Rev. Real Academia de Ciencias. Zaragoza. **60:** 117–131, (2005).

The action of the Commission in the field of hydrogen:

A future alternative to contribute to the security of supply of the European Union and to combat climate change.

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Resumen

El hidrógeno, como la electricidad, es un vector de energía limpia, que puede producirse a partir de diferentes fuentes de energía primaria: combustibles fósiles y nucleares, y una extensa gama de fuentes de energía renovables tal como la energía eólica, la biomasa y la energía solar. Cualquiera que sea la opción elegida para producir hidrógeno, éste puede producirse sin emisiones de dióxido de carbono o con unas emisiones insignificantes.

La producción de energía a partir del hidrógeno se puede conseguir a través de tres tipos de convertidores energéticos: pilas de combustible, motores de combustión interna y turbinas.

En las pilas de combustible, el hidrógeno se combina con el oxígeno del aire produciendo electricidad, agua y calor. Los procesos de conversión electroquímica no están sometidos a las limitaciones termodinámicas que existen en la conversión de la energía térmica en energía eléctrica y ello permite obtener en determinadas pilas de combustibles unos rendimientos que podrían alcanzar valores del 80-90% con el aprovechamiento del calor residual en una turbina. Las pilas de combustible son generalmente alimentadas con hidrógeno pero también pueden utilizar gas natural, metanol o incluso carbón, sin embargo en la mayor parte de ellas es necesario la conversión previa de éstos combustibles en hidrógeno en un reformador o en un gasificador de carbón.

Aunque las pilas de combustible fueron descubiertas por el Sr. William Grove en 1839, todavía en la actualidad las pilas de combustible continúan siendo consideradas como una opción de futuro para la producción de electricidad, siendo el elevado

coste de los materiales para su fabricación y la falta de procesos de producción a escala dos, entre otras, de las razones que impiden su acceso al mercado. Otros problemas que podemos citar en relación con la utilización del hidrógeno son los de su almacenamiento por ser sus átomos los más pequeños de todos los elementos químicos y los de seguridad por su gran reactividad con el oxigeno.

La sustitución de los combustibles fósiles y en particular del petróleo por el hidrógeno y por las pilas de combustible es hoy en día uno de los objetivos prioritarios de la Investigación y Desarrollo de todos los países desarrollados.

La acción política de la Comisión en este campo se apoya a nivel comunitario en la actividades y proyectos realizados en el marco de la Plataforma del Hidrógeno y de las Pilas de combustible y en los proyectos financiados por la Comunidad en el sexto programa marco, próximamente séptimo, de Investigación y Desarrollo de la Unión Europea; y a nivel internacional en la participación de la Comunidad Europea en el Acuerdo Internacional sobre la Economía del Hidrógeno (IPHE).

La acción de la Comisión va dirigida a la consecución del objetivo anteriormente citado y a situar a la Unión Europea como líder mundial en las tecnologías del hidrógeno y de las pilas de combustible. El presente artículo trata de explicar la acción de la Comisión en este campo.

1 Introduction

Hydrogen, like electricity, is a clean energy vector. It can be produced from a wide variety of primary energy sources: fossil fuels, nuclear and through a range of renewable primary energy sources such as wind, biomass and solar energy

Depending on the means of production (it is possible to de-carbonise fossil fuels by carbon capture, allowing for the production of hydrogen from these traditional fuels with negligible carbon emissions), hydrogen can be produced with or without negligible carbon dioxide emissions.

Hydrogen should be the alternative energy vector of the future, gradually replacing fossil energy and in particular, oil, through three types of energy converters: fuel cells, internal combustion engines and turbines.

In fuel cells, hydrogen combines with oxygen from the air to produce water and electricity. The efficiency of the electrochemical conversion processes is not limited to the same thermodynamic constraints as the conversion of thermal energy in electric energy, and therefore a higher efficiency can be achieved. Fuel cells generally use hydrogen as a fuel but other fuels, such as natural gas and methanol, can also be used.

Although fuel cells were discovered by Mr William Grove in 1839, nowadays fuel cells still remain an option of the future. The aim at world level is that fuel cells in the long term (2050) will be the dominant technology in transport, in distributed power generation

and in micro applications.

The action of the European Commission in the field of the hydrogen is to achieve the above mentioned objective and to position the European Union as a world leader in hydrogen technologies.

The European Community started to finance research projects in the field of hydrogen and fuel cells in 1986 through the second Research and Demonstration Framework Programme. Nevertheless the political reflection on the role that hydrogen and the fuel cells could play to achieve a sure and sustainable energy started in the Community only at the beginning of the XXI century.

