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FUEL CELLS AND HYDROGEN JOINT UNDERTAKING (FCH JU)

Multi - Annual Implementation Plan 2008 - 2013

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Introduction

For the implementation of the Joint Technology Initiative (JTI) on Fuels Cells and Hydrogen (FCH) a Joint Undertaking (hereinafter referred to as "FCH JU") was set up by a Council Regulation[1] for a period up to 31 December 2017. The FCH JU is a public-private partnership. The founding members are the European Communities, represented by the Commission, and the European Industry Grouping for Fuel Cells and Hydrogen JTI. The Research Grouping also became a member shortly after the formal establishment of the FCH JU.

This document establishes the Multi-Annual Implementation Plan (MAIP) of the FCH JU, outlining the scope and details of the initial planning of the research, technological development and demonstration (RTD) activities for the time frame 2008 - 2017. It also describes the objectives of the FCH JU, the policy and global context, technical targets, required actions for the implementation of the JTI and governance structure.

The first version of the MAIP was adopted by the Governing Board the 15th of May 2009. In 2010, it was judged appropiate to do a reassesment of the situation to take into account the results of the first calls, the ongoing revision of the Council Regulation, the first interim evaluation, new technology developments, the different economic environment, as well as the evolution of different European Union policies. This has led to this revised version of the MAIP. As the previous one, it is the result of a joint effort by the major stakeholders, namely the Industry and the Research Groupings in cooperation with the Commission, all coordinated through the FCH JU Program Office.

1. Strategic objectives of the FCH JU

The aim of the FCH JU is to accelerate the development and deployment of fuel cells and hydrogen technologies by executing an integrated European programme of RTD activities. Carried out with the involvement and cooperation of stakeholders from industry (including SMEs), research centres, universities, Member States and regions, the Joint Undertaking builds on the achievements of the European Hydrogen and Fuel Cell Technology Platform and on the results of completed and ongoing EU funded activities.

In particular, the FCH JU:

- Places Europe at the forefront of fuel cell and hydrogen technologies worldwide and enables the market breakthrough of fuel cell and hydrogen technologies, thereby allowing market forces to drive the substantial potential public benefits.
- Supports RTD in the Member States and Associated Countries participating in the 7th Framework Programme in a coordinated manner in order to overcome the high market entry barriers, develop market applications and facilitate additional industrial efforts towards a rapid development of fuel cell and hydrogen technologies.

[1] (EC) N° 521/2008 (EU Official Journal 2008 - L 153)

- Supports the implementation of the RTD priorities of the Multi-Annual Implementation Plan (MAIP), notably by awarding grants following competitive calls for proposals.
- Evaluates the energy, environmental, economic and social sustainability of technological solutions by means of horizontal activities at programme and project level.
- Monitors progress in relation to competing and complementary technologies to assess sustainability and economic competitiveness.
- Aims to encourage increased public and private RTD investment in fuel cells and hydrogen technologies in the Member States and Associated countries.
- Promotes public awareness and understanding of these technologies and the contributions they can make to address energy, environment and transport policies.
- Ensures the coordination and efficient management of funds guided by the principles of transparency and openness, competitiveness and excellence, inclusiveness and mutual cooperation among stakeholders in order to achieve the best possible benefit for Europe. RTD activities will respect the fundamental and ethical principles applicable to the 7th Framework Programme.

2. Global context

The challenge facing fuel cells and hydrogen technologies is of great complexity, requiring substantial investments and a high level of scientific, technological and industrial expertise. At the same time, their potential contribution to Union policies - in particular energy, environment, transport and industrial competitiveness (see section 3.13) – is very important.

In May 2003, the Hydrogen and Fuel Cell High Level Group presented its vision report, "*Hydrogen Energy and Fuel Cells – A Vision of Our Future*". In this, the formation of a hydrogen and fuel cell public-private partnership was recommended in order to substantially accelerate the development and market introduction of these technologies.

In December 2003, the European Commission facilitated the creation of a European Hydrogen and Fuel Cell Technology Platform (HFP), bringing together all interested stakeholders. In March 2005, the HFP published a Strategic Research Agenda and Deployment Strategy, followed by an Implementation Plan in January 2007 – a comprehensive, long-term road map for Europe.

This process confirmed that a coherent, long-term approach at EU level is essential for achieving critical mass in terms of scale, excellence and potential for innovation. The Commission's proposal for a long-term public–private partnership in the 7th Framework Programme of the European Community (2007-2013) in the form of a Joint Technology Initiative (JTI) on Fuel Cells and Hydrogen was a consequential step to address the challenge. In practical terms, this JTI was set up as a Joint Undertaking on the basis of Article 171 of the EC Treaty, now replaced by Article 185 of the TFEU.

In accordance with article 16 of the Council Regulation N° 521/2008 setting up FCH JU, the Commission was responsible for the establishment and initial operation of the FCH JU until the Joint Undertaking had the operational capacity to implement its own budget. The FCH JU became an autonomous legal entity on 15 November 2010.

3. MAIP structure, goals and priorities

3.1 MAIP structure

In order to achieve the FCH JU objectives, as well as manage and implement the programme of RTD activities in an efficient manner, the MAIP is divided into four main application areas (AA): Transport & Refuelling Infrastructure; Hydrogen Production & Distribution; Stationary Power Generation & Combined Heat & Power (CHP); and Early Markets. Cross-cutting activities have been established as a fifth area in order to emphasise their relevance and provide programme level coordination. These include Regulations Codes and Standards (RCS), Pre-Normative Research (PNR), socio-economic research, technology and life cycle assessments, market support (particularly for SMEs), public awareness and education. Important interfaces and synergies are expected between all these areas drawing mutual benefits from each other's results.

The structure of the plan reflects the RTD cycle and comprises long-term and breakthrough-orientated research, research and technological development, and demonstration and support actions, including pre-normative research.

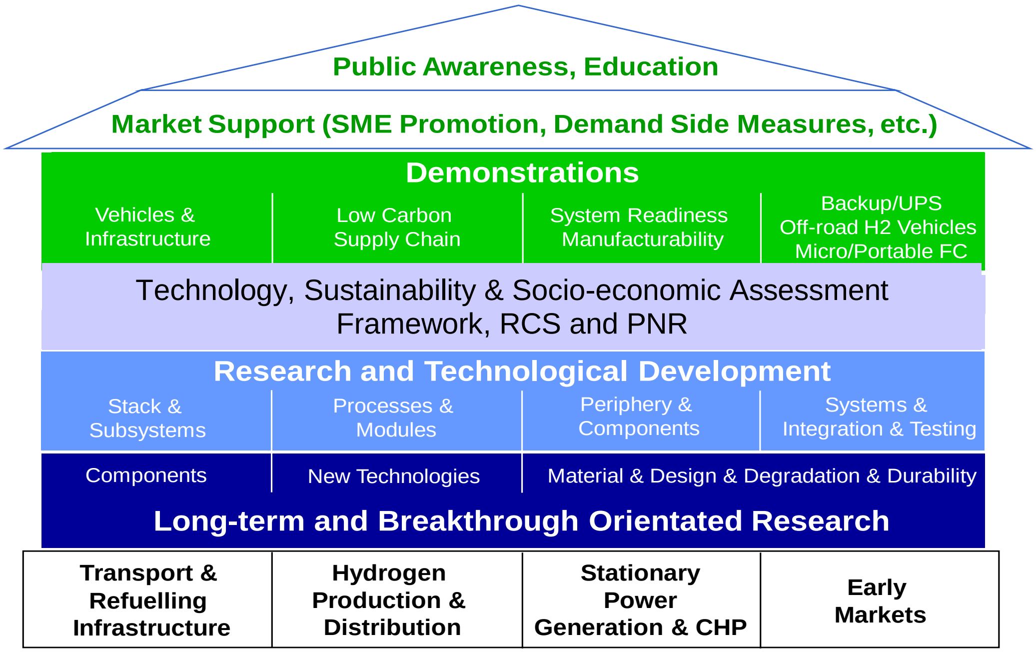

Figure 1: The Structure of the Multi-Annual Implementation Plan

3.2 FCH JU objectives and technical targets

High level objectives and targets have been identified for the four application areas and cross-cutting activities following a thorough assessment performed primarily by working groups comprising representatives of the Industry and Research Groupings and in consultation with the Commission. The most important volume and cost targets are presented in Table 1, while a broader set of them, including performance targets is found in annex 1.

The targets represent qualitative and quantitative objectives against which the progress of the FCH JU is to be assessed. They also represent decision points to consider future budget expenditure, including potential redirection of activities.

		Volume & cost		
Application Area	**Market application**	**2010 baseline**	**2015 mid-term**	**2020 long-term**
AA1 - Transportation & Refuelling	***Cars: Vehicle PEM-FC System***	>100 / 0.5M€ >1,000€/kW	>5,000 / <50k€ 100€/kW	500,000 /<30k€ 50€/kW
	Busses: Vehicle PEM-FC System	>10 / 2M€ >3,500€/kW	500 / <1M€ <3,500€/kW	1,000 / <500k€ <400€/kW
	Hydrogen refuelling stations	<75 / 1 - 3 M€ (depending on size of filling station)	<300 / 0.6 - 2.5 M€ (depending on size of filling station)	>2000 / 0.6 - 1.6M€ (depending on size of filling station)
	APU's for truck applications (5kW)	3,000€	1,000€	500€
	APU's for aircraft applications (20-120kW)	Lab test units only	flight validation supply	early operation (hundreds) / 500 €/kW
	APU's for maritime applications (50-500 kW)	single demonstrations	some tens / 3000-4000 €/kW	hundreds / <2000 €/kW
AA2 – Production	***Hydrogen delivered to retail station***	-	*5 €/kg*	*5 €/kg*
	Distributed production of hydrogen by water electrolysis	*1.5 t/d cap. | 65% eff. | 3.1 M€/(t/d)*	*1.5 t/d cap. | 68% eff. | 2.8 M€/(t/d)*	*3.0 t/d cap. | 70% eff. | 1.9 M€/(t/d)*
	Distributed production by reforming of biogas SMR (incl. purification)	*1.5 t/d cap. | 64% eff. | 4.2 M€/(t/d)*	*1.5 t/d cap. | 64% eff. | 3.8 M€/(t/d)*	*3.0 t/d cap. | 67% eff. | 2.5 M€/(t/d)*
	Total installed production capacity from renewables	-	-	*103 t/d*
	Centralized production of hydrogen by water electrolysis	-	-	*50 t/d cap. | 70% eff. | 1.5 M€/(t/d)*
	Centralized underground storage of hydrogen	-	-	*4000 t cap. | 0.006 M€/t*
	Distributed storage of gaseous hydrogen	*0.8 t cap. | 0.5 M€/t*	*5 t cap. | 0.45 M€/t*	*10 t cap. | 0.4 M€/t*
	Storage of hydrogen in solid materials	*3 t cap. | 5 M€/t*	*5 t cap. | 1.5 M€/t*	*10 t cap. | 0.85 M€/t*
	Total installed storage capacity of H2 produced from grid	-	-	*129 t*
	High capacity compressed H2 trailer	*0.6 t cap. | 0,55 M€/t*	*1.3 t cap. | 0,55 M€/t*	*1.6 t cap. | 0,4 M€/t*

