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Roads2HyCom
www.roads2hy.com

Financing the Hydrogen (and Fuel Cell) Economy

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Phil Doran: Core Tec Ventures

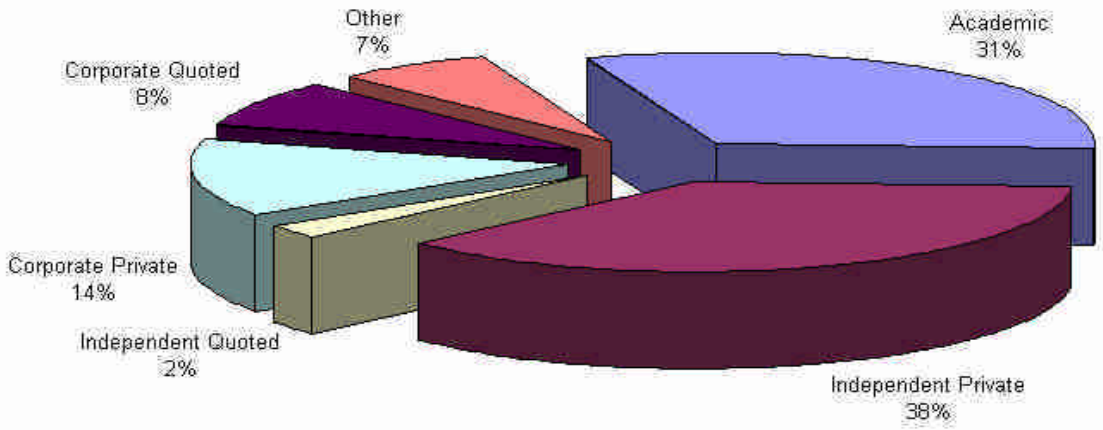
Presentation to the conference "Funding for RTD Projects and Infrastructures from the European Technology Platforms by the European Investment Bank"

Brussels, 17th October 2006

Data presented here from the Roads2HyCom project is PROVISIONAL and represents work-in-progress. It should be treated as indicative only.

Structure of the European Fuel Cell Industry: Numerically dominated by innovative Independent and Academic organisations

Provisional data from Roads2HyCom



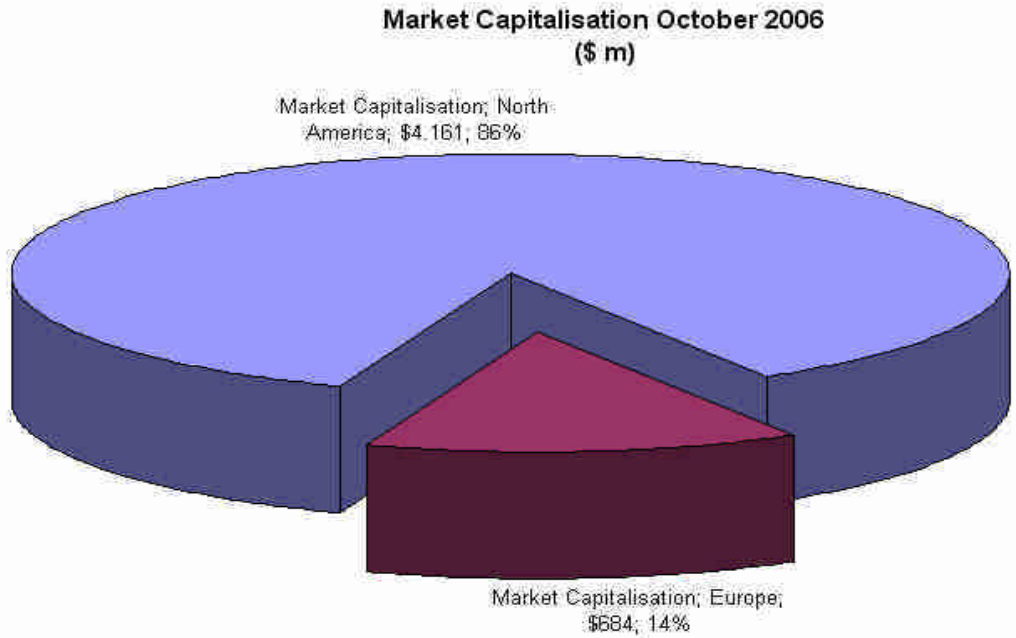
H2&FC Developers	Potentially Available Financial Instruments
Corporate Quoted	Debt & Equity, Grants & Subsidies, Tax breaks, Retained Profits
Corporate Private	Debt, Grants & Subsidies, Tax breaks, Retained Profits
Independent Quoted	Debt & Equity, Grants & Subsidies, Tax breaks
Independent Private	Venture Capital, Private Sources
Academic	R&D Grants, Industry sponsorship

Corporate Developers, refers to companies whose main business activity is not the development of H2&FC technologies.

Independent developers refers to companies whose business activity is exclusively the development of H2&FC technologies

Academic developers refers to both universities and national research institutes which are developing H2&FC technologies. (A significant problem for these entities arises when the technology is spun out and 100% funding evaporates)

North America vs Europe: Independent H2&FC Developers: Very different market cap landscape



Total R&D spend in 2004 by independent quoted H2&FC developers $220m

Of which:

- North America: $210m (95%)
- Europe: $3.5m (1.5%)
- Australia: $7.3m (3.5%)

Source: 2005 PriceWaterCoopers 2005 Fuel Cell Industry Survey on Independent H2&FC Developers

Source: Core Tec Ventures based on data from:
LSE & Yahoo: Stock Prices
Reuters: Exchange Rates