In this article I will discuss:

A.- Energy policy in the European Union in the XXI century.

B.- The Strategy of the Commission to implement the transition towards an economy based on hydrogen.

C.- Hydrogen and fuel cells in the research and demonstration framework programmes of the European Union.

D.- The Commissions proposal for the 7th RTD and in particular for Hydrogen in this programme.

2 Energy policy in the European Union in the XXI century

Until now there has not been a common energy policy except for coal and atomic energy in the European Union. European policy for coal was established by the European Community for Coal and Steel Treaty (which expired in 2002), and for atomic energy, by the EURATOM Treaty signed in 1957 which remains in force today.

Nevertheless, the political context as regards energy from the beginning of the XXI century has been defined by:

A.1 The Commissions Communication adopted on 29 November 2000, entitled Green Paper Towards a European Strategy for the Security of Energy Supply

A.2 The Commissions Communication adopted on June 2005, entitled Green Paper Energy effectiveness or Doing More with Less And in indirect way by:

A.3 Commissions Communication adopted on 12 September 2001entitled "White paper European transport policy for 2010: time to decide

A.4 The Lisbon strategy launched in the Lisbon Council on 23-24 March 2000.

2.1 A.1. The Green Paper: "Towards a European strategy of security of energy supply"

The two main points of this communication were:

2.1.1 A.1.1. THE SECURITY OF SUPPLY OF THE EUROPEAN UNION

The level of energy dependence of the Union in 2000 was about a 50%. If nothing is undertaken this dependence will increase to up to 70% by 2030.