AA3 – Stationary	***Micro-CHP (residential), natural gas based***		*1,000 units / 10,000 € per system (1kWe + household heat) Assuming supported deployment from 2013+*	*50,000 units / 5,000 € per system (1kWe + household heat) Anticipating commercial introduction beyond 2020*
	Industrial/commercial, H2 based	*1 MW / 4,500 €/kW*	*>5 MW / 3,000 €/kW Assuming supported deployment from 2013+*	*>50 MW / 1,500 €/kW Anticipating commercial introduction beyond 2018*
	Industrial/commercial, natural gas based		*>5 MW / 4,000 €/kW Assuming supported deployment from 2013+*	*>100 MW / 2,000 €/kW Anticipating commercial introduction beyond 2018*
AA4 - Early markets	***Heavy duty material handling vehicles***	*<50 units | <3,500€/kW fuel cell system*	*>1,500 units | <1,500€/kW fuel cell system Anticipating supported deployment from 2013+*	*>20,000 units | <1,000€/kW fuel cell system Anticipating commercial introduction beyond 2015+*
	Back-up power systems	*150 units | 5,000€/kW fuel cell system*	*9.000 units | <1.500€/kW fuel cell system*	*20.000 units | <800€/kW fuel cell system*
	Small micro fuel cells	*>4,000 units | <10,000€/kW fuel cell system*	*>30,000 units | <6,000€/kW fuel cell system*	*>250,000 units | <3,600€/kW fuel cell system*

Table 1: MAIP Targets for the FCH JTI

3.3 RTD priorities and budget distribution

The maximum EC contribution to the FCH JU for the implementation of the MAIP activities is 450 M€ for the period from 2008 – 2013. The initial tentative budget breakdown of the MAIP is shown in table 2. The rows of the table provide the budgets for and reflect the proportional weight of the application areas and cross-cutting activities within the overall programme. The columns show the budgets for the different action categories and their relative shares.

	FCH JU Funding by Action Categories					
Application Areas	Break-through research	Research & technological development	Demon-strations	Support actions	TOTAL €m	TOTAL %
Transportation & Refuelling Infrastructure	20-23	20-22	94-106	10-11	**144-162**	**32-36%**
Hydrogen Production & Distribution	17-20	16-19	12-15	0	**45-54**	**10-12%**
Stationary Power Generation & CHP	23-25	95-103	35-38	1	**154-167**	**34-37%**
Early Market		11-13	42-49	1	**54-63**	**12-14%**
Cross-cutting Issues				27-36	**27-36**	**6-8%**
TOTAL (€m)	**60-68**	**142-157**	**183-208**	**39-49**	**450**	
TOTAL (%)	**13-15%**	**31-35%**	**41-46%**	**9-11%**		**100 %**

Table 2: The initial tentative budget breakdown of the Multi-Annual Implementation Plan

This budget breakdown reflects the level of resources needed to reach the objectives of the FCH JU and is based on a consensus reached by several working groups comprising representatives of the Industry and Research Groupings working in consultation with the Commission. These groups identified specific priority topics and developed detailed technical and financial frames described in the document "*Priority Research, Technological and Development and Demonstration Topics 2008-2013*" (see http://www.fch-ju.eu/page/documents). This document constitutes an important input to Annual Implementation Plans (AIPs) and the calls for proposals.

The budget breakdown by application area, i.e. "Transport & Refuelling Infrastructure", "Hydrogen Production & Distribution", "Stationary Power Generation & CHP", "Early Markets" and "Cross-cutting Activities" is displayed in figure 2.

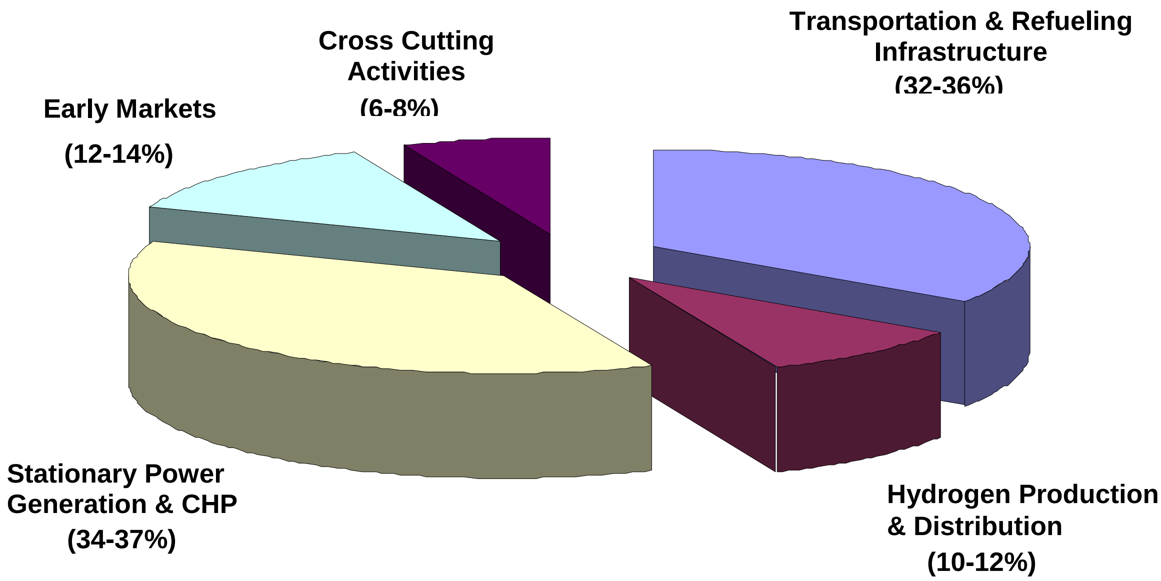

Figure 2: Initial tentative budget breakdown by Application Area

The breakdown emphasises the key importance of Transportation & Refuelling Infrastructure as well as Stationary Power Generation & CHP for the overall programme. A substantial part of the budget is dedicated to Early Markets facilitating near to market applications and specifically supporting SMEs in their commercialisation efforts. The budget allocation for Hydrogen Production & Distribution will help to increase the share of sustainable hydrogen production based on renewable energy sources and to develop new and improve existing hydrogen production methods. Cross-Cutting Activities are established as a separate budget category to address the need for programme level actions on RCS, PNR, Socio-Economic Modelling and Planning, Technology Monitoring and Assessment, and Lifecycle Analysis.

The initial tentative breakdown of the budget by action categories, i.e. "Long-term and Breakthrough orientated Research", "Research and Technology Development", "Demonstration" and "Support Actions", is displayed in figure 3.

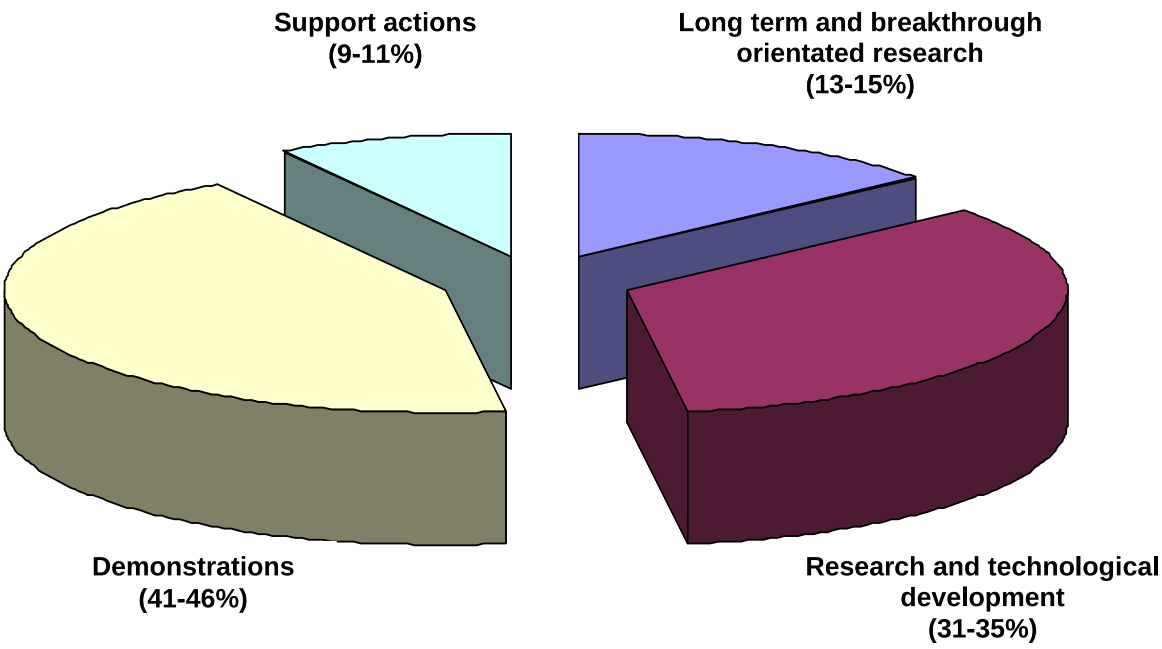

Figure 3: Initial tentative budget breakdown by action category

Efforts are divided between long-term and breakthrough research, research and technological development (which together total 44-50%), support actions and demonstrations. The strong role of demonstrations and market orientated actions reflects the growing technology maturity in “Transportation & Refuelling Infrastructure” as well as in “Early Markets”. These include proof of concept demonstrations for specific applications to attract additional industrial engagement and extend the range of products and applications in the market. Demonstrations will deliver valuable experience and data from fleet operations, establish and test initial infrastructure elements including logistics and supply chains and increase customer awareness and acceptance. This will help to further mature technology, reduce investment risks and thus lay the foundations needed for mass commercialisation.

The focus of the application areas “Stationary Power Generation & CHP” and “Hydrogen Production & Distribution” is on long-term and breakthrough orientated research and research and technological development. This will enable the European research community and industry to address critical issues for these two application areas such as material durability, components reliability, large-scale manufacturing processes and sub-systems and systems design.

Approximately one tenth of the overall budget will be spent on support actions addressing the removal of non-technical market barriers particularly through the development of RCS, assessment of the socio-economic and environmental impact of the technologies, support to SMEs, public awareness and education. Some of the issues will be dealt with in the cross-cutting activities while others (e.g. LCA, safety "due diligence") will be implemented as horizontal activities in the different application areas or even at project level.