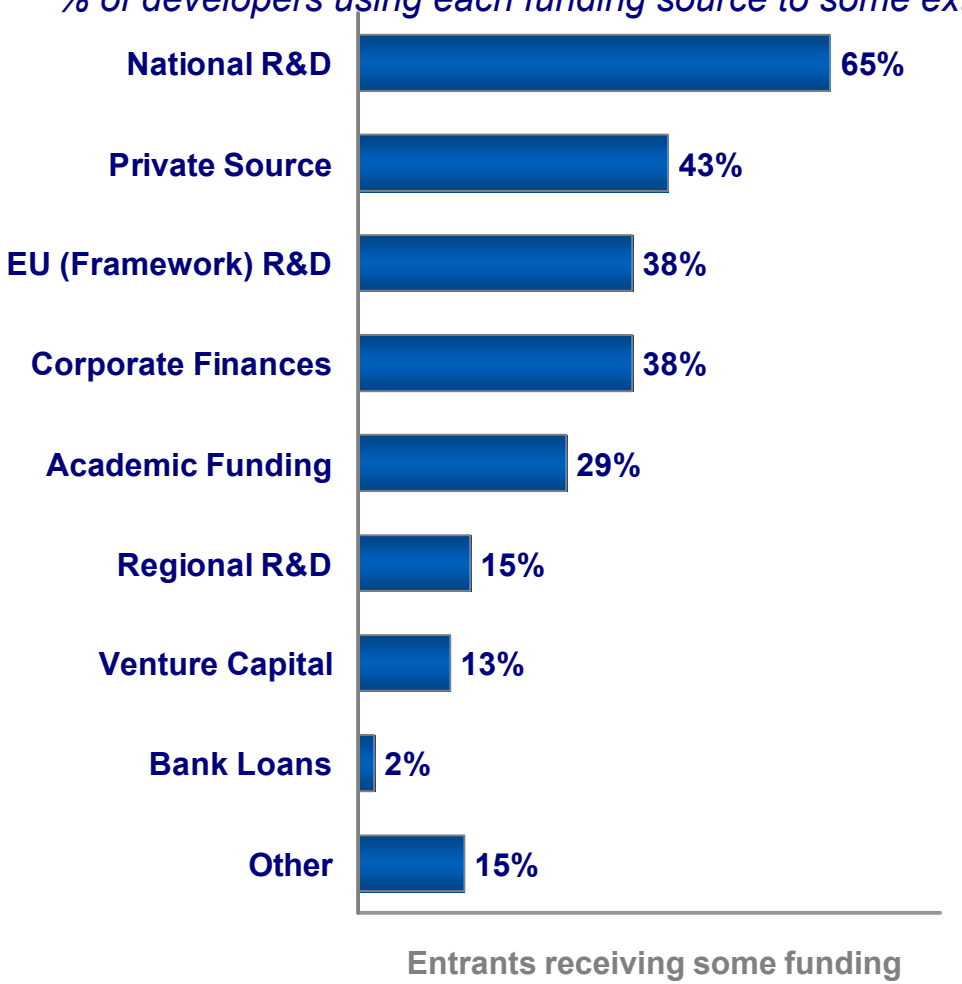
Independent quoted developers of H2&FC technologies make up just 2% of the R2H database, while corporate quoted developers account for just 8%, indicating severe limitations on European stock markets as a source of H2&FC funding.

A further factor to consider is that the market capitalisation of Europe's independent developers is some 6X smaller than their North American counterparts, a reflection of the difficulties experienced by independent and academic developers

The current technology funding scene in Hydrogen and Fuel Cells: Dominated by grant-funded research.

Access to RTD funding

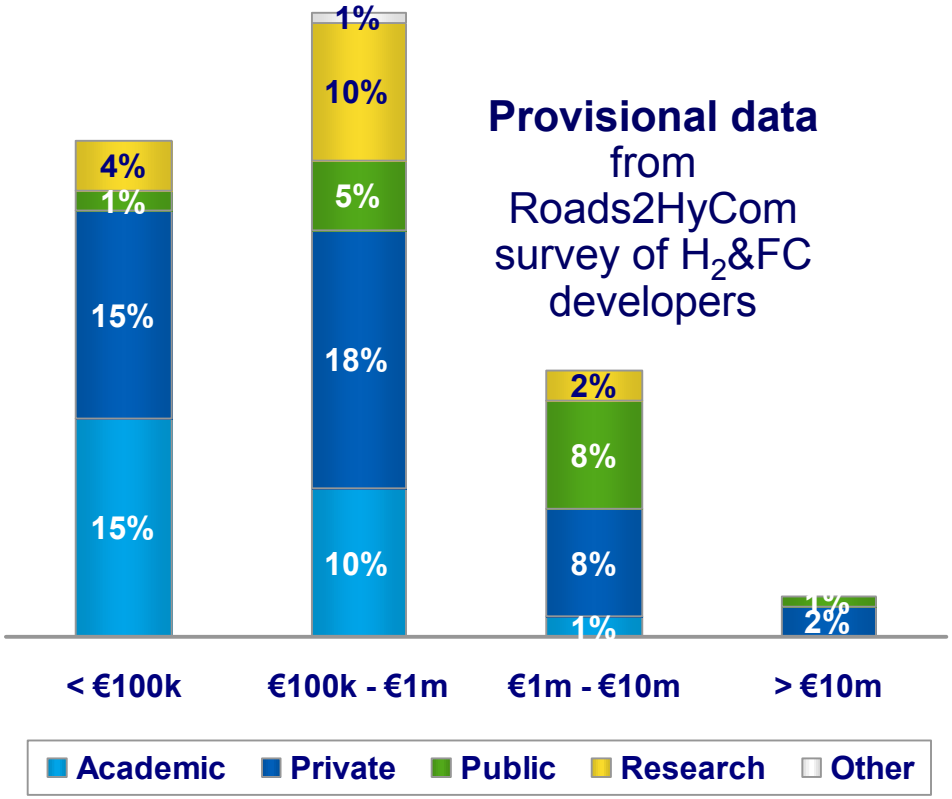
% of developers using each funding source to some extent



- **Provisional data** from Roads2HyCom survey of H_2&FC Developers
- **Over 60% of developers use National R&D grant programs** to fund typically 30-40% of their work
- **Just under 50% using Framework program** on similar basis
- **Corporate finances (re-investment of income) and "private sources"** cited as key sources of co-funding
  - **Known to be more challenging for SMEs**, who can be key sources of innovation