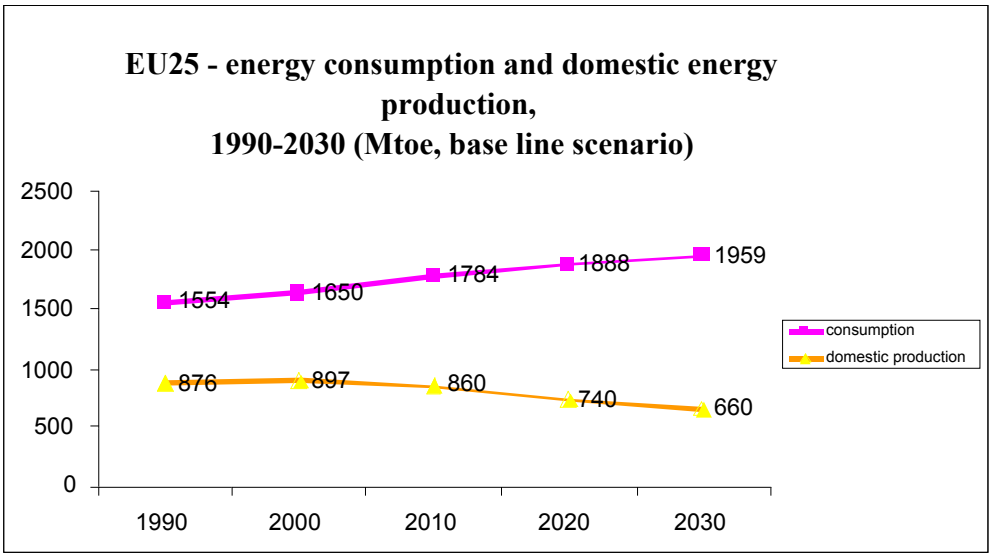

Figure 1.— Energy consumption and internal energy production

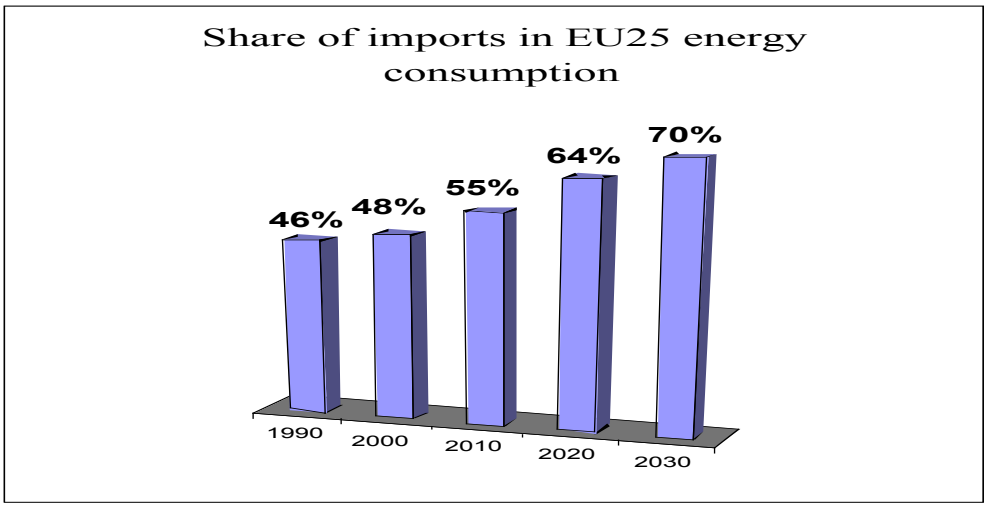

Figure 2.— Share of imports in the energy consumption of the UE25

The trend is to an increase in energy consumption of about 0.6% per year between

2006 and 2030. The reduction in production (of around 35 %), will be compensated with an increase in imports, mainly natural gas.

2.1.2 A.1.2. The fight against climate change and in particular the achievement of the Kyoto Treaty, signed on 16 February 2005.

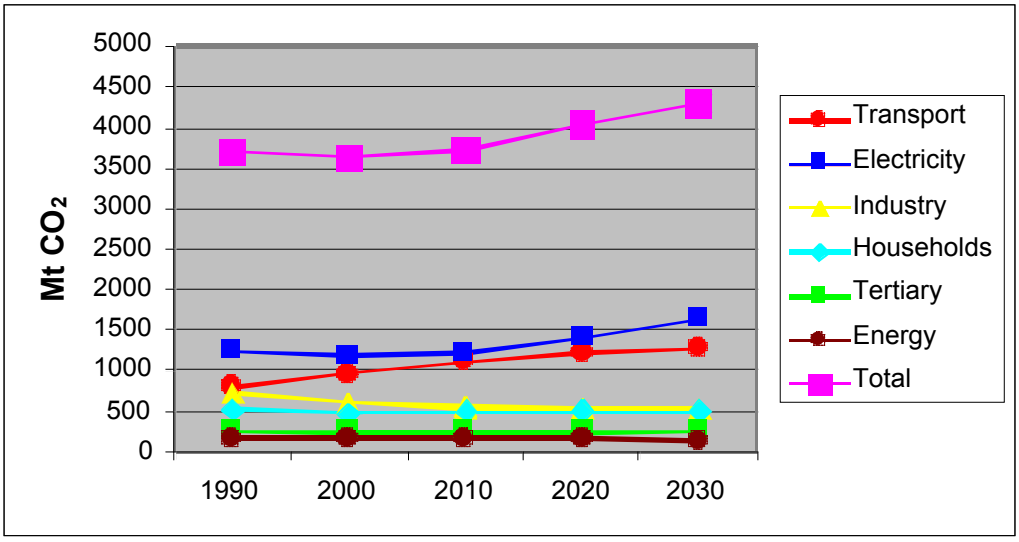

Figure 3.— UE25

The Kyoto protocol entered into force on 16 February 2005 following its ratification by the Russian Federation. The European Union committed itself under this protocol to reducing its emissions of greenhouse gases during the period 2008-2012 by 8% in relation to 1990 levels.

Today greenhouse gas has decreased by 2.9% in the European Union to 15 in compared with 1990. However the trends indicate that emissions will start to increase around about 2010 if no extra measures are taken.

It should be noted that the European Union has not waited for the Kyoto protocol to enter into force before putting legislation in place[1] which aims to reduce greenhouse gas emissions. The European market for the emission trading has been a reality since 1 January 2005. It covers in particular energy producers.

[1]Directive 2003/87/EC of the European Parliament and of the Council at its meeting on 13 October 2003 establishing a system of exchange of quotas of emission of greenhouse gases in the Community and amending Council Directive 96/61/EC (presenting Text of the interest in the EEA) Official Journal No. L 275 of 25/10/2003 p. 0032 00461

2.2 Green Paper Energy effectiveness or Doing More with Less

The Green Paper on energy efficiency outlines an ambitious programme with the objective of harnessing cost-effective energy savings for Europe equivalent to 20% of the EUs current energy use. This means reducing the amount we spend on energy, mainly imported hydrocarbons, by € 60 billion per annum, equivalent to the present combined energy consumption of Germany and Finland. Instead, this money would be invested in energy efficient equipment and services, in which Europe is a world leader.