3.4 Priorities of the MAIP application areas

3.4.1 Transport & Refuelling Infrastructure

The main objective of this application area is the development and testing of competitive hydrogen-fuelled road vehicles and corresponding hydrogen refuelling infrastructure, and the full range of supporting elements for market deployment and increased industrial capacity. Approximately 32-36% of the overall budget will be devoted to this application area.

The main emphasis is on large-scale fleet demonstration of hundreds of next-generation fuel cell hybrid vehicles, including cars and buses, hydrogen-fuelled vehicles and an appropriate number of refuelling stations, Europe-wide. This action should demonstrate the durability, robustness, reliability, efficiency and sustainability of both vehicles and infrastructures for everyday use by the general public. In particular, the demonstrations are to provide the necessary data for the comprehensive assessment of the energy, economic and environmental impacts of the different hydrogen-based energy chains needed to meet the global market objective of thousands of vehicles in the field beyond 2015, and prepare mass production from 2020. They will be complemented by research and technological development to show the application readiness of on-board high capacity hydrogen storage.

In this context, action will be taken to integrate the currently fragmented PEMFC stack research and development activities within Europe and to establish European leadership in the transportation fuel cell stack industry. This is to be achieved through close cooperation between automotive OEMs, the relevant supply industry and research institutes. To that end, a European "cluster" involving all the relevant players in the field is to be set up in order to develop a joint technology roadmap addressing the research and development needs as well as the industrial system integration and manufacturing aspects.

Research and technological development will mainly address specific issues related to PEMFC technology for transport applications. This will include *inter alia*: mechanically and thermally stable and long-life membranes allowing for system architectures simplification; electrochemically stable and low-cost catalysts for polymer Membrane and Electrode Assemblies (MEAs); corrosion resistant and low-weight, -volume and -cost bipolar plates to achieve the target power densities; manufacturing and process development; methodology and tools for reliable life-time assessments that help improving system and vehicle operating strategies; alternative concepts and improved architectures for efficient and robust peripheral fuel cell system components.

Heavy duty road transport applications will also be addressed in this application area. Propulsion systems using on-board power generation in commuter trains, rail cars and city trains are envisaged. Proof-of-concept demonstrations are also foreseen for APUs in aeronautic and maritime applications and also for trucks. The common goal of all these demonstrations is to increase efficiency of onboard power generation and reduce CO_2 emissions and local pollution. The similarity of the base technology of these applications with those in the application area "*Stationary Power Generation & Combined Heat & Power" and "Early Markets*" are to be used to exploit existing synergies in research and technological development in the fields of SOFC, MCFC and PEMFC to avoid duplication of activities and thus to create benefits for all areas.

Concerning the hydrogen refuelling infrastructure, this application area foresees the development and integration of the necessary components for hydrogen refuelling stations and their associated peripheral conditioning systems. The goal is to further improve energy efficiency, robustness, functionality and safety at a component and system level and, to ensure application readiness for large-scale, real-use market introduction. Effort will be directed at fostering suitable value-chain structures to assure safety, quality and reliability of complete equipment systems.

Pre-normative research will complement the RTD in this application area. In particular the following issues will be addressed: hydrogen quality requirements and standards; design and test criteria for high pressure composite and solid state storage tanks; fast refuelling protocols and standards; crash tests for hydrogen powered vehicles and safety of hydrogen vehicles especially in confined spaces.

3.4.2 Hydrogen Production & Distribution

This application area aims to develop and, where possible, fully implement a portfolio of cost-competitive, energy efficient and sustainable hydrogen production, storage and distribution processes enabling supply of the anticipated hydrogen energy demand while demonstrating the role that hydrogen can play as an energy carrier in reaching Europe's key long term and mid term energy objectives:

In line with Europe's longer term objectives for 2020 and 2050, the latter including de-carbonisatrion of the transport sector, the mid-term targets are the following:
1) Supply up to 50% of the anticipated hydrogen energy demand (expected to come mainly from transport and early market applications), from renewable energy sources by 2020, in order to show a significant contribution of hydrogen to the 10% renewable energy in transport objective
2) Reach in 2020 the level of technology readiness required for massive expansion of the hydrogen production and distribution infrastructure as needed for decarbonisation of transport by 2050 with CO2 lean or CO2 free hydrogen, combining carbon capture and storage (CCS) and distributed production from renewables.

Several processes and feedstocks will be used to produce hydrogen either in centralised (large scale) plants providing economies of scale or distributed (small scale) plants taking advantage of locally available primary energy sources and feedstocks with the benefit of generally improved sustainability and lower distribution infrastructure costs. These processes have different degrees of maturity, production capacity and sustainability. In the short and mid-term, the demand will need to be met by the more mature technologies. In the longer term, a wide variety of technologies could become available to exploit available primary renewable energy resources using hydrogen as an energy carrier. In this perspective, new hydrogen production and supply pathways need to be further developed and tested.

Accordingly, the main emphasis of this application area is on research and development of mature production and storage technologies and on breakthrough orientated research of longer term, fully sustainable hydrogen production and supply pathways. The mature production technologies include (i) reforming (and gas purification) based on bio-fuels as well as conventional fuels; (ii) cost-efficient low-temperature electrolysers adapted for the large-scale use of carbon free electricity and (iii) biomass to hydrogen (BTH) thermal conversion. Long-term and breakthrough orientated research will aim at improving efficiencies of technologies for water splitting using high temperature electrolysers as well as thermo-chemical processes based on solar, nuclear or waste heat, and at developing low-temperature, low-cost biological hydrogen (e.g. enzymes for fermentation) and photo-electrochemical processes for direct hydrogen production. A development objective for most decentralized production technologies is scale-up to cost effective capacity, as well more cost efficient, high performance materials (e.g. membranes) to meet the overall cost targets.

With regards to the development of large capacity carbon lean or carbon free hydrogen production, cooperation with the Zero Emission Platform to demonstrate low CO2 hydrogen production using CCS will be sought.

Concerning the establishment of a safe, efficient and reliable hydrogen distribution and refuelling infrastructure the main focus will be on demonstration of technology options for high volume, safe hydrogen storage such as storage in underground caverns and decentralized storage, in synergy with the energy storage requirements resulting from the variability and intermittency of renewable energy sources connected to the electricity grid. This will be complemented by long-term and breakthrough orientated research on improved hydrogen storage based on solid and liquid materials for increased efficiency and storage capability. Some of these technologies are ready for implementation in small and medium scale stationary applications, e.g. in combination with high temperature fuel cells. Here, energy efficient integration and a significant reduction of cost of the storage systems will be the main development targets.

Attention will also be given to improving the means of hydrogen distribution and delivery by road transport (e.g. increased capacity), in order to meet the needs of large fuelling stations.

Finally, efforts will need to be dedicated to closing RCS gaps through further pre-normative research on design/installation requirements for novel hydrogen production, storage or distribution technologies (such as large capacity stationary storage or high capacity gaseous hydrogen transport).

Note: Coordination of RCS will be required within the AA for different topics and between different AAs due to the inter-relationship between the topics.

3.4.3 Stationary Power Generation & Combined Heat & Power

The overall objective of this application area is to improve the technology for fuel cell stack and balance of plant components to the level required by the stationary power generation and CHP markets by bridging the gap between laboratory prototypes and pre-commercial systems. This will include test campaigns for product validation under real market conditions and preparations for the start-up of fuel cell installation, operation and maintenance services. At the same time scaling up of the European manufacturing capacities will allow for industrial production of fuel cell products. Approximately 34-37 % of the overall budget will be devoted to this application area.

The goal of this application area is to achieve the principal technical and economic specifications necessary for stationary fuel cell systems to compete with existing and future energy conversion technologies. For example: electrical efficiencies should be >45% for power only units and >80% for CHP units, combined with lower emissions and use of multiple fuels. In addition, substantial effort is needed to address lifetime requirements of 40,000 hours for cell and stack, as well as competitive costs, depending on the type of application.

Reaching these targets will require deployment of the main fuel cell technologies, in particular PEMFC and SOFC. Although they are at different stages of maturity and targeting somewhat different market segments, none of them can be successfully deployed comercially at present in competitive markets. Based on this consideration the RTD proposed will be highly application orientated but technology neutral. Assessment of the different fuel cell technology options to deliver the programme objectives will be one of the critical aspects to be addressed in the medium term.

Long-term and breakthrough orientated research will concentrate on degradation and lifetime fundamentals related to materials and typical operation environments for relevant power ranges. The aim will be to deliver new or improved materials as well as reliable control and diagnostics tools both at component and system levels. Research and technological development will be directed towards developing components and sub-systems (including BoP) as well as novel architectures for cell and stacks leading to step change improvements over existing technology in terms of performance, endurance, robustness, durability and cost for all technologies. Full system integration - allowing a better understanding and optimisation of the interaction between components as well as achieving the application readiness – is also envisaged.

The largest share of the budget for this area is allocated to technology validation and market capacity building across all applications. Proof-of-concept fuel cell systems are to be developed in order to optimise their interactions with supply and demand interfaces (i.e. other power generation devices, cooling/heating systems) and with the infrastructure (i.e. grid interface, fuel supply and local power output). Then the readiness of fully integrated systems will be validated in simulated environments of typical lead applications. Finally, a number of full scale field demonstrations of proven systems in real end user environment will demonstrate fit-for-purpose technical system performance and extended operational experience. These systems shall be suited for large scale manufacturing, including their supply chain, to enable market growth.

Similarities exist between the base technology and requirements of the fuel cell technologies in this Application Area and those for on-board power generation (e.g. APU), in the "*Transport and Refuelling Infrastructure*" application area and UPS and back-up power in the "Early Markets" application area. Therefore, in order to benefit from the existing synergies coordinated research topics will be promoted.

A number of pre-normative research actions will complement projects. Notably specific technical and economic targets are to be developed and a technology benchmarking, based on a pan-European assessment, is to be performed for residential, commercial and industrial applications. The power grid integration and management aspects related to these applications should also be addressed.

3.4.4 Early Markets

Early markets are considered strategically important to build up and sustain an early manufacturing and supply base for fuel cells products and systems. For this reason, this application area aims to develop and deploy a range of fuel cell-based products capable of entering the market in the near term. Approximately 12-14 % of the overall budget will be devoted to this application area.

Given the key importance of early markets in preparing for the widespread deployment of fuel cells and hydrogen technologies, the largest share of the budget for this application area focuses on short-term demonstrations and ready-to-market products. The main goal will be to show the technology readiness of (i) portable and micro fuel cells for various applications; (ii) portable generators, back-up power and UPS-systems; (iii) specialty material handling vehicles including related hydrogen refuelling infrastructure. The common goal for all the demonstrations will be the need to create basis for volume-buildup that can help reduce cost and pave way for a commercial market introduction. Also demonstration is to address all critical application requirements concerning cost competitiveness, lifetime, reliability and sustainability.