Data indicates how many players access each type of RTD funding - by band as % of total RTD finance

The typical player: Relatively small annual investment, below the level one would expect for commercialisation



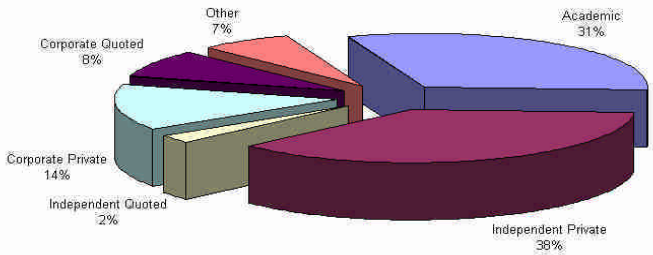
Provisional data from Roads2HyCom survey of H_2&FC developers

- **The typical Hydrogen / Fuel Cell technology organisation invests a few €100k's per year** - more appropriate to basic & applied research than true commercialisation
- **">10m€" players were:**
  - **5** Suppliers of Fuel Cells & key Fuel Cell parts
  - **1** Automotive OEM
  - **1** Electrical Sys' & Products supplier
- **Typical production-program investment for a mass-produced device** (e.g. Automotive powertrain, Domestic CHP unit with *existing* tech) **is €100m - €1000m** over 5 years

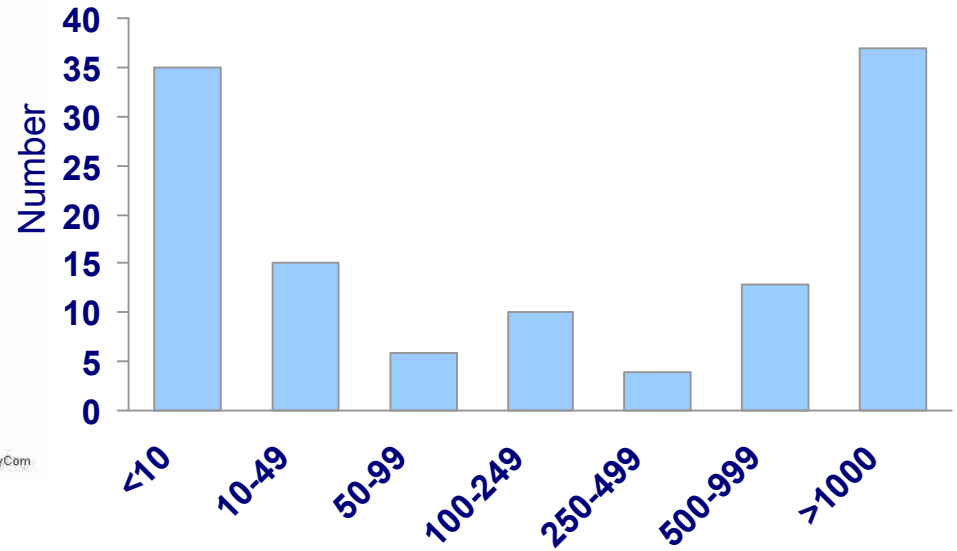
- **A reflection of a fragmented business with fragmented financing?**

However, there is no such thing as a "typical player"

- **Provisional data** from Roads2HyCom survey of H_2&FC developers
- **Marked split between Micro and Large organisations**
  - Different financing needs
  - High risk of poor technology flow between them?



Source: Road2HyCom



- **Unlikely to be a single financing solution with such diversity?**

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Likewise, there is no "typical market" or "typical technology": Some nearer to commercialisation than others.

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Portable Applications

- **Markets**:
  - Small portable electronic items (e.g. Laptops) for Consumers & Defence
- **Market Entry**
  - Many consumer electronic companies forecasting early markets **within 2 years**
- **Fuels**:
  - Methanol, Hydrogen
- **Fuel Cell types:**
  - DMFC, PEMFC, SOFC
- **Dominant Players**
  - Japanese Electronics
  - US system developers

Stationary Applications

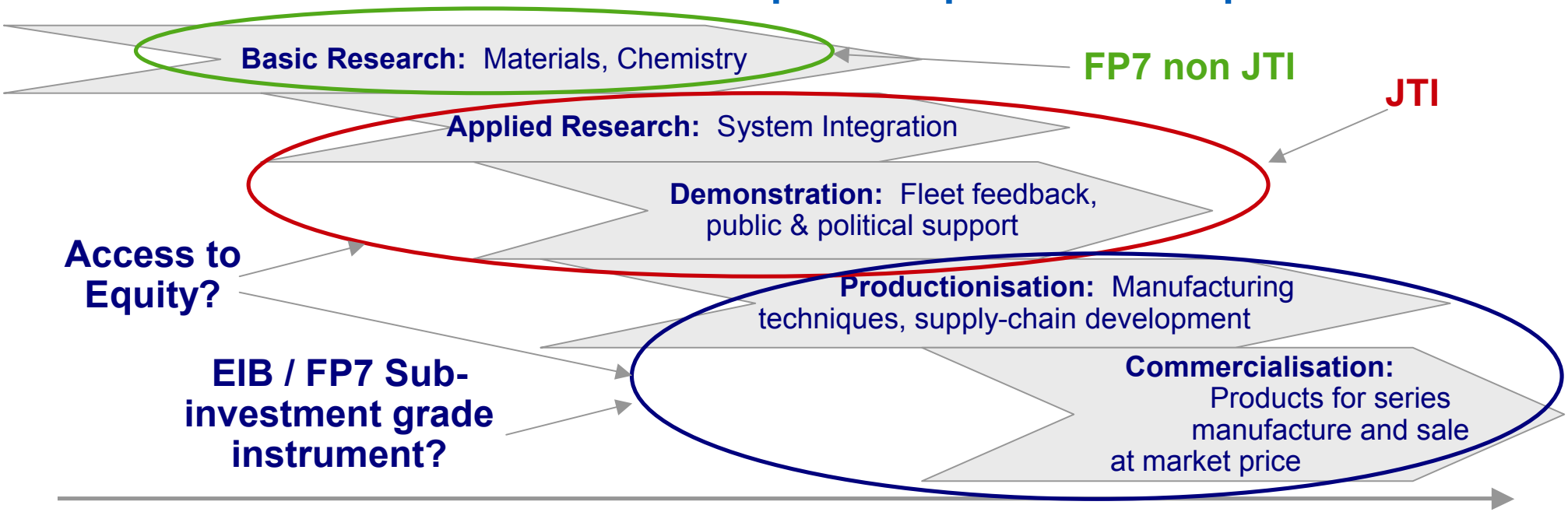
- **Markets:**
  - Residential, Commercial Industrial power and CHP
- **Market Entry**
  - Domestic CHP and Commercial Back-up power rollout by 2010
  - Distributed Power 2015-20
- **Fuels:**
  - Natural & Bio Gases
- **Major Electrolytes**
  - PEM, PAFC, MCFC, SOFC
- **Dominant Players**
  - Utilities in partnership with fuel cell innovators