This Green Paper seeks to identify the bottlenecks presently preventing these cost-effective efficiencies from being captured lack of appropriate incentives, lack of information and lack of available financing mechanisms for example. It then seeks to identify options as to how these bottlenecks can be overcome, suggesting a number of key actions that might be taken.

2.3 The White Paper of the Commission on the transport policy

"The European transport policy by 2010: time to decide " stressed that transport is a captive market for oil. 98% of the road transport market depends on oil, which is equivalent to 70% of final oil demand. The energy consumption of transport is responsible for 28% of CO2 emissions. If nothing is done, the increase in the CO2 emissions in this sector will be about 40% in 2010 compared to 1990. (From 794 Mtons in 1990 to 1,110 Mtons in 2010).

Reducing the dependence of oil and increasing energy efficiency of transport are therefore regarded as both an ecological need and a technological challenge.

2.4 A4. The Lisbon strategy

The Lisbon strategywas launched in March 2000 by the European Council of Lisbon and making the European Union the most competitive area of the world by 2010 was considered by President Barroso as the top priority, based on a sustainable economy and on knowledge. In this context energy is a determining growth factor and the deficiencies as regards energy can have a direct impact on the growth of the Union, and the stability and the well-being of the citizens of Europe. The Lisbon strategy is, in fact, the programme of the European Union which aims to find balance between economic growth, competitiveness and employment on the one hand, and durability at the social and environmental level on the other. Lisbon has as an objective the maintenance of the European model of society for the current and future generations, in a context of increasing world competition and an ageing population.

To conclude this section devoted to the energy in the European Union, I refer to article III-256 of the European Constitution which establishes that the policy of the Union in

the field of energy is:

a) to ensure the operation of the market of energy,

b) to ensure the security of energy supply in the Union, and

c) to promote energy efficiency and energy saving and the development of new and renewable energy.

The Commission currently recommends the following set of measures in relation to energy:

- the control of demand;
- support for renewable sources;
- diversification of energy resources;
- dialogue with producing and consumer countries.

3 B. The Strategy of the Commission to implement the transition towards an economy based on hydrogen

3.1 B.1. Communication in 2001 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions

The Commission, made a Communication in 2001 to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions on alternative fuels for road transport and on a set of measures to promote the use of bio fuels. COM (2001) 547 final.

The communication proposed three main potential alternative fuels that could each be developed to up to 5% or more of the total automotive fuel market by 2020. These were:

- biofuels
- natural gas
- hydrogen

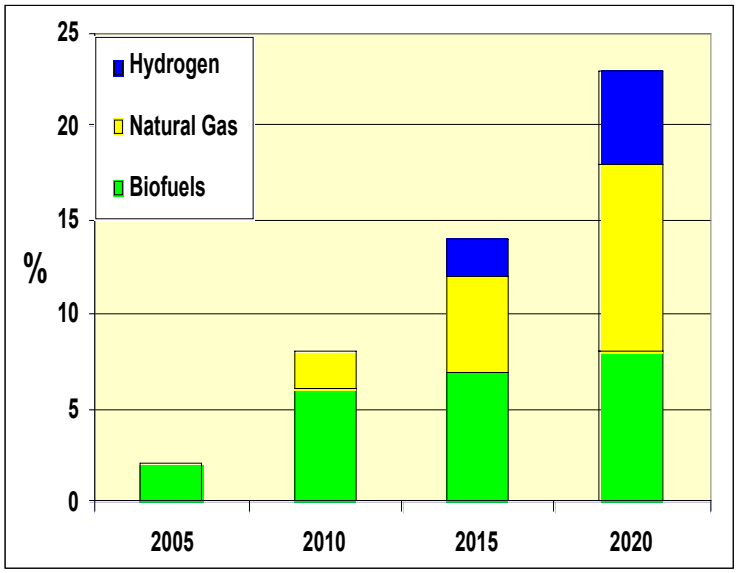

Figure 4.— The three main potential alternative fuels proposed by the communication

3.2 B.2. The High Level Group for Hydrogen and Fuel Cells technologies and the Hydrogen and Fuel Cell Technology Platform

The High Level Group for Hydrogen and Fuel Cells technologies was created in October 2002 by the European Commission. The group was invited to formulate a collective vision on the contribution that hydrogen and fuel cells could make to the realization of sustainable energy systems in the future. In its report the high level group on hydrogen drew up five measures to make hydrogen the energy of the future.