Existing synergies with the other application areas will be identified and exploited. Early market applications will play an important role in gaining operating experience and providing feedback into technical development and manufacturing processes and also demonstrating the technologies to potential users.

Research and technological development will be carried out in parallel with the demonstration areas in order to prepare technologies needed for a full commercial use. Main research focus areas foreseen are:

1) Reducing cost of the fuel cell system by e.g. optimizing and further develop new Balance of Plant components
2) Improving efficiency and lifetime of the fuel cell system, e.g. by optimal hybridization
3) Enhancing fuel supply for fuel cell applications
    a. Reducing hydrogen delivery costs, e.g. by developing new innovative supply concepts
    b. Expanding the fuel sources, e.g. by onboard reforming of logistic fuels
    c. Extending the system operation time by improved (hydrogen) fuel storage devices

In many cases, early markets represent niches that are the business domains of SMEs. Support measures will specifically address existing commercialisation risks and regulatory hurdles that impact on the business of such companies. Also a successful market introduction requires availability of the necessary promotion and support schemes for facilitating market deployment. These will include the promotion of early demand stimulation schemes with focus on joint private or public procurement and on product supply financing (e.g. creation of buyer pools, building of early rental/lease fleets, etc.). These schemes should result in a better integration of SMEs in the industrial supply chains so that their innovations can more easily be translated into practical products and manufacturing processes.

In order to pave the way for a widespread acceptance of fuel cells in early applications pre-normative research will aim to develop methodologies and procedures for safe indoor use of fuel cells, including noise, emissions, safety and compatibility with electrical and building codes.

3.4.5 Cross-Cutting Activities

The cross-cutting activities will aim to support and enable the other application areas at programme level. The main goals are to evaluate the socio-economic, environmental and energy impact of FCH technologies, monitor the RTD programme implementation and support the growth of the European industry, particularly SMEs. These activities mainly include: RCS and PNR ; socio-economic research; technology monitoring; sustainability assessment; education and public awareness; development of financial instruments and logistic support schemes. Approximately 6-8% of the overall budget will be dedicated to these cross-cutting activities.

The setting up of RCS strategy coordination targeting RCS and PNR actions will help European stakeholders to bring their fuel cells and hydrogen products to the market. They will ensure that the non-technical barriers are addressed, so as to provide a strategic advantage to Europe in the global marketplace. Stakeholders will be invited to identify and prioritise RCS and PNR needs. RCS strategy coordination (RCS SC) is described in section 3.5.

To increase the impact of FCH JU activities, it is important to develop strategies on how to inform policy-makers and investors and support regional and local development plans. Socio-economic research including macroeconomic impact analysis is instrumental to this task and should build on the results of several European projects funded in recent years on this subject. International socio-economic and policy evaluation schemes will be agreed (notably with the US) in order to coordinate the early market development phase and compare policy and technology options.

The successful implementation of the MAIP requires a coherent framework to monitor progress towards the FCH JU objectives and vis-à-vis major external developments. A specific technology assessment framework tailored for fuel cells and hydrogen will be developed and applied to collect and compare the data – including on alternative and competing technologies – and to disseminate the results to the relevant stakeholders. This work will be linked with Life Cycle Assessment (LCA) related activities described in section 3.5.

In order to create the human resource base required by a growing industry, educational activities should be undertaken developing training programmes at all levels, in particular for specific target groups such as regulators and technical project managers. This will be complemented by dissemination of the programme results through public awareness events and initiatives. A specific market and finance outreach programme will also be developed for SMEs.

Other important support activities include the establishment of frameworks and schemes to support SMEs to develop a supply chain for fuel cell and hydrogen technologies (e.g. by facilitating testing and certification procedures) and to assess the possibilities for funding opportunities outside the FCH JU, see also 3.4.4.

Cross-cutting issues are for the benefit of all Programme activities and their funding scheme will be adapted to meet specific task requirements and ensure the mobilisation of the best available expertise.

3.5 RCS strategy coordination

The implementation of a RCS strategy coordination (RCS SC) is crucial for the market deployment of FCH systems. Today, the lack of harmonised RCS and PNR to fill RCS knowledge gaps at EU (and world) level are recognised as major barriers for the commercialisation of FCH products.

The overall goal of RCS SC is to enable the development and actual use of harmonised performance-based standards. The RCS SC therefore aims to facilitate the deployment of the activities which will enable meeting EU (industrial) interests in e.g. establishing compliance/certification criteria within the EC and UN regulatory framework; developing European and international standards that provide the technical requirements to achieve safety and build confidence as well as guiding authorities and other stakeholders in their application. The RCS SC will formulate a strategy in consultation with all European stakeholders and will take the necessary actions to implement the strategy. As an important first step, it will focus on two main tasks which have to be implemented in full agreement with both the IG and RG and periodically reviewed and updated, namely 1) prioritisation of RCS needs of strategic importance for EU and 2) identification of related PNR efforts.

Led by industry and supported by the FCH JU Programme Office, the RCS SC will coordinate the following FCH JTI activities on RCS and PNR:

- Identify RCS developments and needs through a continuous global watch function; Interface with the Regulatory Bodies (EC and UN), and international SDO's (ISO, IEC and CEN/CENELEC) for development/amendment of international standards and regulations.
- Tailor PNR activities in the JTI programme to ensure that safety issues are appropriately addressed and validated.
- Collect and evaluate RCS-relevant info from demonstration projects; Monitor PNR activities.
- Maintain, consolidate and disseminate results of RCS and PNR activities (awareness workshops, development of training content, etc.).

These tasks require empowering the RCS SC and the FCH JU PO for setting up effective and efficient structure and providing the tools required for their implementation.

3.6 Environment and sustainability

Fuel cells and hydrogen have a potential for reducing emissions of greenhouse gases and air pollutants, facilitating the increased use of renewable energy sources, raising overall efficiencies of energy use and, in general, establishing a sustainable energy system and mitigating the human factor of global warming. However, the complete energy chain has to be evaluated in order to assess the social, economic and environmental impacts of these technologies so that emissions reduction and resource conservation can occur at all stages of the life-cycle. The main factors affecting the impacts are the pathways chosen to produce hydrogen (i.e. renewable, fossil or nuclear), the availability of scarce materials, the manufacturing processes of the different components, the type of application and the recycling and disposal of all the components and materials at the end of their useful life.

A goal of the FCH JU is to develop and apply Life Cycle Assessment (LCA) at programme and project level on the technology system for hydrogen and fuel cells. This will allow the examination of the above-mentioned impacts in a way that is consistent and compatible with tools currently used by industry and policy makers. To that end the first step will be to elaborate specific practice guidance for these technologies, building upon the International Reference Life Cycle Data System (ILCD) Handbook on LCA http://lca.jrc.ec.europa.eu /EPLCA/). As soon as this guidance becomes available LCAs will be performed at both project and programme levels. The resulting Life Cycle Inventory (LCI) data sets will form a database, published as part of the ILCD Data Network, and maintained by the industry partners of the FCH JU. The FCH JU shall also establish an international exchange thus providing for a globally consistent framework.

The LCA related activities will be properly interfaced with the Technology Monitoring Assessments (TMA). Together they will deliver the necessary quality data and scientific information required to assess, in a systematic and reliable way, the potential benefits and drawbacks of fuel cells and hydrogen technologies along the entire life-cycle, from raw material extraction and processing to recycling and final disposal. This will facilitate a more effective policy evaluation and decision making process and will help prevent the build-up of potential health and/or environmental problems before they can cause serious damage or heavy costs, as well as systematically review the availability of scarce materials such as noble metals.

3.7 Cooperation with JRC

The Commission's Joint Research Centre (JRC) undertakes high quality research in the field of fuel cells and hydrogen that is of considerable relevance to the implementation of the FCH JU activities. The agreement between the FCH JU and the JRC defines areas where JRC provides an in-kind contribution and areas where JRC may participate in competitive calls for proposals with a view to obtaining the best impact. In particular, the JRC contribution covers activities in the area of prenormative research. It also provides support to individual projects, offering the services of a reference laboratory on a voluntary basis. In addition, it may support, upon request of the Governing Board, the formulation and implementation of the FCH JU strategy.

3.8 Coordination with Member States and Associated Countries

One of the main objectives of the FCH JU is to align efforts and leverage additional industrial, national and regional RTD investments. In order to achieve this goal, close coordination and cooperation mechanisms will be developed with Member States and Associated Countries. Several Member States and Associated Countries have already accumulated considerable expertise in fuel cells and hydrogen technologies and are undertaking substantial RTD programmes. Cooperation can considerably expand the scope and impact of FCH JU activities, at programme level and, when possible, at project level through appropriate co-funding schemes.

In particular, cooperation across Europe is essential to ensure a consistent and coherent Fuel Cells and Hydrogen deployment strategy from large scale demonstration projects to market introduction, including infrastructures development.

A strong and coordinated effort with Member States and associated countries is also required for the development of regulations, codes and standards (RCS).

The Joint Undertaking will be assisted by the FCH State Representative Group (SRG) as described in Section 5.2.

3.9 Coordination with Regions

Several Regions in Europe have already started local programmes on fuel cells and hydrogen technologies and significant budgets are committed for future development. Regions will play a crucial role in supporting SMEs, maintaining and expanding hydrogen infrastructures and planning public procurement. Coordination and collaboration with Regions is therefore important in order to pool resources, in particular for large demonstration projects, facilitate the deployment of the fuel cells and hydrogen technology and contribute ensuring a coherent and influential action at local level.

The FCH JU will collaborate with the "Hydrogen Regions and Municipalities Partnership" (*HyRaMP)* – established by a number of committed Regions in April 2008 – in order to fully align strategy and coordinate research and demonstration activities at project level (for example, exploring opportunities for dedicated co-funding mechanisms).

3.10 The role of small and medium size enterprises

In line with the objectives of the 7th Framework Programme, the Statutes of the FCH JU, Article 1, establish the task of promoting the involvement of SMEs in its activities. The Statutes furthermore require, that at least one member of the IG Board shall represent SMEs on the FCH JU Governing Board.

SMEs are a key stakeholder group for the success of the JTI. They are an important source of innovation and represent a large share of companies engaged in early markets and are involved in many industrial supply chains. Their role is crucial for future commercialisation.

Two of the largest obstacles that SMEs must overcome are the need to raise financing, especially in the early stages of growth, and to kick-start sales and thereby gain valuable field experience. In order to address the specific limitations and risks of SMEs, the FCH JU will, inter alia, explore ways to open access to the necessary manufacturing and process capabilities through partnership schemes and education initiatives (as described in Sections 3.4.4 and 3.4.5).

3.11 International cooperation strategy

International cooperation is a major priority for the FCH JU in order to speed up world-wide market introduction. International activities, such as those developed by the International Energy Agency (IEA) and the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), will be closely followed. Bilateral contacts will also be maintained and further expanded with the states most involved in the development of FCH technologies. Of special interest in this context are socio-economic and environmental assessments, LCA, RCS, safety and developing common methodologies for monitoring large-scale demonstrations. Collaboration schemes such as those being implemented by the Working Group "Energy Technology RD&D" of the EU-US Energy Council should be used as a reference.

