **Objectives:**
  - →to develop novel polymer electrolyte membranes and related components for high temperature PEM fuel cells
  - →to test PEMFC stacks based on the developed materials and technologies and evaluate their technical, economic and environmental impacts
- ✓ **Consortium: 13 partners**
- ✓ **Coordinator: Technical University of Denmark**
- ✓ **EU indicative support: 4 million € (under negotiation)**

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Call FP6-2003-ENERGY 1 ML

Specific Targeted Research Projects under negotiation:

- ✓ HYTHEC - High Temperature Thermochemical cycles for hydrogen production (1.9 M€)
- ✓ Hi2H2 - Solid oxide fuel cell for water electrolysis (0.93 M€)
- ✓ MOREPOWER - Compact direct (m)ethanol FC for portable applications (2.16 M€)
- ✓ GREEN-FUEL-CELL - SOFC fuel cell fuelled by biomass gasification gas (3 M€)

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FP6: HyWays

HyWays Objectives:

- Develop European Hydrogen Energy Roadmap
- Provide instruments, methods and tools to develop roadmap
- Include transport and stationary/portable applications with initial focus on hydrogen as vehicle fuel
- Disseminate relevant results to EC, member state governments, relevant industry, institutes/organisations and the public

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HySafe: Network of Excellence Action plan on hydrogen safety

	V1.Hydrogen release, mixing, and distribution	V2. Thermal and pressure effects from H_2 fires and explosions	V3. Development of hydrogen mitigation techniques	V4. Safety and risk studies	V5. Standardization, regulatory issues, and dissemination
H1.Production					
H2. Transport and distribution, refueling stations					
H3. Storing H2 (LH2, CGH2)					
H4. Vehicles powered with H2					
H5. Tunnels, parking and garage					
H6. Utilisation, H_2 applications					

Outcome:

- Experimental databases for hydrogen safety analyses for different applications
- Validated analytical and numerical tools for assessment of safety for different applications
- Experimentally validated mitigation techniques and safety devices
- Innovative hydrogen mitigation technologies
- Methodologies for risk evaluation, both specific and in comparison with today's fuels
- Improved technical culture to handle hydrogen as an energy carrier
- Inputs to European/global regulatory and standardization activities

H2 Quick-Start Projects

(Part of "Growth Initiative")
Endorsed by EU Summit of December 2003

- HYPOGEN: **First large facility generating H2 and Electricity from Fossil Fuels with Sequestration of the CO2**

  Estimated Budget: 1.3 B€

- HYCOM: **Realisation of Hydrogen communities, demonstrating the generation (from Renewable Sources) and utilisation of H2 in stationary (CHP) and Vehicle applications**

  Estimated budget: 1.5 B€

  Estimated time scale: 2005-2015: 3 phases (definition, implementation, operation/validation)

International Cooperation

- **Implementing agreements and hydrogen co-ordination group created by IEA**
- **Bilateral co-operation agreements in place (or under development) with U.S., Japan, Canada, Russia, China, Australia, Brazil…..**
- **The U.S. International Partnership for The Hydrogen Economy (IPHE).**

FP6: Next Calls for Proposals

- EoI exercised closed on March 2004: more than 100 EoIs on H2 and Fuel Cells received
  Assessment in April 2004
  Conclusions published in May 2004
- WP revision under discussion: Basis:
  - ✓ Existing portfolio: outcome of 1st call
  - ✓ Stakeholder views: conclusions of General Assembly
  - ✓ Joint calls envisaged: with nano-technologies, materials and production technologies, aeronautics and sustainable surface transport
- WP to be approved before Summer
- Calls closing in December 2004

Staying Informed

International co-operation
http://europa.eu.int/comm/research/fp6/index_en.html

Cordis FP6 Service
http://www.cordis.lu/fp6/

Energy Research at Europa
http://europa.eu.int/comm/research/energy/index_en.html

Energy research/technology platform
http://europa.eu.int/comm/research/energy/nn/nn_rt_htp1_en.html.

CIRCA website – download presentations and documents
http://forum.europa.eu.int/Public/irc/rtd/eurhydrofuelcellplat/library

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Thank you for your attention