The measures proposed should serve as a guide for the Community action in the field of hydrogen:

- To establish a political framework that enables new technologies to gain market entry within the broader context of future transport and energy strategies and policies;
- To elaborate a Strategic Research Agenda, at European level, guiding community and national programmes in a concerted way;
- To elaborate a deployment strategy to move technology from the prototype stage through demonstration to commercialisation, by means of prestigious lighthouse projects which would integrate stationary power and transport systems and form the backbone of a trans-European hydrogen infrastructure, enabling hydrogen vehicles to travel and refuel between Edinburgh and Athens, Lisbon and Helsinki;
- To establish a European roadmap for hydrogen and fuel cells which guides the transition to a hydrogen future, considering options, and setting targets and decision points for research, demonstration, investment and commercialisation;

- To create a European Hydrogen and Fuel Cell Technology Partnership, steered by an Advisory Council, to provide advice, stimulate initiatives and monitor progress as a means of guiding and implementing the above, based on consensus between stakeholders.

The Commission action aims at implementing these 5 measures. Two directives have been put in force[2] which support hydrogens production from bio fuels.

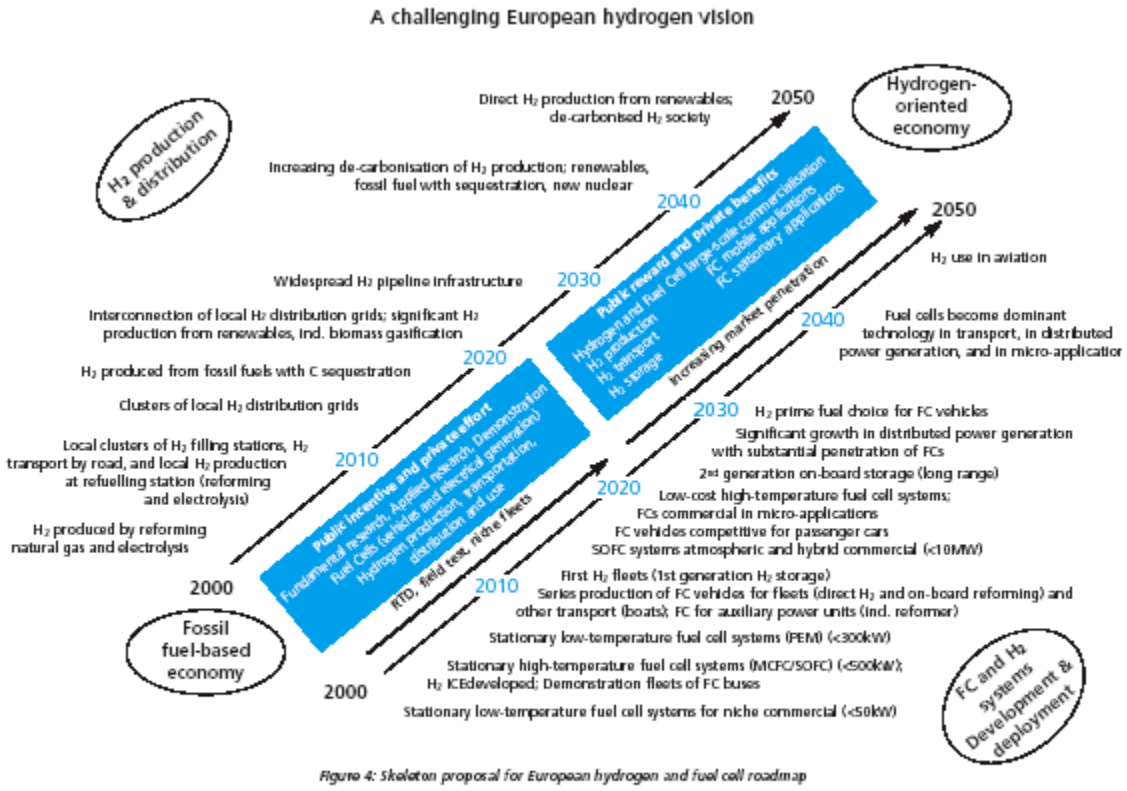

Figure 4: Skeleton proposal for European hydrogen and fuel cell roadmap

Figure 5.— Eskeleton proposal for European hydrogen and fuel cell roadmap

The concept of a platform of technology of hydrogen and of the fuel cell was approved by the European Commission on 2 September 2003 in the communication entitled "A European partnership for a sustainable economy based on hydrogen

In this communication it is stated that hydrogen is a promising energy vector, and fuel cells were identified as major means to help achieve security of supply, reduce effects on the environment, combat climate change and decentralize the energys production.