3.12 Communication and dissemination

Fuel cell and hydrogen technologies are as yet relatively unknown to the public. Their benefits and the RTD results obtained within the programme must therefore be carefully explained and widely disseminated. For this reason, efficient and pro-active communication and dissemination activities are of great importance for the success of the FCH JTI. The objectives are to:

i. Ensure that the FCH JTI is perceived as the key European strategic initiative for focused, coordinated and competitive RTD activities in the field of fuel cells and hydrogen

ii. Raise public awareness of the role of fuel cells and hydrogen in creating a sustainable, secure and affordable energy system and employment

iii. Ensure internal communication and coordination with members and stakeholders managing their expectations and promoting continued interest in the FCH JU activities speaking with one voice

iv. Engage external stakeholders encouraging increased RTD investment in fuel cell and hydrogen technologies.

Communication materials and tools will be chosen according to the target group (e.g., media, influencers, educators, policy makers, general public, etc.). As a key communication tool serving all these groups, the FCH JU will further develop its new website to include press material, brochures, fact-sheets, audio-visual material and standard presentations. Furthermore, the website will be instrumental in disseminating project results. As explained in section 5.4, the Stakeholders General Assembly will also be an important channel for communication and information exchange of FCH JU activities.

Annual review days will be organised parallel to the Stakeholders General Assembly –starting in 2011. They will be a major opportunity to raise visibility on FCH JU activities and to assess projects and, application areas as well as, ultimately, FCH programme development, especially in relation to international developments.

To further increase the presence and visibility of the Joint Undertaking and its activities, there will be a participation to relevant events or exhibitions, at national, European or international level.

3.13 Long-term vision

This Multi Annual Implementation Plan details the initial stages needed for the market introduction of fuel cells and hydrogen technologies. As described in the previous sections, the strategic priorities of the FCH JU are to develop the next-generation technologies which can compete with conventional ones, to demonstrate technological readiness of a number of applications, and to focus the efforts of a growing European industry. However, as indicated in the SET-Plan Investment Communication (COM(2009)519), additional public and private funding of 5 B€ is estimated for the 2013-2020 period.

Fuel cells and hydrogen are medium and long-term energy technology options and, therefore, their contribution to meet the 2020 EU targets on greenhouse gas emissions, renewable energy and energy efficiency (see section 2) will be limited. They are expected to play an important role in achieving the EU vision of reducing greenhouse gas emissions by at least 80% by 2050. By that time it is expected that the critical barriers preventing commercialisation of these technologies (i.e. cost and durability of fuel cells, availability of large amounts of emissions-free, affordable hydrogen, development of a long term stable regulatory framework) will be overcome and their full socio-economic and environmental benefits realised.

In the 2050 vision, hydrogen will be produced through carbon-free or carbon-lean processes. Coal gasification power plants with carbon capture and storage will deliver large quantities of hydrogen. Solar and nuclear heat will be used at large scale to produce hydrogen by high temperature electrolysis and thermo-chemical cycles for high temperature water splitting. Novel methods (such as biological processes and photochemical water splitting) will produce hydrogen from solar energy at low temperatures. Finally, hydrogen will be used as an "energy buffer" to balance the production and demand cycles of intermittent power sources integrating large volumes of renewable energy in the energy system.

By 2050 combined heat and power (CHP) generation and micro-CHP will become increasingly important as smart grids integrate a large number of distributed power generation units in "virtual plants". Ultimately, stationary fuel cells will establish themselves as the reference technology for on-demand power generation in the residential and industrial sector. Finally, fuel cell systems will allow for the best utilisation of biogas and, applied in large scale power plants, they will contribute significantly to emissions reduction.

In the transport sector, climate policy and decreasing oil reserves are expected to drive fuel diversification with biofuels and electricity increasing their market share. Commercialisation of fuel cell vehicles is now expected to start from 2015 onwards and by 2050 hydrogen will compete en masse with other zero-emission energy carriers for transport. Auxiliary Power Units (APU) operated with hydrogen or integrated reformers in long-haul trucks, ships and aircraft will complement the benefits. In parallel with the deployment of fuel cells vehicles, a delivery infrastructure will be developed based on large liquefaction units and on-site production facilities with the capability to serve mass market demands. A network of pipelines and related facilities, partly based on the existing natural gas network, will connect large-scale production sites and decentralised production facilities with their customers.

Achieving this long-term vision for fuel cells and hydrogen will require the successful implementation of the MAIP, including the identification of future RTD needs and planning for further activities, as well as the leverage of resources from the national/regional programmes of the different EU Member States and Associated Countries and from other external sources (e.g. Risk Sharing Financial Facility). This requires a continuation of the current efforts in the timescales of 2013 to 2020 and beyond.

3.14 Interface with other EU policies

The EU 2020 Strategy[2] puts forward the priorities for a smart, sustainable and inclusive growth and proposes a number of EU headline targets as well as a wide range of actions at national, EU and international levels necessary to underpin them. Tackling the challenges of resource efficiency, climate change and energy security is one of the core objectives of the EU 2020 Strategy, which will be mainly addressed by two major EU Flagship Initiatives, namely the "*Resource efficient Europe*"[3] and the "*Innovation Union*"[4].

The portfolio of energy technologies needed to achieve these objectives has already been identified and agreed in the Strategic Energy Technology Plan (SET Plan)[5]. This Plan sets out a long-term energy research, demonstration and innovation agenda for Europe to make low carbon technology fully cost-competitive, more efficient and proven at the right scale for market roll-out. It will be implemented mainly through the European Industrial Initiatives (EIIs) and the Joint Programmes of the European Energy Research Alliance (EERA). The relevant role of the SET Plan is highlighted in the Communication on "*Energy 2020 - A strategy for competitive, sustainable and secure energy*"[6] and the importance of its implementation has been confirmed by the Heads of State and Government on 4 February 2011[7].

Fuel Cells and Hydrogen (FCH) are part of the portfolio of technologies identified in the SET Plan for which their contribution is expected on the medium and long-term (see section 3.13). The FCH Joint Undertaking (FCH JU) is one of the above-mentioned EIIs and will interact and keep regular contacts with the other EIIs in order to explore potential synergies and complementarities and to optimise resources. Also it will be critical that the results and achievements

[2] http://europa.eu/press_room/pdf/complet_en_barroso___007_-_europe_2020_-_en_version.pdf
[3] http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf
[4] http://ec.europa.eu/commission_2010-2014/geoghegan-quinn/headlines/documents/com-2010-546-final_en.pdf
[5] http://ec.europa.eu/energy/technology/set_plan/doc/2009_comm_investing_development_low_carbon_technologies_en.pdf
[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0639:FIN:EN:PDF
[7] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/119175.pdf

delivered by the FCH JU are assimilated and used to inform and support policy and vice versa. To that end, the FCH JU bodies, in coordination with the relevant Commission Services, should explore possible ways and allocate resources to develop the necessary "interface mechanisms" between the FCH JU and the concrete EU initiatives and policies that will stem from the EU 2020 Strategy, particularly in key areas such as transport, environment and industrial competitiveness.

In particular, having regard to the potential future role of hydrogen as a substitute for oil in transport, appropriate links should be established with the forthcoming Strategic Transport Technology Plan, the Clean Transport Systems initiative, the Trans-European Networks for Transport initiative, and actions arising from the White Paper entitled "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system"[8] - to assure a consistent refuelling infrastructure build-up and address the White Paper goals for phasing out conventionally fuelled cars in cities by 2050 and essentially CO_2-free logistics major urban centres by 2030.

4. Implementation of the JTI

4.1. FCH JU Budget

The FCH Joint Undertaking shall be jointly funded by the Members through financial contributions paid in partial instalments, and in-kind contributions from legal entities participating in the activities. The FCH JU is established for the period 2008 – 2017. Funding from the Commission will come from the FP7 that ends in 2013. However, projects can start in 2013 and be terminated in 2017 at the latest, and funding will then be reserved up to and including 2017.

4.1.1 Running costs

The total running costs of the FCH Joint Undertaking shall not exceed 40 M€. This amount corresponds to the 2008-2017 period and shall be covered in cash 6/12 by the Industry Grouping (NEW IG), 5/12 by the Community and 1/12 by the Research Grouping (N.ERGHY).

Running costs will cover administrative expenditures such as staff costs, rental of building, equipment, IT equipment and maintenance, evaluation costs, meetings, etc.

4.1.2 Operational costs

The operational costs of the FCH Joint Undertaking will be covered through the financial contribution of the Community (450 M€ over the 2008-2017 period), and through in-kind contributions from the legal entities participating in the activities. The contribution from these legal entities (except the JRC)[9] shall at least match the Community's contribution.

The level of the in-kind contributions, calculated on a yearly basis, shall be assessed once a year. The methodology for evaluating contributions in kind shall be defined by the FCH Joint Undertaking in compliance with its financial rules and based on the Rules for Participation of the Seventh Framework Programme.

[8] Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system COM(2011)144 final, 28/3/2011

[9] In accordance with the Council Regulation (EU) No 1183/2011 of 14 November 2011 amending Regulation (EC) No 521/2008 setting up the Fuel Cells and Hydrogen Joint Undertaking.

4.2 Calls for proposals

The FCH JU supports RTD activities following open and competitive calls for proposals, independent evaluation, and the conclusion for each selected project of a Grant Agreement and a Consortium Agreement.

Indicative budget for each annual call for proposals are:

2008	27.2 M€
2009	72.5 M€
2010	91.4 M€
2011	109 M€
2012	73.8 M€
2013	80.9 M€

4.2.1 Submission and evaluation procedure

Applications to the FCH JU for financial support for RTD activities will be made following competitive calls for proposals. The evaluation, selection and award procedures are described in the document "FCH JU - Rules for submission of proposals, and the related evaluation, selection and award procedures".

The evaluation criteria (including weights and thresholds) and sub-criteria, together with the eligibility, selection and award criteria, for the different funding schemes are set out in the document "Evaluation criteria and procedures" chapter in each Annual Implementation Plan and call.

Proposals will not be evaluated anonymously.

Ranked lists of proposals will be established for each application area. Proposals from different topics, within the same application area, with equal overall scores will be prioritised according to the overall FCH JU Annual Implementation Plan coverage.

Proposals for the same topic with equal overall scores will be prioritised according to their scores for the S/T Quality criterion. If they are still equal, they will be prioritised according to their scores for the Impact criterion.

A reserve list will be constituted if there is a sufficient number of good quality proposals, which will be taken into consideration if budget becomes available.