Transport Applications

- **Markets:**
  - Road, Rail, Marine as Prime Mover
  - All modes as APU
- **Market Entry**
  - Auxiliary Power for Trucks, Aircraft, Leisure 2010-15
  - Prime Movers 2020 on
- **Fuels:**
  - Hydrogen
- **Major Electrolytes**
  - PEMFC, SOFC
- **Dominant Players**
  - US, Japanese & European Automotive OEMs

- **Auxiliary power and domestic CHP are exciting early markets with strong European potential that needs nurturing**

Framework 7 research and the "Joint Technology Initiative" will help to bridge the "valley of death" - but the transition from grant-based R&D to equity and debt-based investment will be a crucial step, particularly for SMEs and independent private developers



- **Critical issues now:**
  - **Ensuring the right players have access to the right financial instruments** - ability to bridge "valley of death" and play at co-funding; shared risk; supply chain cohesion
  - **Ensuring innovative SMEs are not disadvantaged** in co-funding stages
  - **Encouraging micro-companies and start-ups** with the right equity support

Conclusions: A complex landscape for financing

- **Preliminary data from Roads2HyCom illustrates a complex landscape for Hydrogen and Fuel Cell financing needs**
  - Further targeted research is required to fully understand this field
- **The corporate sector accounts for 22% of the sample (by number)**
  - 8% stock market-listed companies and 14% non-quoted developers
  - Non-quoted corporates should benefit from the introduction of innovative debt instruments, and should be made aware of the existence of such instruments
- **Significant number of micro companies (38%) and academics (31%) developing a wide array of technologies**
  - Many smaller independent private developers seem to be operating with little or no support from the public sector or the private equity markets, exemplifying the existence of the so-called 'Equity Gap', a significant barrier to innovation
  - Market Cap of quoted North American independent developers is around $4bn compared with $0.7bn for Europe
  - Almost 70% of the sample are accounted for by entities with little or no access to equity or debt instruments - indicates urgent need to address the issue
- **Public support for corporate (ETP) and JTI-sponsored demonstration projects**
  - Corporate (ETP) demo projects could benefit from debt instruments in their later stages - typically carried out by well-capitalised companies with non-H2&FC profit and revenues
  - At this stage it remains unclear how equity instruments could be used in the JTI

Appendices

- **Appendix I: About Roads2Hycom**
- Appendix 2: About Hydrogen and Fuel Cells
- Appendix 3: Renewable Policy Drivers
- Appendix 4: Financing Demonstration Projects

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About Roads2HyCom

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Project Objective

- To assess and monitor **Hydrogen and Fuel Cell technology** for stationary and mobile energy applications by considering:
  - what the **technology** is capable of, relative to current and future Hydrogen **infrastructure and energy resources**,
  - the needs of **communities** that may be early adopters of the technology

Project Partners

- **Roads2HyCom is a consortium of 29 key stakeholders** from industry, research institutes and academia. Core Group:

ika INSTITUT FÜR KRAFTFAHRWESEN RWTH AACHEN
Univ.-Prof. Dr.-Ing. Hermann Wallentowitz
PLANET GbR
ie Institute for Energy
ifp
KAΠE CRES
College of Europe Collège d'Europe
Brugge Natolin
AIR LIQUIDE
NTDA Energia
ECN Energy research Centre of the Netherlands
DAIMLERCHRYSLER
FINANCING EXPERTISE:: CORE TECHNOLOGY VENTURES