[2]Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of bio fuels or other renewable fuels for transport; and Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity

The principal objective of the European partnership is to facilitate the development and the deployment of a European energy system based on hydrogen and fuel cells which are competitive on world scale, as well as the associated technologies for applications in transport and systems of fixed and mobile energy production.

The European partnership brings together all actors and all initiatives, public and private, interested in the formulation and the implementation of an integrated strategy for hydrogen. It is governed by an Advisory Board.

The first General Meeting of the European platform on hydrogen and fuel cell technology (HFP), took place in January 2004 in Brussels. The platform was responsible for delivering an integrated European strategy for hydrogen and fuel cells, which was subsequently presented to the second General HFP meeting on 17 on 18 March 2005 in Brussels.

The main goals fixed by the Integrated European Strategy for Hydrogen and Fuel Cells were:

- To reduce of the costs of fuel cell systems by a factor of 10 (and up to a factor 100 for transport applications).
- To increase the performance and the durability of fuel cell systems by a factor 2 or more for various applications.
- To reduce the costs of production and distribution of hydrogen by a factor of 3 or more.
- To obtain a density of storage of hydrogen which will allow vehicles the same autonomy as vehicles with fossil fuels.
- A financing level in the European Union for the RTD in the field of hydrogen and of the fuel cells similar at least to the current levels of the financing of RDT in the United States and Japan, which is about EUR 250 million/year. This figure would require at least a doubling of current financing.

3.3 B.3. The Commission initiative on Communication for Growth (COM (2003) 690)

In November 2003 the Commission launched the European Initiative for Growth to accelerate the economic recovery of the European Union. The Growth Initiative includes a "Quick Start Programme" of projects of public and private investment in infrastructure, networks and knowledge. The aim is to encourage the creation of public-private partnerships, in co-operation with the European Investment Bank.

This programme foresees a major ten year initiative for hydrogen-related research, production and use, with an indicative total budget of 2.8 billion of public and private

funding. The technology platform can help shape this initiative, which has already received the political backing of Member States at the highest level.

Two projects have been selected:

- Hypogen envisages the construction of a testing facility on a large scale intended for hydrogen and electricity production including the sequestration of coal. The estimated budget was 1.3 billion Euros.

- Hycom aims to establish throughout the Union a restricted number of "communities with hydrogen" which will use hydrogen as an energy resource for heating and electricity, and as a fuel for vehicles.

3.4 B.4. International agreements

In June 2003, hydrogen was discussed during the EU-US summit. In a joint statement with the United States, the European Union committed to collaborate on a global scale in accelerating the development of the hydrogen economy. Behind this collaboration is the aim to enhance security of energy supply, increase diversity of energy sources and improve local and global air quality.

With the aim of reinforcing this cooperation, the International partnership on the economy of the hydrogen - IPHE, was launched on the initiative of the United States. The partnership took practical form in the signature on 20 November 2003 of a protocol between 15 countries, including the European Community.

The Community has also signed bilateral cooperation agreements on hydrogen with the United States, Canada, Japan, Canada, Russia, China, Australia and Brazil. The Community also takes part in the activities of the International Energy Agency.

4 C. Hydrogen and fuel cells in the research and demonstration framework programmes of the European Union.

For a long time the Community has been supporting the development of hydrogen and fuel cells technologies. The Community financing for these technologies began with the 2nd RTD[3] framework programme in 1986.

The principal aim of Community research is to identify and evaluate the technical, commercial, operational, organizational, and institutional existing obstacles, which pre-

[3]The title XVIII of the Treaty of the EU (Articles 163-171) envisage a research policy for the European Union and its financial instruments, in particular the multi-annual Research and Demonstration Framework Programme. The Council, taking a decision by a majority qualified on a proposal of the Commission and after consultation with the European Parliament and with the Economic and Social Committee, adopts the Research and Demonstration Framework Programme.

vent hydrogen technologies from appreciably entering the market; and the means to overcome these obstacles.

The principal areas of research in the field of hydrogen and fuel cells have been:

- Systems of hydrogen production, storage and distribution;
- Development of fuel cells (low and high temperatures) for fixed and portable applications, including transport.
- Demonstration of innovative vehicle and bus fleets.