4.2.2 Consortium Agreement

The legal entities wishing to participate in a project shall form a consortium and appoint one of its members to act as its coordinator. As a general rule, the coordinator should come from the Industry Grouping or from the Research Grouping. Any exception to this rule will have to be justified.

The consortium members shall jointly prepare a consortium agreement which shall provide *inter alia* for IPR rules, rules on legal liability of the members and procedures for conflict resolution in the event of dispute.

4.2.3 Grant Agreement and forms of grants

The FCH JU financial contribution will be given as a grant to the beneficiaries. The contribution will depend on the funding scheme, activity, nature of the beneficiary and type of cost. The reimbursement rules will be specified in detail in the Call for proposals.

The Grant Agreement will:

- Govern the relationship between the consortium and the FCH JU.
- Provide appropriate provisions for the implementation of the RTD activities and support actions,
- Ensure that appropriate financial arrangements and rules are in place relating to the intellectual property rights policy and,

the RTD activities shall be financed through a financial contribution from the FCH JU and through in-kind contributions from the legal entities participating in the activities. The overall industry contribution shall at least match the Community financial (cash) contribution.

4.2.4 Requirements for participation

Participation in projects shall be open to all legal entities and international organisations once the minimum conditions have been satisfied.

The minimum conditions for projects funded by the FCH Joint Undertaking are:

(a) At least three legal entities must participate, each of which must be established in a Member State or Associated country, and no two of which may be established in the same Member State or Associated country;

(b) All three legal entities must be independent of each other as defined in Article 6 of the Rules of Participation of the Seventh Framework Programme;

(c) At least one legal entity must be a member of the Industry Grouping or the Research Grouping.

The minimum condition for service and supply contracts, support actions, studies and training activities funded by the FCH Joint Undertaking is the participation of one legal entity. The funding schemes and maximum reimbursement rates for projects funded through the FCH JU are specified in the FCH JU Grant Agreement.

4.2.5 Funding from the FCH JU and the matching principle

The financial contribution from the FCH JU will, as already mentioned, depend on the funding scheme, activity, nature of the beneficiary and type of cost. The contribution may also depend on the estimated in-kind contribution from the participating beneficiaries in the projects.

According to the matching principle, the industry in-kind contribution (i.e. total eligible costs for industry minus FCH JU contribution paid to industry for projects) must equal or surpass the contributions paid by the FCH JU to all participants in these projects.

If reductions in funding rates are needed to comply with the above matching principle (also referred to in Art. 12 (3) of the FCH JU Statutes) these shall be fair and balanced proportionally for all categories of participants in each individual project.
These provisions will be detailed in the FCH JU Annual Implementation Plans and further developed in the corresponding model Grant Agreement.

5. FCH JU Bodies

5.1 Governing Board

The Governing Board is the main decision making body of the FCH JU. It shall have the overall responsibility for the operations of the FCH JU and shall oversee the implementation of its activities in accordance with Article 5 of the Statutes.

The Governing Board shall be composed of six representatives of the IG, five of the EC and one of the RG.

The Governing Board was established at its first meeting on 14 July 2008.

5.2 FCH States Representatives Group

The FCH States Representatives Group (SRG) consists of one representative of each Member State and of each country associated with the 7th Framework programme. Its first meeting took place on December 16, 2008.

According to Article 9 of the Statutes, the SRG shall have an advisory role to the JU and shall act as an interface between the FCH JU and the relevant stakeholders within their respective countries. It shall in particular review information and provide opinions on the following issues:

(a) Programme progress in the FCH JU;

(b) Compliance and respect of targets;

(c) Updating of strategic orientation;

(d) Links to Framework Programme Collaborative Research;

(e) Planning and outcome of calls for proposals and tenders;

(f) Involvement of SMEs.

It shall also provide input to the JU on the following:

(a) Status and interface of JU activities with relevant national research programmes and identification of potential areas of cooperation;

(b) Specific measures taken at national level with regard to dissemination events, dedicated technical workshops and communication activities.

The FCH States Representatives Group may issue, on its own initiative, recommendations to the FCH JU on technical, managerial and financial matters, in particular when these affect national interests. The FCH JU shall inform the FCH States Representatives Group of the follow-up it has given to such recommendations. The Chairperson of the FCH SRG will attend the meetings of the Governing Board as an observer.

5.3 Scientific Committee

The Scientific Committee is an advisory body to the Governing Board.

The members shall reflect a balanced representation of world class expertise from academia, industry and regulatory bodies. Collectively, the Scientific Committee members shall have the scientific competencies and expertise covering the technical expertise needed to make strategic science-based recommendations. It shall have a maximum of 9 members.

According to Article 8 of the FCH JU Statutes, the role of the Scientific Committee is to:

(a) Advise on the scientific priorities for the Annual and Multiannual Implementation Plans proposal;

(b) Advise on the scientific achievements described in the Annual activity report;

(c) Advise on the selection of independent experts.

The Governing Board established the specific criteria and selection process for the Scientific Committee in December 2008. In the selection of members, the Governing Board took into account candidates proposed by the FCH States Representative Group.

The first meeting of the SC took place on 9 March 2009.

5.4 Stakeholder's General Assembly

The Stakeholders' General Assembly (SGA) has an advisory role to the FCH JU. It is open to all public and private stakeholders, international interest groups from Member States, Associated countries as well as from third countries.

The Stakeholders' General Assembly shall be informed of the activities of the FCH JU and shall be invited to provide comments.

The Stakeholders' General Assembly is an important communication channel to ensure transparency and openness of the FCH JU activities with its stakeholders. It shall be convened once a year. The first Stakeholder's General Assembly was held in Brussels on 14-15 October 2008.

5.5 Executive Director and Programme Office

5.5.1 Executive Director

The Executive Director is the legal representative of the FCH JU. Mr Bert De Colvenaer, was appointed as permanent Executive Director by the Governing Board on 15 June 2010 and took up duty on 1 September 2010. He shall be the chief executive responsible for the day-to-day management of the FCH JU in accordance with the decisions of the Governing Board. The Executive Director shall be supported by the staff of the Programme Office.

An Interim Executive Director was appointed by the Commission to fulfil the functions of the Executive Director until he took up his duties. He was supported by a number of Commission officials to ensure that the FCH JU carried out its activities efficiently during this period..

5.5.2 Programme Office

The Programme Office shall, under the responsibility of the Executive Director, execute all responsibilities of the FCH JU. The Programme Office will in particular:

- Monitor, regularly review and update the MAIP, based on programme achievements and information gained from benchmarks and global developments to ensure it has the proper scope and balance of activities and achievable targets from a European perspective. See section 3.3 and 3.4 – RTD priorities.
- Create synergies and manage the interface with relevant national programmes, identify common interest, scope joint activities and implement them together with the national representatives, companies or research institutes and initiatives. See section 3.7 – Coordination with Member States.
- Create synergies and manage the interface with relevant regional programmes, notably with Hydrogen Regions and Municipalities Partnership (HyRaMP), identify common interests, scope joint activities and implement them together with the regional representatives, companies or research institutes and initiatives. See section 3.8 – Coordination with Regions.
- Establish and maintain high profile communication and dissemination activities to ensure public awareness and acceptance of the technologies, share and disseminate information, expertise and experience and thus establish a platform to involve all relevant stakeholder groups. See section 3.11 – Communication and dissemination.
- Identify, manage and coordinate the implementation of RCS and PNR actions needed to remove market barriers. Disseminate accurate RCS information. See section 3.4.5 – Cross Cutting Activities.
- Identify, manage and coordinate activities to remove other non-technical market barriers, facilitate market drivers and reduce critical investment risks for the industry with specific focus on SMEs. See section 3.4.5 – Cross Cutting Activities.

- Identify and manage the implementation of technology monitoring and bench mark activities including life cycle analysis and safety due diligence to assess relevance and impact of fuel cell and hydrogen technologies. See section 3.5 - Environment and sustainability.
- Identify, participate in and explore international cooperation activities to address the global dimension of the technology development and to advance programme objectives. See section 3.10 – International Cooperation Strategy.
- Establish and maintain proper risk management to identify and mitigate risks associated with programme activities and the financial administration of the JU. See section 6.2. – Management control and internal control procedure.
- Support the Bodies of the FCH JU, ensuring proper preparation and follow-up of their activities. See section 5. – FCH JU Bodies.
- Identify and manage interfaces with relevant technology platforms and activities and ensure proper coordination and collaboration. See section 3.13 – Interface with other EU policies.

5.5.3 Staff establishment plan

The staff of the FCH Joint Undertaking is described in the “Staff establishment plan” of the FCH JU.

According to the Council Regulation setting up the FCH JU, the Staff Regulations of officials of the European Communities and the conditions of employment of other servants of the European Communities will apply to the staff of the FCH JU and its Executive Director, taking into account the specificities resulting from the nature of the FCH JU as a public-private partnership.

The Executive Director shall submit a proposal to the FCH JU Governing Board for approval of the organisational structure of the Programme Office and shall organise, direct and supervise the staff to meet the objectives of the FCH JU.

The staff of the FCH JU shall consist of temporary agents (TA) and contract agents (CA) recruited for a fixed period that may be renewed once. The total period of engagement shall not exceed seven years and shall not in any case exceed the lifetime of the FCH JU.

The Programme Office will attract candidates with the required experience, qualifications and knowledge to ensure that its tasks are fulfilled to a high level of professional competence and quality.

Under the responsibility and supervision of the Executive Director, the staff shall, in particular:

- Organise and manage the competitive calls for proposals as foreseen in the Annual Implementation Plans, including the evaluation, and selection of the project proposals with the assistance of independent experts, negotiate the selected proposals and the follow-up and administer the resulting Grant Agreements.
- Monitor and manage scientific, financial and administrative aspects of the operation of the FCH JU.

- Organise and manage calls for tenders for goods and services according to the financial rules of the FCH JU.
- Provide the Governing Board and all other subsidiary bodies with relevant information, documentation and logistical support.
- Prepare and update as appropriate the Multi-Annual Implementation Plan and the corresponding financial plans.
- Set up and implement management and control procedures, including financial auditing.
- Monitor scientific and industrial progress to assess the results of the JU actions towards its goals.
- Organise dissemination and communication activities of the FCH Joint Undertaking.
- Coordination of Member States, Associated Countries and Regions programmes.

6. Programme indicators

6.1 Annual activity report

The Annual Activity Report of the JU presents the progress made by the FCH JU in each calendar year. The major global scientific and industrial developments are also addressed.

It includes information on the RTD and support activities performed; management and internal control systems and the building blocks supporting the Declaration of assurance signed by the Executive Director.

The Annual Activity Report is presented by the Executive Director to the Goberning Board for its analysis and assessment.. Once approved by the Governing Board, it is made public.

6.2 Management control and internal control procedures

The FCH Joint Undertaking and its bodies shall avoid any conflict of interest in the implementation of their activities.