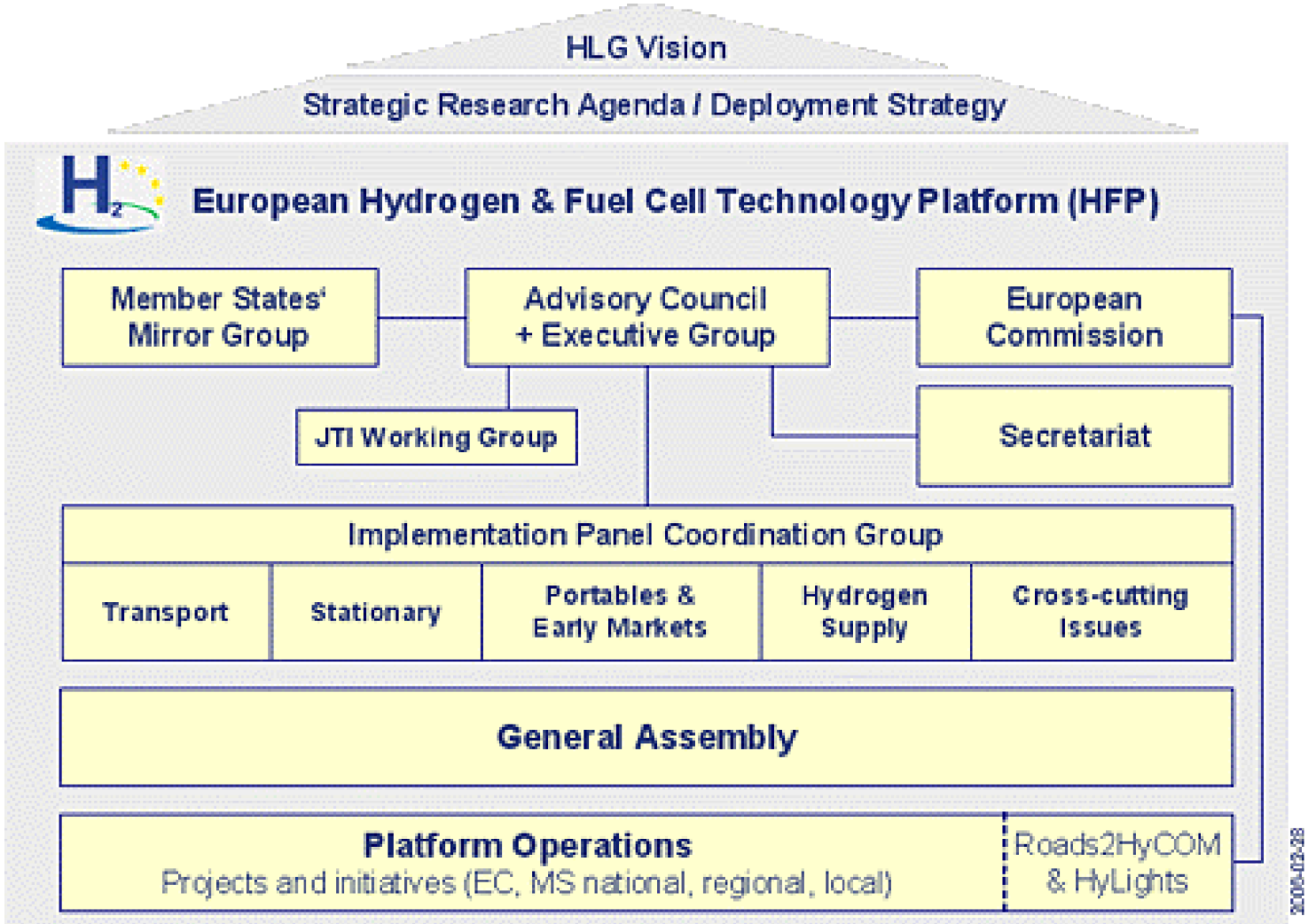
HyLights, Roads2HyCom and the Hydrogen and Fuel Cells Technology Platform (HFP)

- The European Commission is supporting the Coordination Action "HyLights" and the Integrated Project "Roads2HyCom" in the field of Hydrogen and Fuel Cells. The two projects support the Commission in the monitoring and coordination of ongoing activities of the HFP, and provide input to the HFP for the planning and preparation of future research and demonstration activities within an integrated EU strategy.
- The two projects are complementary and are working in close coordination. HyLights focuses on the preparation of the large scale demonstration for transport applications, while Roads2Hycom focuses on identifying opportunities for research activities relative to the needs of industrial stakeholders and Hydrogen Communities that could contribute to the early adoption of hydrogen as a universal energy vector.
- Further information on the projects and their partners is available on the project web-sites **www.roads2hy.com** and **www.hylights.org**

What is Roads2HyCom? Aims & Objectives…

- **A project to co-ordinate, assess and monitor research in the field of Hydrogen and Fuel Cells, to support the European Commission in planning the "Hycom" part of the Growth Initiative**
  - Which aims to develop "hydrogen communities" to stimulate growth and technology advancement in Hydrogen, Fuel Cell and "new energy" markets
  - Covers Transport and Stationary sectors in a broad-ranging study that embraces Technology and Socio-Economics
- **In practice Roads2HyCom is providing information to support the Commission and the Implementation Panel of the Hydrogen and Fuel Cell technology platform**
  - Together with partner project HyLights, wich focuses on Transport demonstrations
- **The project started in October 2005, and is now developing deliverables (reports) from its first work packages**

HyLights, Roads2HyCom and the Hydrogen and Fuel Cells Technology Platform (HFP)



Who is delivering Roads2HyCom? Project Partners…

Ricardo (GB)	DaimlerChrysler (D)	Icelandic New Energy
RWTH Aachen - IKA (D)	Air Products (GB)	Institite of Energy (Poland)
PLANET (D)	Airbus (D)	Intelligent Energy (GB)
EC - Joint Research Centre	AVL (A)	JBRC, Prague University (CZ)
Institut Francais du Petrole (F)	Coretec Ventures (GB)	Centre Cortes, Moscow (RU)
Air Liquide (F)	Centro Richerche FIAT (I)	Norsk Hydro (N)
CRES (Greece)	Element Energy (GB)	Riso (DK)
College d'Europe (B)	EnergieTechnologie (D)	TNO (NL)
NTDA (ES)	FEV Motorentechnik (D)	Volvo Technology (S)
ECN (NL)	Gaz de France (F)	