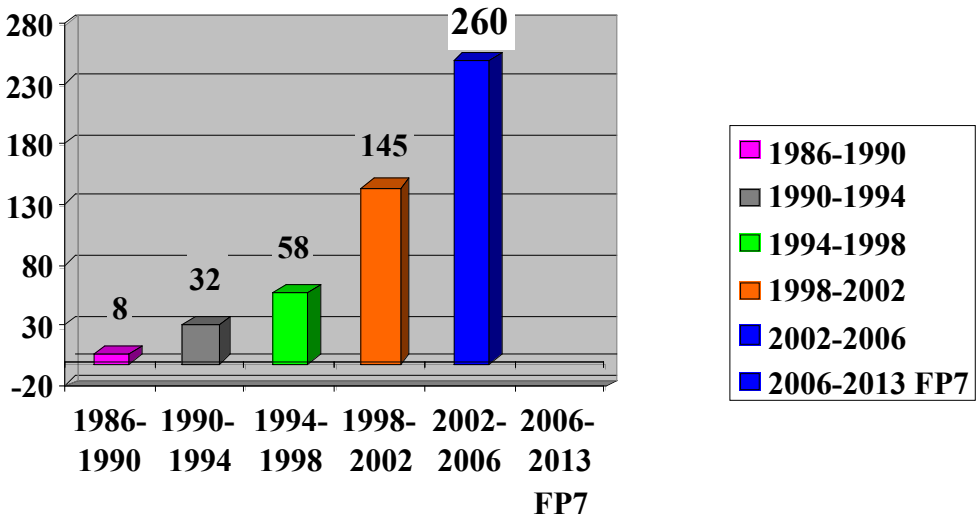

Figure 6.— Global Community funding 1986 2006

The 6th RTD framework programme (2002-2006) was endowed with 3.9% of the overall Community budget, i.e. approximately of EUR 17,500 million

Seven thematic priorities were defined, and one of them was "Sustainable development, energy and transport". Hydrogen and fuel cells were considered into the above mentioned priority under the following items:

i) Development of alternative motor fuels.

ii) Development of fuel cells and their applications, in particular for transport and hydrogen storage.

iii) New technologies and concepts for surface transport, including novel propulsions systems, in particular fuel cells.

The priority "Sustainable development, energy and transport" was endowed with EUR 890 M€ of which 260 M€ were allocated to hydrogen and to fuel cells.

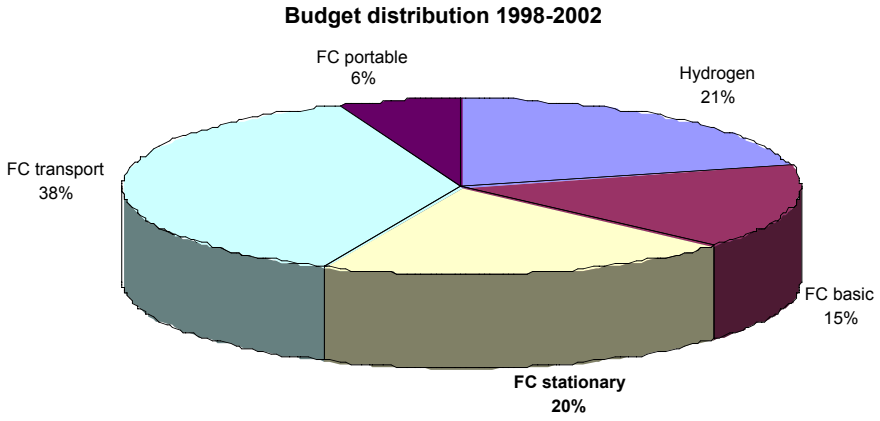

Figure 7.— The Community financing in the 5th RTD framework programme (1998-2002) in the field of hydrogen and of the fuel cells was of EUR 145 million, covering some 70 projects.

5 D. The Commissions proposal for the 7th RTD and in particular for Hydrogen in this programme

5.1 D.1. The 7th RTD framework programme

On 6 April 2005 the European Commission adopted a proposal for a RTD framework programme for the EU. The proposal provides new impetus to increase the growth and competitiveness of Europe, recognizing that knowledge is Europes greatest resource.

The date envisaged for the adoption of the 7th framework programme by the Council is June 2006 and the date planned for the publication of the first call for proposals is November 2006.

The duration of the programme will be 7 years, from 2007 2013. The budget proposed by the Commission will be 73.2 billion euros, this budget amounts to 0.1% of the P.I.B. of the European Union and just under 10% of the public expenditure on research and development within the European Union.

The Commission proposes a new research framework programme articulated around four objectives, each one of which is supported by its own programme:

- Cooperation.
- Ideas.
- Persons.
- Capacities.