The FCH Joint Undertaking adopted its specific financial rules in accordance with Article 185 (1) of the Council Regulation 1605/2002, which departed from the framework Financial Regulation in cases where the specific operating needs of the FCH Joint Undertaking so required and were subject to prior consent of the Commission.

The FCH Joint Undertaking established its own internal audit capability according to the Council Regulation (EC) No. 521/2008 setting up the JU (art 6.2) and the financial rules of the JU (art 38.4). The Commission's Internal Audit Service was entrusted the functions indicated by Article 185(3) of Regulation (EC, EURATOM) No.1605/2002 under the responsibility of the Governing Board.

The FCH JU shall protect the financial interests of the members and implement anti-fraud measures. In particular, the FCH Joint Undertaking shall ensure that the financial interests of its members are adequately protected by carrying out or commissioning appropriate internal and external controls.

In the case of irregularities committed by the FCH Joint Undertaking or its staff, the members shall reserve the right to recover any amount unduly spent, including by a reduction or suspension of subsequent contributions to the FCH JU.

For the purposes of combating fraud, corruption and other illegal acts, Regulation (EC) No 1073/1999 shall apply.

The FCH Joint Undertaking shall also carry out on-the-spot checks and financial audits among the recipients of the FCH Joint Undertaking's public funding.

The Commission and/or the Court of Auditors may, as necessary, also carry out on-the-spot checks among the recipients of the FCH Joint Undertaking’s funding and the agents responsible for its allocation. To that end, the FCH Joint Undertaking shall ensure that grant agreements and contracts provide for the right of the Commission and/or the Court of Auditors to carry out, on behalf of the FCH Joint Undertaking, the appropriate controls and, in the event of the detection of irregularities, to impose dissuasive and proportionate penalties.

7. Definitions & Abbreviations

Term	Definition
AA	Application Area i.e. T, H, S, E and C
AIP	Annual Implementation Plan
APU	Auxiliary Power Unit
BoP	Balance of Plant
BR **Long-term and break-through oriented research**	Activities addressing basic scientific fundamentals related to critical barriers and/or open up new pathways for technology, product and manufacturing improvements in the long run
BTH	Biomass-to-hydrogen (reforming processes)
CA	Contract Agent
CHP	Combined Heat & Power
EC	European Commission
EII	European Industrial Initiative
Demonstration	Activities for a given technology and/or infrastructure comprising all or some elements of: 1) Validation/field testing of prototype/pilot systems including feedback to RTD, proof of safety aspects, functional and endurance testing under real-life conditions. 2) Market preparation demonstrating relevant numbers of application ready products, aiming at infrastructure development and expansion, customer acceptance and development of RCS, economic assessment, attraction of capital investment and achieving target costs for commercial deployment
Deployment	Activities for a given technology and/or infrastructure from its market introduction to its widespread use
Early Markets	Short-term markets encompassing a group of applications for which products can be commercially deployed within the 2007-2013 timeframe.
FCH	Fuel Cells & Hydrogen
FCH JU, JU	The FCH Joint Undertaking: name used to refer to the legal entity established as the public & private partnership. It may also be referred

	to as the JTI
FP7	The Seventh Framework Program of the EC for Research & Technological development (2007-2013)
HFP	The European Hydrogen and Fuel Cell Technology Platform
HyRaMP	Hydrogen Regions and Municipalities partnership
IG	European Industry Grouping for a Hydrogen and Fuel Cells JTI also referred to as "Industry Grouping" or NEW IG".
ILCD	International Reference Life Cycle Data System, set of technical guidance documents supporting good practice in Life Cycle Assessment
IP	Implementation Plan
JRC	Joint Research Centre of the Commission
JTI	Joint Technology Initiative - referring to the political research initiative introduced by the EC in the FP7. The Term JTI may also be used to referred to the legally established structure implementing the initiative (cf. above FCH JU)
LCA	Life-Cycle Assessment
MAIP	Multi-Annual Implementation Plan
MCFC	Molten Carbonate Fuel Cell
Members	The term "members" refers to the founding members of the FCH JU (EC & IG) and the Research Grouping, as the case may be.
MEA	Membrane Electrode Assembly
MS **Member States**	The "Member States" shall be understood as the EU-27 Members States. If not stated clearly in the document, the term "Member States" can also refer to countries associated to the FP7 (named "Associated Countries" in the current document). It may also be referred to as "MS"
PEMFC	Polymer Electrolyte Membrane Fuel Cell
PNR	Pre-normative Research, R&D work that addresses technical knowledge gaps in the development of RCS
RCS	Regulations, Codes and Standards
RG	European Research Grouping for a Hydrogen & Fuel Cells JTI, also referred to as " Research Grouping" or "N.ERGHY"
RTD Research and technological development	Activities that directly support the development, operation and commercialisation of products within the duration of the program
S/T Quality criteria	Scientific and technological quality criteria (to evaluate a proposal)
SET Plan	Strategic Energy Technology Plan, see COM(2007) 723 Final
SGA	Stakeholders General Assmbly see section 5.4
SME	Small and Medium size Enterprise
SOFC	Solid Oxide Fuel Cell
SRG	States Representative Group, advisory body of the FCH JU gathering representatives from Member States and Associated Countries
Stakeholders	The term "Stakeholders" embodies any public or private actors with interests in FCH activities from the MS or third countries. It shall not be understood as “partners" or "members" of the FCH JU
TA	Temporary Agent
TMA	Technology Monitoring Assessment
UPS	Uninterruptabe power supply

Annex 1 Extended Target Tables.

AA1 Transportation and refueling - Targets

Application	Technology/Size	Cost/Volume Target							
		Cost component / system			Remarks	Volume in the European market			Remarks
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
Road vehicles	Vehicle	0.5 M€	< 50K€	<30K€	mid size passenger car	> 100	> 5000	500,000	Cumulative numbers Significant market incentives required, to achieve these numbers FCH JU budget by far not sufficient, strong additional efforts and support by government organizations needed on an European and national/regional level.
	PEM-FC System	>1000€/kW	100€/kW	50€/kW					
Buses	Vehicle	< 2 M€	< 1 M€	< 500K€		> 10	500	1000	
	PEM-FC System	>3500€/kW	<3500€/kW	< 400 €/kW					
Hydrogen Refueling Stations (70MPa road vehicles, excl. production/distribution)	Very small (50-80 kg/day)	<1 M€	<0,6 M€	-	*Station price differers from hydrogen supply method. The upper range of price targets are shown.*	<75	<300	>2000	
	Small (200 kg/day)	<1,5 M€	<1 M€	<0,6 M€					
	Medium (400 kg/day)	<2 M€	<1,5 M€	<0,9 M€					
	Large (1000 kg/day)	<3 M€	<2,5 M€	<1,6 M€					
	Very Large (2500 kg/day)	-	-	<2,8 M€					
APU for truck applications	System, 5kW	3,000 €	1,000 €	500 €	Volume production of 500000				
APU for aircraft applications	System 20-120kW			500 €/kW	(IP 2006 value)	test units only	flight validation supply	early operation (hundreds)	
APU for maritime applications	50-500 kW		3000-4000 €/kW	<2000 €/kW	Current baseline single unit prototype costs, very case dependent	single demonstrations	some tens	hundreds	Current demos include at least 1 by Wärtsilä and 1 by MTU

AA1 Transportation and refueling – Targets II

Application	Technology/Size	Technical target							
		Efficiency / energy consumption			Remarks	Durability / Reliability			Remarks
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
Road vehicles	Vehicle	1kg/100km	0.9kg/100k	0.85					
	PEM-FC System					2000h	5000h	5000h	
Buses	Vehicle	8 - 15 kg/100km	< 12kg/100km	< 10kg/100km					
	PEM-FC System					10000h	12000h	20000h	Two approaches are being developed for fuel cell bus stacks, one with dedicated long life stacks for buses where stack lives over 20,000 hours are expected. The other involves automotive stacks where shorter warranties will be more likely, but with reduced stack replacement costs.
Hydrogen Refueling Stations (70MPa road vehicles, excl. production/distribution)	Very small (50-80 kg/day)								
	Small (200 kg/day)								
	Medium (400 kg/day)								
	Large (1000 kg/day)								
	Very Large (2500 kg/day)								
APU for truck applications	System, 5kW	20%	25%	30%		12000h	20000h	20000h	
APU for aircraft applications	System 20-120kW	50%	50%	50%	H2 fed system	1500-2000	3000h	10000h	High reliability and very high MTBF rates as critical as system lifetime
APU for maritime applications	50-500 kW	42%	50%	55%	Efficiency based on LNG (current baseline w/ methanol). ~0.75 de-rating should diesel be used	20000h/3000h	40000h/4000h	80000h/7000h	System lifetime/MTBF. Additional relevant parameter service interval of 1-2 years

AA1 Transportation and refueling – Targets III

Application	Technology/Size	Technical target		
		H2 price dispensed at pump €/kg		
		Baseline 2010	Mid-term 2015	Long-term 2020
Road vehicles	Vehicle			
	PEM-FC System			
Buses	Vehicle			
	PEM-FC System			
Hydrogen Refueling Stations (70MPa road vehicles, excl. production/distribution)	Very small (50-80 kg/day)	€15-20/kg	€10-15/kg	<€5-10/kg
	Small (200 kg/day)			
	Medium (400 kg/day)			
	Large (1000 kg/day)			
	Very Large (2500 kg/day)			
APU for truck applications	System, 5kW			
APU for aircraft applications	System 20-120kW			
APU for maritime applications	50-500 kW			

AA2 Production and Distribution - Targets

H2 Energy supply chain function			Characteristics (effective)	unit	Current	Target***	
					2010	2015	2020
Production	Centralised	SMR or IGCC (CCS ready)	Capex*/capacity(1)	M€ /(t/day)	0.66	0.63	0.61
			Efficiency	%	71%	71%	72%
	Decentralized	Electrolysis from renewable electricity	Unit capacity**	t/day	1.5	1.5	3.0
			Capex*/capacity**	M€ /(t/day)	3.1	2.6	1.9
			Efficiency	%	65%	68%	70%
		Biogas SMR (incl. purification) (ref: Waste Water Treatment Plant)	Unit capacity**	t/day	1.5	1.5	3.0
			Capex*/capacity**	M€ /(t/day)	4.2	3.8	2.5
			Efficiency	%	64%	64%	67%
		Total installed production capacity (from renewable)		ton/day			460(2)
	Fraction of cumulated H2 consumption in FCH JU demo projects from carbon lean sources			%		20%	
Stationary storage (of H2 from renewable electricity)	Centralized	In underground cavity - compressed	Capacity/site**	t	-	4,000	n.a.
			Capex*/capacity**	M€ /t	-	0.006	n.a.
	Decentralized (above ground)	Compressed	Capacity/site**	t	0.80	5.00	10.00
			Capex*/capacity	M€ /t	0.50	0.45	0.40
		In solid materials	Capacity/site**	t	3.00	5.00	10.00
			Capex*/capacity	M€ /t	5.00	1.50	0.83
	Total installed storage capacity of H2 from grid			t			580(3)
Distribution	Road transport	High capacity compressed H2 trailer	Capacity	t	0.6	1.3	1.6
			Capex/capacity	M€/t	0.55	0.55	0.40