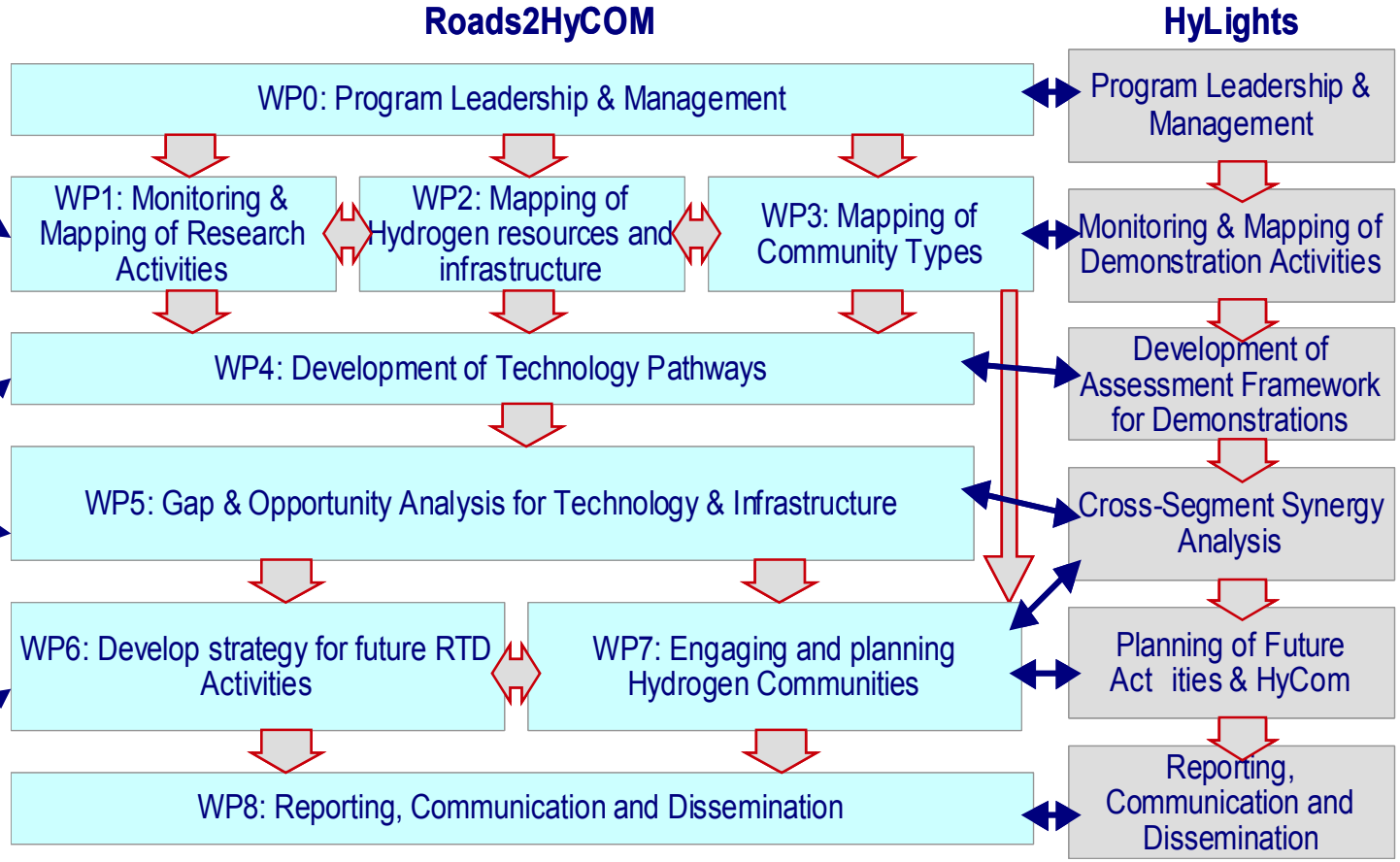
- **Brings together 29 partners from a broad cross-section of areas**
  - Energy and Hydrogen Supply
  - Transport industries (Surface, Air)
  - Stationary power (Buildings, Industry)
  - Engineering and Socio-Economic research
  - Community Expertise

How the Project Works: Approach

Mapping of current RTD, Infrastructure and candidate "communities" (early adopters)

Analysis: State of the Art versus adopter needs; Evolutionary steps; Gaps & Synergies

Engagement: Communities, RTD Stakeholders



Project is being delivered in cooperation with HyLights, which examines Transport Demonstration projects

Project Achievements so far…

- The project has delivered:
  - **Support to Commission** in organising the "HFP Review Days 2005"
  - **Five "Area Reports"** on the research presented there, divided to align to HFP IP Working Groups
  - **Input to the EIB** on new Financing instruments
  - **Review of US research**, based on a delegation to the DoE's Annual Review
- And will deliver (October-November this year)…
  - **Mapping of research** (public and privately funded) in Europe
  - **Assessment of "State of the Art"** of European research
  - **Mapping of European Hydrogen infrastructure** and potential of Renewable and Low Carbon energy resources to provide H_2
  - **Hydrogen Communities -** Mapping and characterisation of potential early adopters
  - **Organisation of "Regions Workshop"** at HFP GA, together with HyLights

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Hydrogen and Fuel Cell technologies represent key elements in the Commission's strategy for a Sustainable Energy economy

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Hydrogen

- **Seen by many as the ultimate "sustainable energy vector",** alongside electricity
- **Likely to be most attractive where electricity is least attractive** - transport, mobile power, and grid-remote locations
- **Can be created from renewables, bio-mass, nuclear…** or fossil fuels
- **Can be used as a fuel for the Fuel Cell,** and most conventional engines, burners etc

Fuel Cell

- **A very efficient device** that turns a fuel (ideally Hydrogen) into electricity
- **Seen by many as "the ultimate engine"** in terms of efficiency and cleanliness
- **Applications include transport, mobile and stationary power** generation (including combined heat / power)
- **With some extra technology, can operate on today's fuels** including Natural Gas / Biogas, Bio-Fuels and Fossil Fuels

- **Both Hydrogen and Fuel Cells are multi-application technologies which offer many potential advantages**
- **Technical and commercial challenges - productionisation at acceptable cost, build-up of infrastructure and supply chain - require the right financing environment if they are to be overcome**

The full transition to a Sustainable Energy Economy will take a long time even with strong driving forces - identifying successful early markets is critical