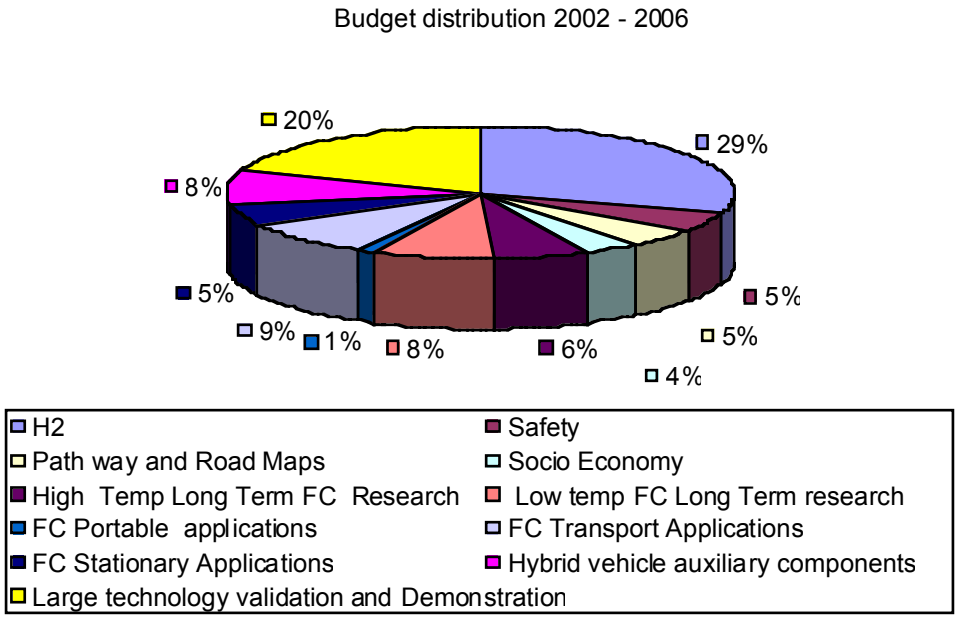

Figure 8.— The priority "Sustainable development, energy and transport" was endowed with EUR 890 M€ of which 260 M€ were allocated to hydrogen and to fuel cells.

The 7th framework programme is conceived to meet better the needs of industry; it will take as a starting point the strategic agendas of research and deployment developed by the technological platform of hydrogen.

5.2 D.2. Activities concerning Hydrogen in the Energy Cooperation programme

Hydrogen and fuel cells.– Integrated action to provide a strong technological foundation for competitive EU fuel cell and hydrogen industries, for stationary, portable and transport applications.

Electricity production from renewable energy resources.– Technologies to increase overall conversion efficiency, driving down the costs of electricity production from indigenous renewable energy resources, and the development and the demonstration of technologies suited to different regional conditions.

Renewable fuel production.– Integrated conversion technologies: to develop and drive down the unit cost of solid, liquid and gaseous fuels (including hydrogen) produced from renewable energy resources, aiming at the cost effective production and use of carbon-neutral fuels, in particular liquid biofuels for transport.

5.3 D.3. Activities concerning Hydrogen in the topic Transport of the Cooperation programme

The greening of surface transport.– Reduction of environmental and noise pollution; development of clean and efficient engines, including hybrid technology and the use of alternative fuels for transport applications; end of life strategies for vehicles and vessels.

Ensuring sustainable urban mobility.– Innovative organisation schemes, including clean and safe vehicles and non-polluting means of transport, new public transportation modes and rationalisation of private transport, communication infrastructure, integrated town planning and transport.

5.4 D.4. The Hydrogen Joint technology Initiative

In its proposal for the 7th Framework Programme, the Commission has introduced the concept of Joint Technology Initiatives as a new way of realising public-private partnerships at European level. The European Commission has defined such possible initiatives in six areas of high industrial and policy interest, one of them is Hydrogen and Fuel Cells.

The Joint Technology Initiative are considered by the Commission as key elements to create the necessary long-term public-private partnerships so as to develop and apply technologies and guide future large-scale investment; being the overall aim to create an industrial base at European level able to compete globally and capitalise on future opportunities for new job creation and economic growth.

The overall objective of the Hydrogen Joint Technology Initiative is to define and execute a target-oriented European programme of industrial research, technological development and demonstration on hydrogen and fuel cells in the most efficient manner, to prepare for the deployment of these technologies; being the specific objective to deliver hydrogen and fuel cell technologies developed to the point of commercial take-off in 2015, with a view to large-scale mass market roll-out by 2020, for transport applications; and to provide the technology base to initiate market growth for stationary fuel cell (domestic and commercial CHP) and portable applications from 2010-2015.