*fully installed ; ** high end of size range ; *** in industrial operating conditions

(1) Including CCS readiness but excluding CCS systems - assuming a capacity of 200 t/d

(2) 2020 target is derived from the objective of a 10% share of renew able energy in transport sector's energy mix, optimistically assuming that 8% w ill be achieved w ith bio-fuels, leaving 2% to be achieved by electric vehicles (battery or FC) - w ith 20% margin betw een capacity and yearly production

(3) Total storage capacity equivalent to 3 days of consumption by transport

AA3 Stationary -Targets

Application/power range	FC tech.	Cost/Volume Target							
		Cost system € /kW			Remarks	Volume in the European market			Remarks
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
Small Scale - Domestic 1 - 5 kWe	Single home residential CHP system			2,000€/kW	Complete CHP System; production volume from 2015 onwards; PEMFC and SOFC system costs will vary; Larger units for mulitple family homes will be less expensive per kWe		1,000 units	20,000 units	Dependent upon support for deployment; costs = function of numbers deployed and 'production volumes' achieved from 2015 onwards.
Small Scale - Commercial 5 - 50kW	Commercial CHP system		4000 €/kW	2000 €/kW	Complete PEM/SOFC CHP system for commercial use		100+ units	50,000 units	Minimum numbers for deployment mid-2015
Mid Scale - Commercial < 300kW	Commercial CHP System		<4000 €/kW	<2000 €/kW	Complete PEM/SOFC CHP system for commercial use				Volumes uncertain
Large Commercial/Industrial Scale - >300kW to < 5MW Note different technologies have differing capabilities and hence are suitable for different applications (Note variants may include RES, Waste to energy plants, plus others)	MCFC system	8000 €/kw	4000 €/kw	2000 €/kw	Commercial CHP system; Assumed production volume from 2016		20 MW	70 MW	Sales volume per year (expressed as MW of sales rather than unit numbers)
	PEMFC system	4500 €/kW	3000 €/kW	1500 €/kW		1 MW	5 MW	50 MW	Sales volume per year (expressed as MW of sales rather than unit numbers)
	AFC system		850 €/kW	600 €/kW	Excludes cost of inverters and related control equipment		2.5 MW	20MW	Current target numbers
	SOFC system		<4000 €/kw	<2000 €/kw	Assumes production volumes beyond 2020				

AA3 Stationary – Targets II

Application/power range	**FC tech.**	**Technical target**							
		Efficiency el. (LHV based)/efficiency overall			**Remarks**	**Durability / Reliability**			**Remarks**
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
Small Scale - Domestic 1 - 5 kWe	Single home residential CHP system		35% to 45% (elec) 75% to 85% total	40% to 50% (elec) 80% to 90% total	For complete CHP system; actual efficiencies will vary between PEMFC and SOFC and on the type of fuel used eg NG or H2.			30,000hrs	Must sustain repeated on/off cycling / > 20,000 hrs enable mass market diffusion
Small Scale - Commercial 5 - 50kW	Commercial CHP system		55%+ (elec) 85%+ (total)	60%+ (elec) 90%+ (total)	Complete SOFC CHP system for commercial use, natural gas fuel			30,000 hrs	Must sustain repeated on/off cycling / > 20,000 hrs enable mass market diffusion
			35% to 45% (elec) 80% to 90% total	40% to 50% (elec) 85% to 95% total	Complete PEM CHP system for commercial use, natural gas fuel				
Mid Scale - Commercial < 300kW	Commercial CHP System		55%+ (elec) 85%+ (total)	60%+ (elec) 90%+ (total)	Complete SOFC CHP system for commercial use, natural gas fuel			40,000 hrs	
			35% to 45% (elec) 80% to 90% total	40% to 50% (elec) 85% to 95% total	Complete PEM CHP system for commercial use, natural gas fuel				
Large Commercial/Industrial Scale - >300kW to < 5MW	MCFC system	42% (elec)	47% (elec)	52% (elec)	Natural gas fuel.	15,000 hrs	30,000 hrs	40,000 hrs	Stack lifetime
Note different technologies have differing capabilities and hence are suitable for different applications	PEMFC system	50% (elec)	55% (elec)	55% (elec)	Natural gas fuel ?	8,000 hrs	20,000 hrs	40,000 hrs	Stack lifetime
(Note variants may include RES, Waste to energy plants, plus others)	AFC system		58% (elec)	58% (elec)	Hydrogen as fuel ie no losses for fuel cleaning and reformation		16,000 hrs		Lifetime of 80,000 hrs being sought, with stack reconditioning
	SOFC system	50% (elec)	55% (elec)	>60% (elec)	Natural gas and biogas as fuels	10,000hrs	20,000 hrs	40,000hrs	Stack lifetime

AA4 Early Markets - Targets

Power range	**Application**	**Cost/Volume Target**							
		Cost component / system € /kW			**Remarks**	**Volume in the European market (nr deployed/production capacity)**			**Remarks**
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
kW Fuel Cells (>1 kW)	**Heavy duty Material Handling (8-15 kW)**	<3,500 €/kW	<1,500 €/kW	<1,000 €/kW	*Per complete system including hydrogen storage, anticipating supported deployment from 2013+ & commercial introduction beyond 2015+*	<50 units	>1,500 units	>20,000 units	*Accumulated volume, ainticipating supported deployment from 2013+ & commercial introduction beyond 2015+*
	Light duty material handling (x-x kW)	<10000-4000 €/kW	<7000-2000 €/kW	<6000-1500 €/kW	*Per complete system including hydrogen storage*	10 units (prototypes)	15000/7000	60000/13000	*Deployed*
	1-6 kW back-up power system (targets in bracket is including electrolyser)	5,000 €/kW (N/A)	1,500 €/kW (2500 €/kW)	800 €/kW (1,200 €/kW)	*Assumed production volume from 2015*	150 units (N/A)	8,000 units (1,000)	15,000 units (4,000)	*10% market share*
	7-12 kW back-up power system (targets in bracket is including electrolyser)	5,000 €/kW (N/A)	1,300 €/kW (2,200 €/kW)	700 €/kW (900 €/kW)	*Assumed production volume from 2015*	20 units (N/A)	1,000 units (600)	4,000 units (1,000)	
Small-Micro Fuel Cells - hydrogen-based - (<1 kW)	**Small (<500-1,000 W)**	8,000	3,000	<1,000		100	>5,000	>20,000	Deployed
	Mini (50 - 500 W)	7,500	4,500	2,700		100	10,000	100,000	Deployed
	Micro (<50 W)	10,000	6,000	3,600		100	10,000	100,000	Deployed
Small-Micro Fuel Cells - logistic non-hydrogen fuel - (<1 kW)	**Small (<500-1.000 W)**	20,000	10,000	5,000		150	2,000	20,000	Deployed
	Mini (50 - 500 W)	30,000	24,000	19,200		2,000	3,000	4,000	Deployed
	Micro (<50 W)	50,000	40,000	32,000		2,000	3,000	4,000	Deployed

AA4 Early Markets – Targets II

Power range	Application	Technical target								
		Efficiency / energy consumption			Remarks	Durability / Reliability			Remarks
		Baseline 2010	Mid-term 2015	Long-term 2020		Baseline 2010	Mid-term 2015	Long-term 2020	
kW Fuel Cells (>1 kW)	**Heavy duty Material Handling (8-15 kW)**	0.45 kg H2	0.4 kg H2	<0.35 kg H2	*Consumption per VDI duty hour*	>5,000 h	>10,000 h	>15,000 h	*System lifetime, with regular servicing and stack refurbishment*
	Light duty material handling (x-x kW)	45%	50%	55%	Tank-to-Whell efficiency fuel cell system	4000 hours	10000 hours	20000 hours	*System lifetime*
	1-6 kW back-up power system (targets in bracket is including electrolyser)	N/A (20%)	N/A (30%)	N/A (35%)	*For fuel cell only reliability is more important than efficiency. With electrolysers efficiency is relevant.*	2,000 h (same)	10,000 h (same)	15,000 h (same)	*Data refers to MTBF(Mean Time Between Failure Indicator)*
	7-12 kW back-up power system (targets in bracket is including electrolyser)	N/A (20%)	N/A (30%)	N/A (35%)	*For fuel cell only reliability is more important than efficiency. With electrolysers efficiency is relevant.*	2,000 h (same)	10,000 h (same)	15,000 h (same)	*Data refers to MTBF(Mean Time Between Failure Indicator)*
Small-Micro Fuel Cells - hydrogen-based - (<1 kW)	**Small (<500-1.000 W)**					1,000	2,000	5,000	System lifetime
	Mini (50 - 500 W)	50	50	50		2,000	4,000	7,000	System lifetime
	Micro (<50 W)	50	50	50		2,000	4,000	7,000	System lifetime
Small-Micro Fuel Cells - logistic non-hydrogen fuel - (<1 kW)	**Small (<500-1.000 W)**	30	35	40	SOFC technology promises much higher efficienc than DMFC technology	4,000	10,000	15,000	SOFC technology promises much higher efficienc than DMFC technology
	Mini (50 - 500 W)	18	20	22	assumed efficiency for DMFC technology might be overriden by coming SOFC technology	2,000	4,000	7,000	assumed efficiency for DMFC technology might be overriden by coming SOFC technology
	Micro (<50 W)	18	20	22	assumed efficiency for DMFC technology might be overriden by coming SOFC technology	2,000	4,000	7,000	assumed efficiency for DMFC technology might be overriden by coming SOFC technology

AA4 Early Markets – Targets III

Power range	Application	Additional targets			
		Hydrogen price nessesary			**Remarks**
		Baseline 2010	Mid-term 2015	Long-term 2020	
kW Fuel Cells (>1 kW)	**Heavy duty Material Handling (8-15 kW)**	10-12 €/kg	8-10 €/kg	5-8 €/kg	*End-user price dispensed at pump (35MPa)*
	Light duty material handling (x-x kW)	12€/kg	10€/kg	8€/kg	End-user price dispensed at pump (35MPa)
	1-6 kW back-up power system (targets in bracket is including electrolyser)				
	7-12 kW back-up power system (targets in bracket is including electrolyser)				
Small-Micro Fuel Cells - hydrogen-based - (<1 kW)	**Small (<500-1.000 W)**				
	Mini (50 - 500 W)				
	Micro (<50 W)				
Small-Micro Fuel Cells - logistic non-hydrogen fuel - (<1 kW)	**Small (<500-1.000 W)**				
	Mini (50 - 500 W)				
	Micro (<50 W)				