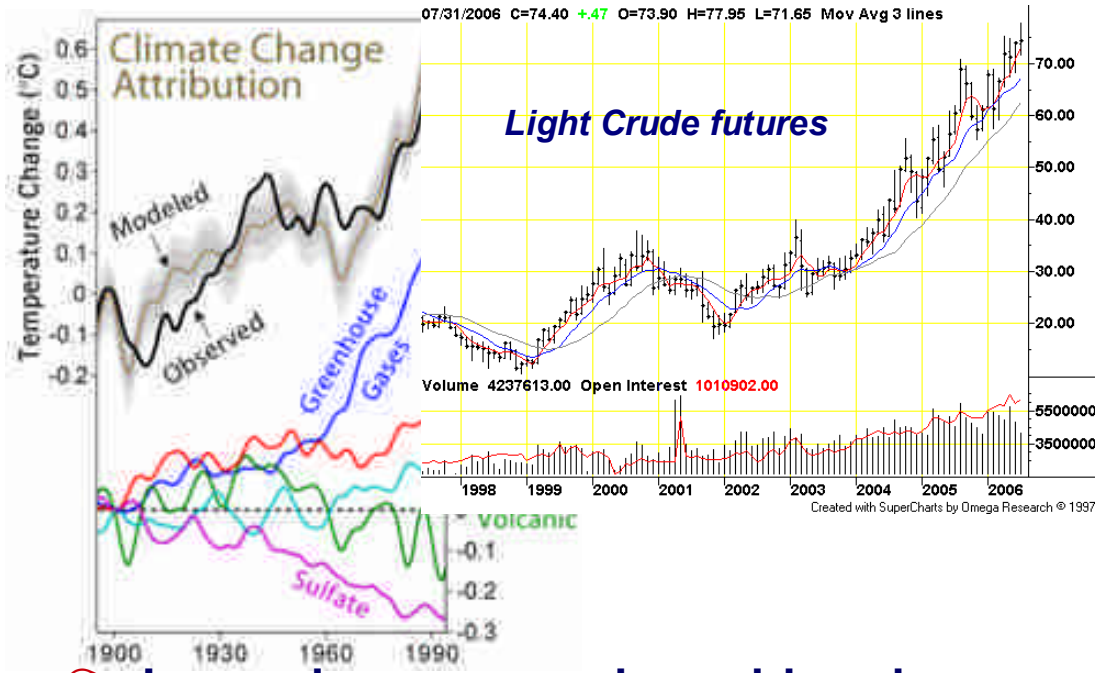
Transition to the Fossil Fuel Economy

1712: Newcomen's first Steam Engine for mine drainage

1829: Rainhill Trial for first steam railway locomotive

1938: Last sailing ships transport wheat from Australia to the UK

226 years



- **Transition TO the Fossil Energy Economy was driven by simple economics** - efficiency, speed and market attractiveness
- **Today's transitions may be no quicker** - for example in 10 years the Hybrid car is still <1% of the market
- **Increasing energy prices, driven by narrow supply/demand gap, create some driver for change**, but the environmental agenda tends to drive *politics* more than it drives *individual buyers*

- **Identifying and stimulating early markets is critical**

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Products have to be attractive to customers and profitable to industry, against benchmarks that are constantly improving

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Hydrogen / Fuel Cell Technology

Fuel Cell Car

- Fuel: **Hydrogen**
- Driving Range: **300km**
- CO_2 Emissions (Well-Wheel):
  - Fossil-source H_2: **150g/km**
  - Potentially: **75-100g/km**
  - With renewable H_2: **Zero**
- Pollutants: **Virtually zero**
- Cost:
  - Prototype: **€1m**
  - Production: **+€5,000-€10,000 on today's car**

Today's Benchmark

Standard Medium Car

- Fuel: **Gasoline or Diesel**
- Driving Range: **600-800km**
- CO_2 Emissions (Well-Wheel):
  - Gasoline Engine: **210g/km**
  - Diesel Engine: **160g/km**
- Pollutants: **Euro 4 standard**
- Cost: Production: **€20,000 to €24,000**

2020 Benchmark

Advanced Hybrid Car

- Fuel: **Diesel with bio-content**
- Driving Range: **>1000km**
- CO_2 Emissions (Well-Wheel):
  - Fossil Fuel: **100g/km**
  - 30% Bio Sourced: **80g/km**
- Pollutants: **Euro 7 (v.low)**
- Cost: Production: **+€3,000 - €5,000 on today's car**

- **Benchmark data from Roads2HyCom "State of the Art" assessment**
- **Fuel Cells for domestic CHP and portable power** may become attractive much earlier, using Natural Gas and other fossil fuels

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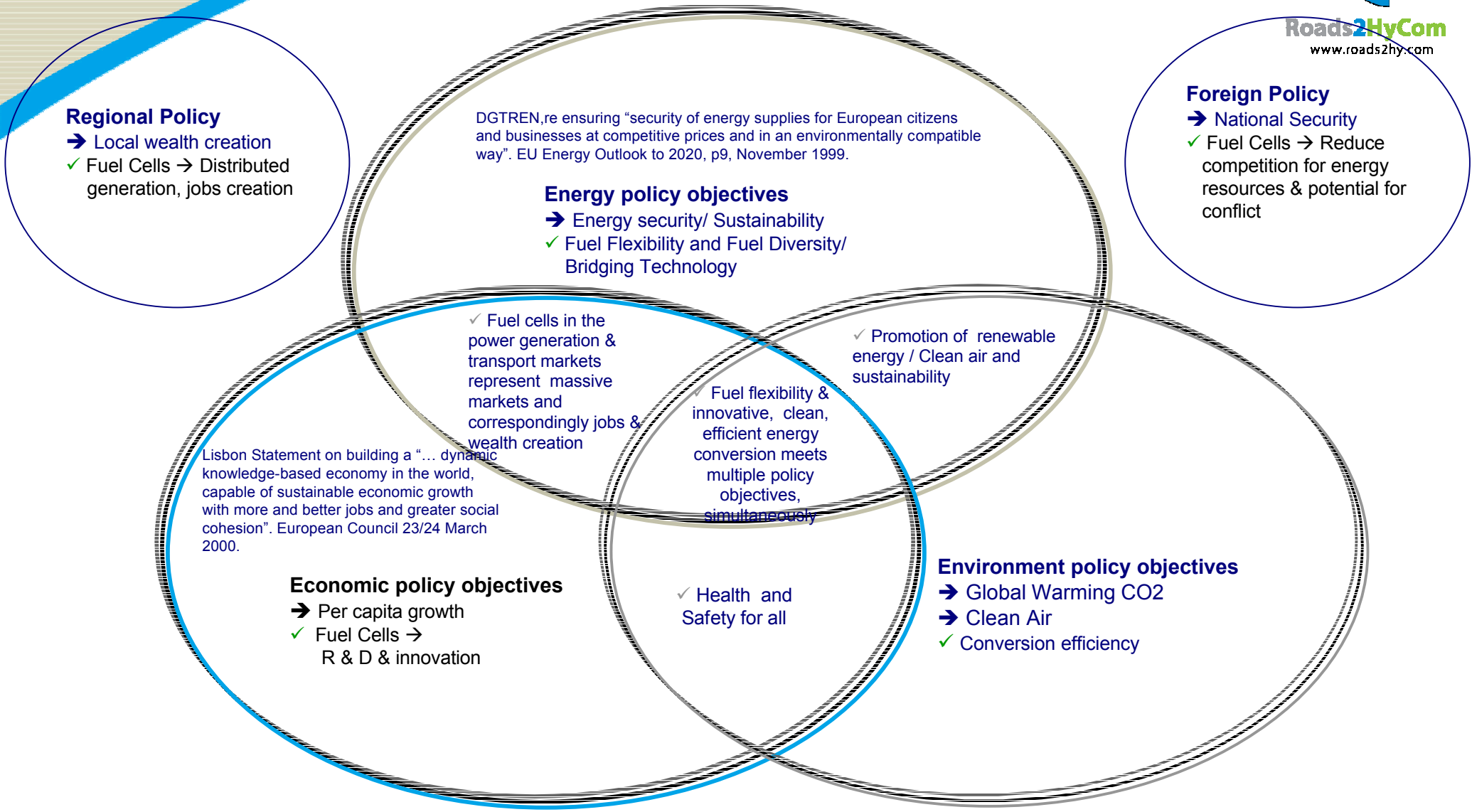
Appendix 3: Renewable Policy Drivers



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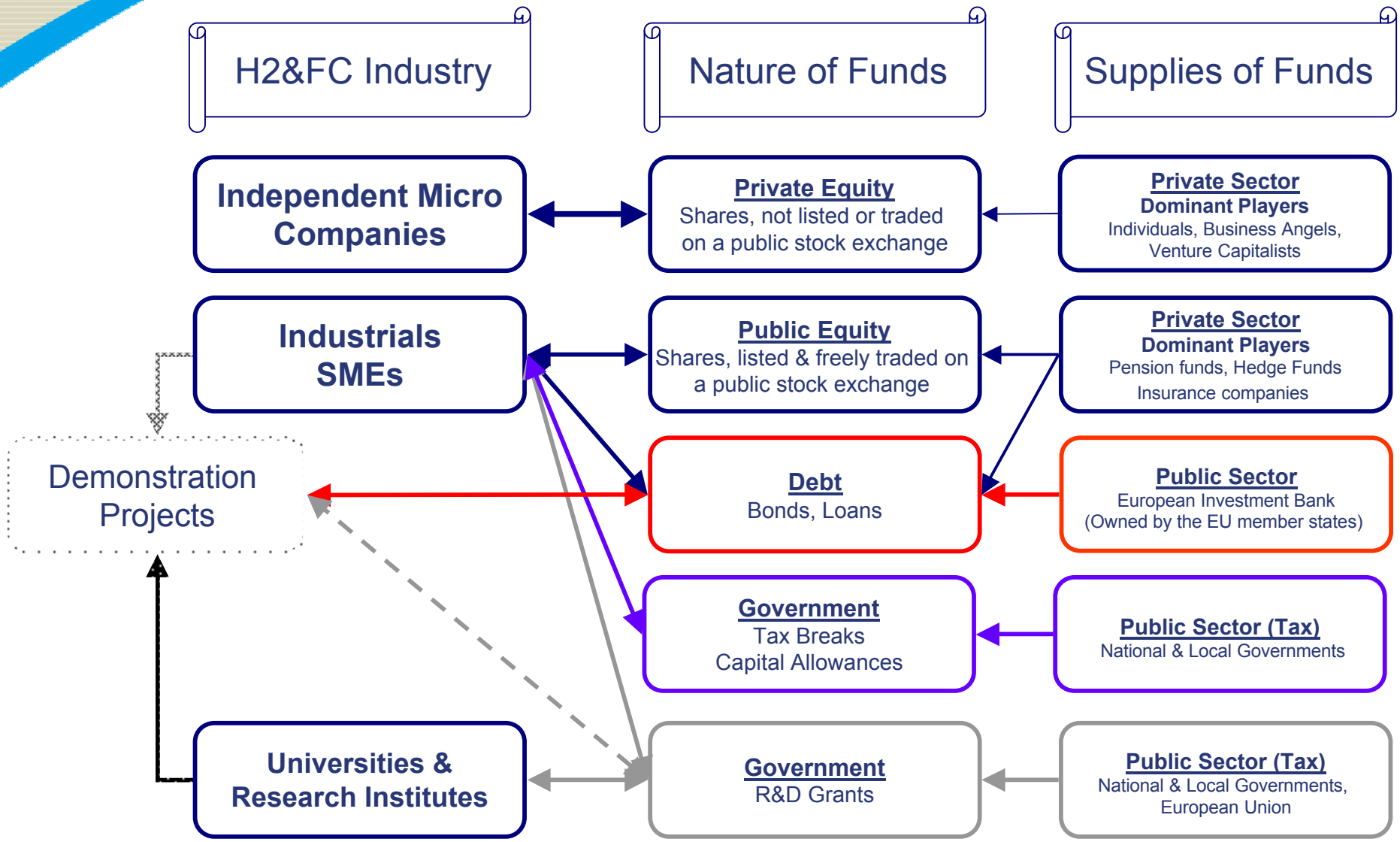
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